



The Impact of Nurse Staffing Levels on Adverse Events, Morbidity, Mortality, and Healthcare Costs

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Abstract:

Background: Nurse staffing levels are a critical factor in healthcare settings, impacting the quality of nursing care and patient outcomes.

Objectives: This study aims to assess the impact of nurse staffing on adverse events, morbidity, mortality, and healthcare costs.

Methods: Data from two databases were utilized, including 232 acute care hospitals and 124,204 patients across 20 surgical diagnosis-related groups. Adverse events considered were patient fall/injury, pressure ulcer, adverse drug event, pneumonia, urinary tract infection, wound infection, and sepsis. Multilevel analysis was conducted to analyze the effects of nurse staffing, alongside patient and hospital characteristics, on patient outcomes.

Results: The study revealed significant associations between nurse staffing levels and adverse events. An increase of 1 hour worked by registered nurses (RNs) per patient day correlated with an 8.9% decrease in pneumonia odds. A 10% increase in RN Proportion was linked to a 9.5% decrease in pneumonia odds. However, higher nursing hours per patient day were associated with a higher likelihood of pressure ulcers. Adverse events were also linked to extended length of stay and increased medical costs. Patients with pneumonia, wound infection, or sepsis had elevated mortality risks during hospitalization.

Conclusion: Adverse events occur during hospitalization, necessitating care systems to mitigate their impact. Adequate nurse staffing is crucial in addressing these challenges.

Introduction

Nurse staffing levels are a critical issue impacting the quality of nursing care and patient outcomes, as evidenced by recent studies (ANA, 1997, 2000; Blegen, Goode, & Reed, 1998; Blegen & Vaughn, 1998; Kovner & Gergen, 1998). These studies have explored the relationship between nurse staffing and various patient outcomes, including adverse events like medication errors, pressure ulcers, and postoperative complications. Adverse nurse-sensitive events identified by Buerhaus and Needleman (2000) include adverse drug events, patient falls and injuries, nosocomial infections, and skin breakdown, with additional focus on length of stay (LOS) and mortality rates as nursing-sensitive outcomes.

However, previous research has often focused on the inverse relationship between nurse staffing and adverse events, LOS, or mortality rates without delving deeply into their interconnections. For instance, while some studies suggest that appropriate nurse staffing reduces LOS (ANA, 1997, 2000), this overlooks the potential for increased nursing care hours due to decreased LOS as patients may require more intensive care. Moreover, few studies have thoroughly investigated the impact of nurse staffing on the medical costs of adverse events.

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Given the increasing availability of large public databases for research, there is a growing trend towards using such datasets for studying patient outcomes across different regions or states. However, this approach presents challenges for nurse researchers, including limited information on nursing staff characteristics and patients' clinical conditions within public databases. Additionally, deciding the unit of analysis is crucial when using large datasets, with the common approach being to aggregate patient-level variables at the institution level. Nevertheless, this method may result in incomplete risk adjustment at the patient level, essential for comparing outcomes across institutions.

Therefore, this study aims to address these gaps by examining the relationship between nurse staffing and patient outcomes, specifically focusing on adverse events, morbidity, mortality, and medical costs. Using large public databases and employing multilevel analysis as the analytical strategy, this study seeks to minimize data aggregation at the institutional level and thoroughly investigate the staffing-outcome relationship at the individual patient level. The study is guided by the Nurse Staffing and Patient Outcomes Model (NSPOM) proposed by Cho (2001), which provides theoretical insights into how nurse staffing influences patient outcomes, emphasizing the indirect impact of nurse staffing on morbidity, mortality, and costs through adverse events.

Methods:

Data Source: The Hospital Financial Data provided information on hospital characteristics, nurse staffing, and financial details. Since hospitals reported data for different fiscal years, information

Sample: The selection of hospitals and patients aimed to create a sample that was representative of the target population while ensuring homogeneity in hospital and patient groups. The study included 232 acute care hospitals, excluding government, long-term care, and "noncomparable" hospitals as defined by OSHPD. Additionally, 20 common surgical diagnosis-related groups (DRGs) were selected as patient groups based on their substantial adverse event rates and diagnostic categories. The final sample comprised 124,204 patients.

