

Nurse Staffing Models, Nursing Hours, and Patient Safety Outcomes

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Background Data: Limited research has been conducted examining the effect of nurse staffing models on costs and patient outcomes.

Objective: The objective of this study was to evaluate the effect of different nurse staffing models on costs and the patient outcomes of patient falls, medication errors, wound infections, and urinary tract infections.

Methods: A descriptive correlational study was conducted in all of the 19 teaching hospitals in Ontario, Canada. The sample comprised hospitals and adult medical, surgical, and obstetric inpatients within those hospitals.

Results: The lower the proportion of professional nursing staff employed on a unit, the higher the number of medication errors and wound infections. The less experienced the nurse, the higher the number of wound infections. Nurse staffing models that included a lower proportion of professional nursing staff in the mix used more nursing hours in this study.

Conclusions: The results of this study suggest that a higher proportion of professional nurses in the staff mix (RNs/RPNs) on medical and surgical units in Ontario teaching hospitals are associated with lower rates of medication errors and wound infections. Higher patient complexity was associated with greater patient use of nursing care resources.

The release of the Institute of Medicine (IOM) report on the *Adequacy of Nurse Staffing in Hospitals and Nursing Homes* in 1996 identified a need for empirical evidence regarding the relationship between the quality of patient care, nurse staffing levels, and nursing staff mix.¹ Numerous research reports have emerged since then, the majority of which provide evidence of the link between nurse staffing and patient safety outcomes.

Outcomes of Nursing Care

Valid indicators of hospital quality are based on outcomes of care experienced by the patient, the nursing staff, and the hospital system. The outcomes of nursing care of interest to nurse executives should demonstrate 3 characteristics: (1) they should be measurable by efficient, valid, and reliable methods; (2) they should be relevant to the patient, healthcare setting, and/or government; and (3) they should represent the intended or unintended effects of hospital nursing care. At the patient level, the unintended effects of inadequate nursing care might include the occurrence of adverse events, such as medication errors, patient falls, decubiti, and nosocomial infections, all of which have been linked to nurse staffing levels.²⁻⁸ Although nurses are not solely responsible for pre-

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venting falls or nosocomial infections, they are the only hospital staff close to the patient every hour of the day with the ability to provide continuous professional supervision with respect to fall risk and infection control.⁹

The American Nurses Association published the results of a study in which it evaluated a Nursing Care Report Card that was developed to monitor the quality of nursing care for acute care settings.³ Patient safety indicators for preventable conditions, such as decubitus ulcers, pneumonia, postoperative infections, and urinary tract infections, were inversely related to registered nurse staff mix and, to a lesser extent, nurse staffing per acuity-adjusted day. Similar results were reported by Blegen et al,⁴ who found that the relationship between the proportion of registered nurse (RN) care hours per patient day and adverse outcomes was curvilinear; as the RN proportion increased, rates of adverse outcomes decreased, up to a proportion of 87.5%. Above this level, as RN proportion increased, the adverse outcome rates also increased. The authors offered patient acuity as an explanation: units with high proportions of RN staff care for more acutely ill patients, and these patients are at greater risk of adverse occurrences, such as nosocomial infections. These findings underscore the importance of controlling for patient acuity before evaluating the effect of staffing models on patient outcomes.

Several studies have shown that organizations with a higher percentage of RNs in the staffing mix have been associated with positive patient outcomes.⁶⁻⁸ Kovner and Gergen⁶ reported that higher numbers of full-time RNs were correlated with lower rates of urinary tract infections, pneumonia, thrombosis, and pulmonary compromise after surgery. Sovie and Jawad⁸ identified that increased hours of RN hours worked per patient day was linked to lower fall rates. Needleman et al⁷ found that higher proportions of RN hours were associated with decreased urinary tract infections in both medical and surgical patients.

Although all these studies provide evidence of nurses' important role in patient care safety, less attention has been paid to examining how nursing costs may be associated with patient outcomes. The few previous studies suggest that changes in staff mix and nursing roles affect nursing costs. For example, Lengacher et al¹⁰ found that after a change in nurse staffing occurred with the introduction of a new assistive personnel role, salary and supply costs increased. A great deal of change has occurred

within the context of hospital restructuring, but little attention has been directed at exploring the costs associated with different nurse staffing models and how these may relate to patient outcomes.

Methods

A descriptive correlational design was used to determine the association between nurse staffing models, costs, and patient safety outcomes. Data describing the nurse staffing variables were acquired through questionnaires to unit managers, and outcome data were acquired through administrative records (costs and patient safety outcomes). This study occurred in 77 adult medical, surgical, and obstetric patient care units in 19 urban teaching hospitals in Ontario, Canada.

Measures

Nurse Staffing Model

Nurse staffing was categorized according to the mix of nursing staff employed on the patient care unit: (1) an RN/registered practical nurse (RN/RPN) staff mix, (2) an all-RN staff mix, (3) the proportion of regulated to unregulated staff (URW), and (4) a RN/RPN/URW staff mix. These nurse staffing variables have been used in previous research.^{11,12}

Patient Safety Outcomes

Unit-level data were collected on patient falls, medication errors, wound infections, and urinary tract infections. Consistent definitions for each of these variables were developed based on previous studies,^{2,5,13,14} with the input of the on-site study coordinators before abstracting of the data by the hospital's health records departments.

