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Nurse Staffing and Patient Outcomes [Articles]

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Abstract TOP

Background: Nursing studies have shown that nursing care delivery changes affect staff and organizational outcomes, but the effects on client outcomes have not been studied sufficiently.

Objective: To describe, at the level of the nursing care unit, the relationships among total hours of nursing care, registered nurse (RN) skill mix, and adverse patient outcomes.

Methods: The adverse outcomes included unit rates of medication errors, patient falls, skin breakdown, patient and family complaints, infections, and deaths. The correlations among staffing variables and outcome variables were determined, and multivariate analyses, controlling for patient acuity, were completed.

Results: Units with higher average patient acuity had lower rates of medication errors and patient falls but higher rates of the other adverse outcomes. With average patient acuity on the unit controlled, the proportion of hours of care delivered by RNs was inversely related to the unit rates of medication errors, decubiti, and patient complaints. Total hours of care from all nursing personnel were associated directly with the rates of

Article Outline

decubiti, complaints, and mortality. An unexpected finding was that the relationship between RN proportion of care was curvilinear; as the RN proportion increased, rates of adverse outcomes decreased up to 87.5%. Above the level, as RN proportion increased, the adverse outcome rates also increased.

Conclusions: The higher the RN skill mix, the lower the incidence of adverse occurrences on inpatient care units.

Concern for the effect of nurse staffing on the quality of patient care guided early nursing research. In **1960, Safford and Schlotfeldt** reported that the results of their field experiment supported the hypothesis: "quality of nursing care would decrease as nurses' responsibilities were increased through the assignment of additional patients" (1960, p. 152). **Aydelotte and Tener (1960)** did not find an increase in patient welfare, in general, when the number of professional nurses was increased, although they did find a small decrease in patient complaints. **Abdellah and Levine (1958)** found that patient satisfaction was higher when the professional nursing care hours were higher, but patient satisfaction was lower when the total nursing hours were higher but professional hours were lower. Forty years later, nurses continue to be concerned about optimal staffing levels.

In response to the concern for controlling the costs of health care, there is a trend to use fewer nursing care personnel or personnel with less training (who cost less). The main argument against this approach is that the quality of patient care will decline if the numbers and training of nursing caregivers decrease. **Prescott (1993)** concluded after an extensive review of the literature that cost-reducing measures should not target the nursing staff, who improve quality, but other sources of high cost such as overuse of technology. Other reviews of the literature concluded that nursing studies have shown that nursing care delivery changes affect staff and organizational outcomes, but that the effects on client outcomes have not been studied sufficiently and that the effects on cost are equivocal**(Huston, 1996; Krapohl & Larson, 1996; Verran, 1996)**.

The Institute of Medicine (IOM) committee on the Adequacy of Nurse Staffing recently concluded, after soliciting testimony, commissioning reports from experts, and reviewing current research, that:
...literature on the effect of [registered nurses (RNs)] on mortality and on factors affecting the retention of RNs is available. But there is a serious paucity of recent research on the definitive effects of structural measures, such as specific staffing ratios, on the quality of patient care in terms of patient outcomes when controlling for all other likely explanatory or confounding variables(**Wunderlich, Sloan, & Davis, 1996**, pp. 121).

Nursing care is a key factor in the outcomes of hospitalized patients, but patient outcomes are also affected by care from other disciplines, the severity and complexity of the patient's condition, other characteristics of the patients, and the work environment. Systematic research addressing these issues has been conducted but suffers from several shortcomings in regard to the relationship of nursing care to patient outcomes.

The relationships between nurse staffing and patient outcomes found in large multi-institutional studies have been relatively low, sometimes reaching the level of statistical significance and sometimes not. Many of the studies used data gathered by the Health Care Financing Administration (HCFA) and the American Hospital Association (AHA). **Aiken, and Lake (1994); Hartz et al. (1989); and Scott, Forrest, and Brown (1976)**(AHA). found a negative and statistically significant relationship between nursing care intensity and patient mortality rates. That is, the higher the nurse staffing, the lower the mortality rate. The Aiken et al. study used 1988 HCFA and AHA data for 39 "magnet" hospitals and 5 sets of 39 control hospitals. Magnet hospitals had lower mortality rates and higher skill mix than the control hospitals. The Hartz study examined 30-day mortality rates from 3,100 hospitals and reported that lower mortality rates were related to several factors including a higher skill mix for the nursing staff. Surgical patients from 17 hospitals were included in the Scott et al. study, and both mortality and severe morbidity were included as adverse outcomes. Both a higher RN ratio and longer tenure of RNs were associated with better outcomes.