Measures:

1. **Hospital Characteristics:** This included ownership, hospital size, teaching affiliation, and location, categorized based on OSHPD definitions.
2. **Nurse Staffing:** Nurse staffing levels were measured in three categories (medical/surgical acute care, medical/surgical intensive care, and coronary care) and quantified using three measures: All Hours (total nursing hours per patient day), RN Hours (registered nurse hours per patient day), and RN Proportion (ratio of RN hours to total nursing hours).
3. **Patient Characteristics:** These included age, sex, race, primary payer, DRG, number of diagnoses at admission, and type of admission (scheduled or unscheduled).
4. **Adverse Events:** Seven adverse events were considered using ICD-9-CM diagnosis codes, identified through literature review and expert panel validation.
5. **Morbidity and Mortality:** Morbidity was indirectly measured through length of stay (LOS), while mortality was assessed as a dichotomous outcome (died or did not die during hospitalization).
6. **Costs:** Hospital charges were converted to costs using hospital-specific cost-to-charge ratios.

Data Analysis:

Descriptive analyses were conducted on patient and hospital characteristics. Multilevel regression models were employed for statistical analysis, considering two levels of data structure (patient level and hospital level) to examine the effects of nurse staffing, patient characteristics, and hospital characteristics on patient outcomes. SAS PROC MIXED was used for continuous dependent variables, and the GLIMMIX SAS macro was used for dichotomous outcomes.

Results:

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Nurse Staffing Levels: The mean All Hours of the 232 hospitals studied was 8.9 hours per patient day, with patients receiving an average of 6.3 hours of RN staffing per patient day (RN Hours). RNs provided 71% of All Hours (RN Proportion).

Adverse Events: The occurrence of adverse events was rare, with 93.2% of patients experiencing no adverse events. Among the 124,204 patients, 5.6% experienced one adverse event, and 1.2% had more than one adverse event. Pneumonia was the most frequent adverse event (2.59%), while falls/injuries had the lowest occurrence rate. Adverse event rates varied across the 11 DRG categories, with different rates for pressure ulcers, wound infections, and other events.

Effects of Nurse Staffing on Adverse Events: Controlling for patient and hospital characteristics, nurse staffing had significant effects on adverse events. RN Hours and RN Proportion were inversely related to pneumonia, with each additional RN Hour associated with a decrease in the odds of pneumonia. An increase in RN Proportion also correlated with a lower likelihood of pneumonia.

Effects of Adverse Events on Morbidity, Mortality, and Costs: Adverse events were associated with prolonged length of stay (LOS), increased mortality rates, and higher medical costs. Pressure ulcers had the greatest impact on LOS, while sepsis had the highest impact on mortality. Pneumonia and sepsis were linked to increased costs, with sepsis showing the greatest cost increase. Patients with adverse events experienced longer LOS, higher mortality rates, and increased costs compared to those without adverse events.

Overall, these findings highlight the importance of nurse staffing levels in influencing adverse events and subsequent patient outcomes, including LOS, mortality, and medical costs.

Discussion

Impact of Patient Characteristics on Adverse Events: The study emphasizes the significant influence of patient characteristics on adverse events, with RN staffing showing an expected inverse relationship with pneumonia. This finding underscores the importance of considering patient demographics and health status when analyzing adverse events. (American Nurses Association, 2000)

Contradictory Results on Pressure Ulcers: The study notes an unexpected positive relationship between All Hours and pressure ulcers, contrary to the assumption that adequate staffing can prevent such events. This discrepancy suggests the need for further investigation into the specific risk factors for pressure ulcers in surgical patients. (Aiken & Patrician, 2000)

Lower Adverse Event Rates Compared to Previous Studies: The study reports lower rates of adverse events compared to earlier research. This difference may be attributed to factors such as the exclusion of medical patients, variations in data collection methods, and the use of ICD-9 codes for detecting adverse events. (Cho, 2001)

Impact of Adverse Events on Patient Outcomes: The study highlights the substantial impact of adverse events on length of stay (LOS), mortality rates, and medical costs. However, it acknowledges the potential overestimation of these impacts and calls for more precise research designs to obtain accurate estimates. (Thomas et al., 2000)

Limitations and Future Directions: The study identifies several limitations, including measurement issues related to nurse staffing, the exclusion of certain hospital and nursing personnel characteristics, and the need for a more comprehensive assessment of adverse events and their causes. It suggests future studies should address these limitations and explore the appropriateness of ICD-9 codes for assessing nursing care quality. (Littell et al., 1996)

Overall, the discussion underscores the complexity of the relationship between nurse staffing, adverse events, and patient outcomes, highlighting the need for continued research and refinement of methodologies to better understand and improve healthcare outcomes.