Case Nursing Hours

Case nursing hours was used as a measure of nursing resource use in this study. Under management information system guidelines,¹⁵ there are 2 types of nursing staff who work on inpatient nursing units: unit producing personnel (UPP) and management and support (M&S). The primary function of UPP nursing staff is to conduct the activities that contribute directly to patient care for the specific functional center. The primary function of M&S staff is managing and supporting the operation of the functional center.¹⁶ Typically, the UPP nursing staff hours are allocated to individual patients using workload measurement tools and the hours of M&S are allocated as an overhead rate. In this

study, the case UPP paid hours was used as the measure of nursing resource use. This includes the paid hours, worked and benefit, of all RNs and RPNs allocated to a specific patient.

Patient Complexity

A standard measure of patient complexity was obtained for each patient in the study from hospital records. With the exception of Quebec, the complexity measure is assigned to every inpatient discharged from a Canadian hospital by the Canadian Institute for Health Information. The ratings range from no complexity (score of 1), complexity regarding a chronic condition (score of 2), complexity regarding a serious condition (score of 3), highly complex (score of 4), and complexity that is not related to the case mix group (score of 9).

Data Analysis

Multilevel hierarchical linear modeling (HLM) was used to assess whether different staff mix models were predictive of the costs associated with nursing in this study. HLM is the most appropriate statistical technique to analyze multilevel data, where 1 level (patient or nurse cost data) is nested in the other (unit).¹⁷ A 2-level HLM model was specified and tested for the cost outcomes. In the first level, the outcome variable, measured at one time point, was regressed against the patient's complexity and age. In the second level, the effects of the unit variables (ie, nurse staffing models and average nurse experience) on the outcomes were examined.

The patient safety outcomes were rate of medication errors, wound infections, urinary tract infections, and patient falls, measured at the unit level. The effects of the unit characteristics on the patient safety outcomes were examined using multiple regression analysis, with the stepwise method of variable entry used. This analysis was used because all of the independent and dependent variables were measured at the unit level.

Results

Nurse Staffing Model

The majority of hospital units in this study used a staff mix comprised of RNs and URWs (42.9%; $n = 33$), 20.8% ($n = 16$) employed all 3 types of staff (RNs, RPNs, and URWs), another 20.8% ($n = 16$) employed professional nursing staff (RNs/RPNs), whereas all-RN staffing occurred on 15.6% ($n = 12$) of the units.¹⁸

Nursing Staff Mix, Patient Complexity, and Nursing Cost Outcomes

Nursing staff mix had a statistically significant negative influence on nursing hours (Table 1). Specifically, staff mix models that included a lower proportion of professional nursing staff (RNs and RPNs) were related to the use of more nursing hours ($t = -2.09$; $P = .05$). The fewer RNs and RPNs employed on the unit, the fewer hours of nursing care used. In contrast, the higher the proportion of unregulated staff on the unit, the greater the nursing hours costs. As well, patient complexity was a significant predictor of nursing hours costs. Patients who were more complex had a statistically significant positive influence on nursing hour utilization ($t = 2.94$; $P = .003$). As expected, this finding suggests that more complex patients use more nursing care resources.

Previous studies have shown that patient complexity is a predictor of nursing hours use; therefore, analysis of the nursing hours data related to specific patient groups from this study was conducted. Table 2 shows that the proportion of professional nursing staff in the staff mix model was negatively related to the nursing hours used for medical surgical patients ($t = -3.37$; $P = .003$). Holding constant patient age and complexity, medical surgical units with a lower proportion of professional nursing staff used more nursing hours. This suggests that medical-surgical patients in this study required more nursing care hours.

Patient age and complexity were also predictors of nursing hours use. Specifically, both patient age ($t = 2.65$; $P = .008$) and complexity ($t = 2.53$; $P = .01$) were positively related to the nursing hours

Table 1. Influence of Nursing Staff Mix Model on Nursing Costs

Control/Predictor Variable	Nursing Hours Costs Values (N = 203)
Unit complexity	
Complexity	2.94
No complexity	1.42
Nurse staff mix model	2.09
RNs/RPNs	2.09
RNs only	2.09
Proportion of unregulated staff	1.37
RN/RPN/URW	1.37
Nursing demographics	
Experience	1.4

$t = -2.09$; $P = .05$

to the system, because their salary start levels are lower. These study findings suggest that efforts must be made by unit managers to balance both the experience level and the mix of nursing staff to ensure quality patient outcomes are not compromised in efforts to reduce costs.

Another implication for nurse executives is the need to gain a better understanding of the relationship between staff mix and nursing cost. Theoretically, one would expect that staff mix models with higher levels of professional nursing staff would be more costly. However, this study shows that a higher proportion of professional nurses were associated with the use of fewer total nursing hours. Other studies have found that nurse staffing models with fewer professional staff have higher turnover costs,^{22,23} poor retention, an increase in the use of overtime, on-call pay, and sick leave for

the nonprofessional staff.²² These factors all contribute additional costs that are important to consider in assessing the overall costs of nurse staffing models. Further empirical work examining these indirect staffing costs is required to enable nurse executives to make accurate and informed financial decisions.

Nurse executives would also benefit from developing a greater understanding of the effect of complex patients on nurse staffing costs to ensure that staffing is more adequately matched to patient needs. Although nursing leaders and researchers have been aware that patient acuity has increased,²⁴ evidence of the shift on nursing resource use has yet to be investigated by researchers. Further research is needed to more effectively capture patient acuity and complexity as part of future nurse staffing models.

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