Three studies of patient outcomes across institutions did not find statistically significant effects for nurse staffing levels. **Al-Haider and Wan (1991) and Shortell and Hughes (1988)** used HCFA data to study

hospital characteristics associated with patient mortality rates. Both found that the proportion of the nursing staff that were RNs was unrelated to patient mortality. In contrast to the previous studies, Shortell and colleagues (1994) gathered data directly about the performance of 42 intensive care units (ICUs). They included a variety of measures of patient care quality and characteristics of the unit management. The average nurse-to-patient ratio was not related to patient outcomes. Overall, these multi-institutional studies provide only weak support for the idea that more professional nurses lead to better patient outcomes.

There are several limitations in this group of studies. First, as Jones (1993) notes, it is difficult to find standardized data that reflect outcomes specifically affected by nursing care. The research reviewed used mortality rates at the level of the hospital. Mortality is not the best indicator of the quality of nursing care; however, until nursing develops standardized databases, we must use existing data and use the indicators that are the most sensitive to nursing care.

Second, nurse staffing was measured with hospital-level ratios and included all RNs employed in all positions in the hospital whether or not they provided direct patient care. The ratio of RNs to average patient census was used in three studies (Aiken et al., 1994; Hartz et al., 1989; Shortell et al., 1994). The number of RNs as a ratio of total nursing personnel was used in three studies (Aiken et al., 1994; Al-Haider & Wan, 1991; Hartz et al., 1989); number of RNs to total hospital employees was used in one study (Shortell et al., 1994); and number of RNs in direct patient care to number of licensed practical nurses/licensed visiting nurses (LPNs/LVNs) in direct care was used in one study (Scott et al., 1976). These measures differed slightly from study to study, but only one separated the direct caregivers from the rest of the personnel and that study included only LPNs, not other assistive personnel.

Third, the level of analysis for most of these studies was the hospital level. Although these studies have been valuable, they have necessarily aggregated differing types of patients with differing levels of illness. Adjustments for patients severity were made at the level of the hospital(case-mix adjustments), but these cannot reflect severity of patients on separate nursing care units. However, the impact of nurse staffing is most direct at the nursing care unit level. Two studies did use data focusing on specific groups of patients; Scott et al. (1976) used only surgical patients and Shortell et al. (1994) used ICUs. Only the latter study was conducted at the level of the nursing care unit. As noted previously, Scott found a significant effect for nurse staffing and Shortell did not.

Other studies conducted during the last decade have contributed indirect evidence of the importance of professional nursing care to patient outcomes. Two studies of ICUs suggested that communication between nurses and physicians was crucial to the outcome of patients in ICUs (Knaus, Draper, Wagner, & Zimmerman, 1986; Mitchell, Armstrong, Simpson, & Lentz, 1989). An extensive study comparing team nursing and primary care nursing models demonstrated that quality was better and that costs were reduced with primary care (Gardner, 1991).

Reducing skill mix was a feature in several recent studies using samples of 1 to 3 nursing care units (Bostrum& Zimmerman, 1993; Grillo-Peck & Risner, 1995; Lengacher et al., 1993; Mularz, Maher, Johnson, Rolston-Blenman, & Anderson, 1995; Powers, Dickey, & Ford, 1990). Results indicated that, in general, either positive patient outcomes did not increase as expected or negative patient outcomes did increase. These small studies suggest but do not provide strong support for the idea that retaining a strong mix of professional nurses in direct care would have a positive effect on patient outcomes. In a study of downsizing in 281 hospitals, Murphy (1993) reported that those with across-the-board staffing cuts of 7.5% or more and those with 3.35 or fewer full-time equivalents (FTEs) per adjusted occupied bed had higher mortality levels.