References

1. Agency for Healthcare Research and Quality. (2000). Healthcare Cost and Utilization Project State Inpatient Databases. Rockville, MD: Author.

2. Aiken, L. H., & Patrician, P. A. (2000). Measuring organizational traits of hospitals: The revised nursing work index. *Nursing Research*, 49(3), 146-153.
3. American Nurses Association. (1997). Implementing nursing's report card: A study of RN staffing, length of stay and patient outcomes. Washington, DC: American Nurses Publishing.
4. American Nurses Association. (2000). Nurse staffing and patient outcomes in the inpatient hospital setting. Washington, DC: American Nurses Publishing.
5. Blegen, M. A., Goode, C. J., & Reed, L. (1998). Nurse staffing and patient outcomes. *Nursing Research*, 47(1), 43-50.
6. Blegen, M. A., & Vaughn, T. (1998). A multisite study of nurse staffing and patient occurrences. *Nursing Economic\$,* 16(4), 196-203.
7. Bliss, M., & Simini, B. (1999). When are the seeds of postoperative pressure sores sown?: Often during surgery. *BMJ*, 319, 863-864.
8. Buerhaus, P. I., & Needleman, J. (2000). Policy implications of research on nurse staffing and quality of patient care. *Policy, Politics, & Nursing Practice*, 1(1), 5-15.
9. California Rural Health Policy Council. (1998). California general acute care hospitals in rural and nonrural areas selected utilization and financial data 1996 and 1997. Sacramento, CA: Author.
10. Cho, S. H. (2001). Nurse staffing and adverse patient outcomes: A systems approach. *Nursing Outlook*, 49(2), 78-85.
11. Classen, D. C., Pestotnik, S. L., Evans, R. S., Lloyd, J. F., & Burke, J. P. (1997). Adverse drug events in hospitalized patients: Excess length of stay, extra costs, and attributable mortality. *JAMA*, 277(4), 301-306.
12. Finkler, S. A. (1982). The distinction between cost and charges. *Annals of Internal Medicine*, 96, 102-109.
13. Gaynes, R. P. (1998). Surveillance of nosocomial infections. In J. V. Bennett & P. S. Brachman (Eds.), *Hospital Infections* (4th ed., pp. 65-84). Philadelphia: Lippincott.
14. Geraci, J. M., Ashton, C. M., Kuykendall, D. H., Johnson, M. L., & Wu, L. (1997). International Classification of Diseases, 9th Revision, Clinical Modification Codes in discharge abstracts are poor measures of complication occurrence in medical inpatients. *Medical Care*, 35(6), 589-602.
15. Kemp, M., Keithley, J. K., Smith, D. W., & Morreale, B. (1990). Factors that contribute to pressure sore in surgical patients. *Research in Nursing & Health*, 13, 293-301.
16. Kovner, C., & Gergen, P. J. (1998). Nurse staffing levels and adverse events following surgery in U.S. hospitals. *Image: Journal of Nursing Scholarship*, 30(4), 315-321.
17. Littell, R. C., Milliken, G. A., Stroup, W. W., & Wolfinger, R. D. (1996). SAS system for mixed models. Cary, NC: SAS Institute.
18. Office of Statewide Health Planning and Development. (1998). Hospital Annual Financial Data: Selected Datafile Documentation for Report Periods Ended January 1, 1997 through December 31, 1997. Sacramento, CA: State of California Office of Statewide Health Planning and Development.
19. Shamian, J., Hagen, B., Hu, T. W., & Fogarty, T. E. (1994). The relationship between length of stay and required nursing care hours. *Journal of Nursing Administration*, 24(7,8), 52-58.
20. Thomas, E. J., Studdert, D. M., Burstin, H. R., Orav, E. J., Zeena, T., Williams, E. J., et al. (2000). Incidence and types of adverse events and negligent care in Utah and Colorado. *Medical Care*, 38(3), 261-271.