This study extended current knowledge about the relationship between nurse staffing and patient outcomes by comparing two different measures of nurse staffing calculated at the level of the nursing care unit, by using a wider range of patient outcome indicators and by controlling for patient severity at the nursing care unit level. Specifically, the purpose of this study was to describe the relationship among (a) incidence rates of six commonly collected adverse patient outcomes, (b) the hours of care provided by all nursing personnel, and (c) the proportion of those hours of care given by RNs, controlling for the acuity of the patients on the unit. The adverse patient outcomes were medication

errors, patient falls, urinary and respiratory tract infections, skin breakdown (decubiti), patient complaints, and mortality.

Methods TOP

Data were used from each month of fiscal year (FY) 1993 (July 1992 through June 1993) for nursing care units in a large university hospital. FY 1993 was chosen because more recent data would reflect the instability of changes from restructuring efforts begun in FY 1994. All 42 inpatient units in this 880-bed hospital were used; ambulatory or outpatient clinics, operating rooms, emergency rooms, and delivery rooms were excluded. There were 21,783 discharges from these 42 units in FY 1993 and 198,962 patient days of care were provided. The units came from 8 divisions: 5 surgical, 10 medical, 3 obstetric/gynecology, 8 pediatric, 4 critical care, 4 psychiatric, 2 eye/ear/nose and urology, and 6 orthopedic and neuroscience units. Care was provided on these units by 1,074 total FTE nursing staff members; 832 of these FTE staff members were RNs.

Measures: All data came from hospital records. Nurse staffing, tenure, and patient days of care each month came from payroll and human resources databases. The quality assurance department provided the data for nursing care unit rates of medication errors, falls, decubiti, infection, and deaths. Patient complaint data were obtained from the office of patient relations. The patient acuity data used to control for severity of patient illness across units were obtained from files containing the monthly acuity system reports.

Two nurse staffing variables were included in the analyses. First, nurse staffing was included as the hours of care per patient day from all nursing personnel: All Hours = Hours of direct patient care by RNs, LPNs, and nursing assistants each month divided by the patient days of care on the unit for the month. Second, the hours of care provided by RNs was calculated using only the hours of direct patient care from RNs divided by patient days. The variable RN Proportion was then calculated as RN Hours per patient day divided by All Hours per patient day. Standardizing by patient days controlled for the size and occupancy of units. For the purpose of this study, direct patient care meant that the employee was assigned to provide care for a patient or group of patients. A record of hours worked for each individual employee was completed by the staffing clerk and approved by the employee and nurse manager before being entered into the computerized payroll database. When staff members were scheduled to attend council meetings or in-service meetings or to work on unit projects, a nonpatient-care code was entered in the record of hours worked to indicate the hours that the staff members were not involved in direct patient care. In addition, these hours of care did not include administrative or paid, nonworked time such as vacation, sick leave, and holidays.

Patient outcome variables included medication errors per 10,000 doses, patient falls, decubiti, urinary tract and respiratory infections, patient/family complaints, and death rates per 1,000 patient days. Reviewers from the quality assurance department were assigned to each inpatient area and reviewed the patient charts for decubiti and infections. These data in turn were entered into a computerized record-keeping system and verified for accuracy and duplication. Surveillance for infections and decubiti was not conducted in the psychiatric and other units with histories of low incidence; therefore, these units were not included in the analyses for infections and decubiti.

Decubiti were defined as new incidences of skin breakdown secondary to pressure or exposure to urine or feces. Infections were defined as nosocomial infections that express themselves in hospitalized patients in whom the infection was not present or incubating at the time of admission. Only urinary tract and respiratory infections were included because these are believed to be more sensitive to nursing care than other types of infections(American Nurses Association, 1995; Mark& Burleson, 1995; Taunton, Kleinbeck, Stafford, Woods, & Bott, 1994). Death rate data included all deaths, whether expected, unexpected, procedure-related, or do not resuscitate.

Patient fall and medication error data were gathered from incident reports. Patient falls were defined as suddenly and involuntarily leaving a position and coming to rest on the floor or some object. All reported falls were included whether or not injuries resulted. Medication errors included wrong dosage,

duplication, omission, transcription, wrong route, wrong patient, wrong solution, or wrong time. For this study, medication errors were standardized by the number of medication doses given on the unit each month using data from the hospital pharmacy. Medication errors then were rated per 10,000 doses administered.

Patient complaints included both patient and family complaints about aspects of the patient's care such as nursing care, medical care, food, and housekeeping. The patient representative's office received all complaints and compiled a monthly report for each unit. These reports included the number of complaints, and this number was standardized as a rate per 1,000 patient days.

To control for patient severity, nursing acuity system data were used. This institutionally standardized measure was derived from the nursing diagnoses and interventions documented online in the nursing care plan. The acuity system data came from a patient classification scale originally developed at the University Hospital, Arizona Medical Center(Hinshaw, Verran, & Chance, 1977) and adapted for use in this institution. Factors included in the classification scale were physical activity, hygiene, feeding, medications, vital signs, treatment and medical orders, physical or mental impairments, emotional components, and teaching needs. Patient acuity levels can range between 1 and 7, with 7 being the most acute or requiring the most care. Data were collected in the hospital information system on a daily basis and average daily acuity per month was reported to each nursing unit.

Procedures TOP

After approval from the Institutional Review Board, data were obtained from the hospital computer system and hard copy files and entered in a computerized database. To minimize the effect of random fluctuations from month to month, these data were aggregated to an annual rate. Although guided by previous research, the analyses were exploratory in nature and two-tailed significance tests were used. Results meeting both alpha < .05 and alpha< .10 (.05 in each tail) are indicated.

An examination of the data showed several nonlinear relationships between RN Proportion and the outcome variables. Regression analyses with a quadratic term for RN Proportion were conducted; the increase in variance, when quadratic terms were included, demonstrated that linear coefficients alone were not sufficient. Of the available options for dealing with this problem(assuming a goal of describing linear effects of the independent variables), we chose to conduct multiphase or piecewise linear regression(Hardy, 1993; Seber & Wild, 1989). In multiphase regression, dummy variables are created for the portion of the variable beyond the point where the regression line changes direction. This variable is a stand-in or proxy for an unknown factor that alters the relationship between the variables.

Results TOP

Data for each of the 42 units were obtained for staffing variables, medication errors, falls, complaints, and deaths. Data for infections and decubiti were obtained for 33 units. The mean, standard deviation, and range for each of the variables are displayed in Table 1. Units included those caring for very low acuity patients with low needs for nursing care to those with very high acuity with correspondingly high needs for nursing care. The average monthly acuity level was 4.19 in a range of 2.15 to 6.80 on the 7-point scale. All Hours of direct care per patient day ranged between 6.88 and 26, again reflecting the range of patient acuity within these units. The range of RN Proportion was 46% to 96% of all direct nursing hours per patient day, with an average of 72% across all units. Rates of adverse outcomes varied widely across the 42 units.

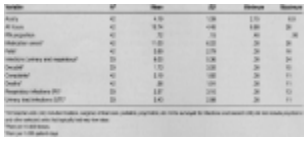

TABLE 1. Means, *SD*, and Range of Study Variables

The correlations among staffing and outcome variables are presented in Table 2. Several issues are apparent from these correlations. First, the Acuity measure and the All Hours measure are highly correlated, r = .819. This is undoubtedly owing to the use of the acuity measure to plan staffing. The patient outcome measures appear to cluster into two groups in the bivariate correlations. Rates of medication errors and falls are positively correlated with each other (.192) but negatively correlated with decubiti, complaints, infections, and death rates, although these latter variables are positively correlated with each other. Patient acuity was negatively correlated with medication errors and falls and positively correlated with the other adverse outcomes.

TABLE 2. Correlations For All Study Variables

Four multivariate models were evaluated for each dependent variable(Table 3). Acuity and RN Proportion were included in each model. Because of the collinearity noted earlier, All Hours was excluded in two of the models. Given the curvilinearity, two multiphase models were evaluated, one with the All Hours variable and one without. In general, many of the partial correlations from the regression analyses were similar in direction to the bivariate correlations; the Acuity of patients on a unit was associated with a higher rate of infection, decubiti, patient and family complaints, and death, and lower rates of medication errors and patient falls. The partial effects of All Hours convey that the total hours of care from all personnel related with these outcomes similarly to the relationships with Acuity. Units with more acutely ill patients had more hours of care from all nursing personnel and had higher rates of infections, decubiti, complaints, and death. However, the proportion of those hours of care delivered by RNs, RN Proportion, was related to the adverse outcomes in a different manner.

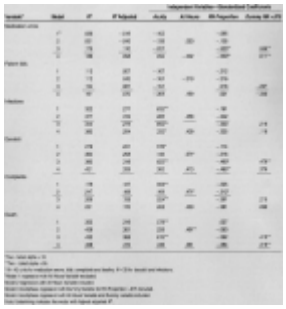

TABLE 3. Multiple Regression Models for All Outcome Variables

In the first regression model for each dependent variable the effects of RN Proportion, controlling for patient Acuity, were negative for all adverse outcomes except death rates; however, these coefficients were not statistically significant. When All Hours of nursing care was added to the analyses in model 2 for each outcome variable, the direction of the relationship between RN Proportion and the outcome variables remained negative and the size increased. The coefficient for complaints became statistically significant. Higher total hours of care from all nursing personnel on the unit (All Hours) were associated with a higher incidence of negative outcomes, but higher RN Proportion was related to lower incidence of negative outcomes.

Multiphase regression modeled the curvilinear relationships among RN Proportion and the outcome variables by inserting a dummy variable for the upper 25% of RN Proportion. This dummy variable allowed the calculation of a linear coefficient throughout the intended range of RN Proportion by adding a separate variable that estimates the slope of the relationship for units with greater than 87.5% RNs. This cutpoint was chosen by analyzing graphs of the relationship between RN Proportion and each dependent variable to determine where the slope changed directions. As this point varied slightly from one adverse outcome to another, the final choice represented a value that was within the range of change points and that allowed 75% of the units to be used in estimating the linear coefficient. When the dummy variable for the change in the regression line was added in Model 3, the coefficient for RN Proportion increased further for five of the six outcome variables and became statistically significant for

medication errors and decubiti. The relationship between RN proportion and patient falls was small and not statistically significant; however the coefficient for the dummy variable was negative, unlike the rest. Falls decreased in the upper ranges of RN Proportion. Model 4 contains both the dummy variable for the change in slope of the regression line and the All Hours variable. With all variables in the model, the negative relationships between RN Proportion and the outcomes remain.

The change in adjusted variance (adjusted R^2) was used to indicate the model that best explained the relationships. When additional terms are added to a regression model, the amount of variance explained will most likely increase, but this is offset by a loss in degrees of freedom. The adjusted R^2 takes into account this loss. The model that maximizes the adjusted R^2 is indicated with underlining in**Table 3**.

The unit rates of Medication Errors were explained best (adjusted R^2 = .110) by the combination of Acuity, RN Proportion, and the dummy variable. RN proportion was negatively related (β = -.525,p < .05) with the unit rates of medication errors up to an RN proportion of 87.5%. Another unknown event is pushing the rate up in units with more than 87.5% RNs. The units with RN Proportion levels greater than 87.5% were critical care and intermediate care units.

The rates of Patient Falls were not explained well by any of the models. None of the coefficients was statistically significant. Although not statistically significant, the negative coefficient for the dummy variable suggests that the factor that explains the higher rates of other occurrences above 87.5% RN staffing leads to lower rates of falls.

Urinary and respiratory infection rates and rates of decubiti appear to be higher on units with higher Acuity and higher All Hours of care (bivariate correlations and regression Models 1 and 3). Incidence rates of decubiti were lower on units with higher levels of RN Proportion (-485, p <.05).

Rates of patient complaints appear to be higher on units with higher Acuity and higher All Hours of care (β = .471, p < .10) but were lower on units with higher RN proportion (β = -.312,p < .10). Coefficients for death rates were not statistically significant in the model explaining the most variance.

Discussion TOP

The proportion of hours of care delivered on a patient care unit by RNs was inversely related to the unit rates of three adverse patient occurrences in this sample of 42 nursing care units. The effect was present across adverse outcomes measured in several different ways: medication errors from self-report documents, decubiti rates obtained from chart review, and complaints initiated by patients or their families. Although not statistically significant, the results suggested that urinary and respiratory infections obtained from chart review and deaths reported by the hospital morgue may also be inversely related to the proportion of nursing care delivered by RNs. These effects are present up to a staff mix of 87.5%. Patient fall rates were not well explained by these data.

In contrast, the total hours of patient care (delivered by nursing assistants, LPNs, and RNs) was associated with higher rates of decubiti, complaints, and deaths. The total hours of care was determined to a great extent by the average acuity level of patients on these units. Given the high correlation between acuity and total nursing care hours, the interpretation of these coefficients must be done with care.

Finding that a multiphase regression model described some of the outcome rates calls for a search for the factor or factors responsible for the higher rates of these adverse outcomes (except patient falls) on units with RN proportions greater than 87.5%. Patient acuity is a likely factor. Although this study controlled for acuity, the indicator may not have been sensitive enough to control for the sharply higher acuity of patients on today's critical care and intermediate care units. These units had higher levels of mortality, decubiti, infections, complaints, and medication errors, but lower rates of patient falls than units with less than 87.5% care by RNs. This describes populations of patients who are critically ill and receiving multiple complex medications and those who are immobile and thus susceptible to decubiti

but unlikely to move about enough to fall. These units are likely to have patients with urinary catheters and ventilators, and some will have patient populations where higher infection rates are expected, such as immunosuppressed patients **(Larson, Oram, & Hedrick, 1988)**. Multi-institutional studies with standardized and sensitive acuity measures are needed to describe further the relationship between rates of adverse occurrences in units with higher acuity patient and staff mix.

Most of the previous research in this area was multi-institutional and generalizeable but suffered from an accompanying lack of detail. The results of this project are more detailed and specific but less generalizeable. In previous studies, patient severity was adjusted only at the level of the hospital, using a well-accepted case-mix indicator. In this study, patient severity was adjusted at the unit level, but an acuity system unique to the hospital was used.

Relying on incident reports as the data source for medication errors and falls may be problematic. Although units track these rates as part of their quality improvement monitoring, the rigor with which reports are completed will vary from unit to unit. **Bates, Leape, and Petrycki(1993)** noted that onsite review detected many more errors than were reported by personnel. **Edmondson (1994)** reported that rates of reporting medication errors varied across units in response to the management style of the unit. The actual rate of errors, as opposed to the rate of reported errors, is often unknown. In this study, the relationship between patient outcomes and proportion of care delivered by RNs was similar whether the outcome was measured with self-report data, chart survey data, or patient reports/complaint data. The consistency of results across outcomes helps to validate each individual outcome measure.

At the bivariate correlation level there were indications that medication errors and falls may be more sensitive to nursing care, whereas other variables are most sensitive to patient acuity (see also**Reed, Blegen, & Goode, in press**). Rates of medication errors and patient falls varied together but were negatively associated with the other outcome indicators. The rates of infections, decubiti, complaints, and death varied together and with the acuity measure. However, in the multivariate analyses when acuity was controlled, the indicators related negatively to the proportion of care hours given by RNs.

Cost-containment efforts over the last decade have led to decreasing lengths of hospital stay, and as the length of stay decreases, the average nursing care needs of the patients in the hospital increase **(Coben, 1991; Shamian, Hagen, Hu, & Fogarty, 1994)**. That is, patients are discharged as their need for nursing care diminishes, leaving only patients with high needs for care. Further cost-containment efforts that attempt to decrease the proportion of professional nurses on inpatient units may be ill advised.

Although this study must be replicated in other settings with other kinds of hospitals before policy recommendations are made, the results have implications for health care administrators and nursing administrators making staffing decisions. Staffing of patient care units must correspond to the needs of the patients on each unit and the staffing required to achieve desired outcomes. **Sovie (1995)** recommended on the basis of her extensive experience, while calling for systematic research, at least a 70% RN staff for medical/surgical units and a 80% RN staff for intensive and intermediate care units. The results of this study lend support to Sovie's recommendation; as the total hours of care from nursing assistants, LPNs, and RNs was not associated with lower rates of adverse outcomes but the proportion of RN care hours was associated with outcomes. Although further research is needed to guide nursing administrators in the redesign of current nursing care delivery models in acute care hospitals, this study provides a foundation for developing the research base for this decision making.

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