NURSE STAFFING AND PATIENT OUTCOMES: BRIDGING RESEARCH INTO EVIDENCED-BASED PRACTICE
Nurse Staffing and Patient Outcomes: Bridging Research into Evidenced-Based Practice

Abstract
This paper describes innovative research that quantified relationships between nurse staffing and nurse-sensitive patient outcomes. Building on existing studies, the research added controls for patient workload, analyzed data at a daily-level of detail and employed rigorous multi-site data control. A key finding in the study was that staffing to effectively meet patient workload demands mitigated negative patient outcomes. The study also identified clinical indicators predictive of risk for negative outcomes and implications of staffing skill mix and characteristics.

Background
A growing body of research suggests a relationship between nurse staffing and nurse-sensitive patient outcomes, but beyond inferences that higher staffing relates to more favorable outcomes, these findings haven’t been successful at suggesting effective staffing levels or practices. Most published studies compared aggregated staffing and outcome measures compiled at the hospital or service level over extended time periods. Results, if found, focused on outcomes in well-staffed settings versus staffing-challenged settings. Further, most studies relied on staff-to-patient ratios and did not control for patient workload differences. A better model was needed to transcend staffing-to-outcomes research into evidenced-based practice.

Building on existing nurse staffing to outcomes research that has used retrospective aggregate staffing and outcome measures, the QuadraMed study was designed to measure daily staffing and outcomes to quantify the effects of short term staffing fluctuations on patient outcomes. Further, beyond using staff-to-patient ratios as a control, patient workload was utilized to accurately quantify and compare nurse staffing levels.

Study Design
The basic study design was to track patient outcomes and nurse staffing on a daily basis to enable detailed comparisons of nurse staffing to outcomes. Patient characteristics and nursing unit staffing demographics were also tracked to determine influence on patient outcomes. A standardized measure of daily patient workload was tracked to provide comprehensive study control.

To facilitate the outcomes study, QuadraMed approached clients willing to track outcomes and staffing demographics using standardized definitions. Patient outcomes were tracked on a patient-specific, daily basis. The common use of a standardized patient acuity system...
was able to provide the necessary patient workload controls and also provide both daily recommended and actual staffing levels by skill level. As part of the acuity assessment, patient clinical indicators were also collected.

Forty-nine inpatient units from nine QuadraMed client hospitals participated in the study. The hospitals ranged in size from about 170 to 700 operating beds. The participant hospitals represented both teaching and non-teaching institutions and multiple diverse geographic regions of the US. The forty-nine units were of various clinical specialties with the majority being categorized as medical/surgical (17), telemetry/step down (12) or intensive care (10).

The nurse-sensitive patient outcomes studied included patient falls (with or without injury), tracked on 44 units; hospital associated pressure ulcers (stage II and beyond), tracked on 17 units; and, medication errors, tracked on 11 units. To ensure data consistency, standardized definitions of the nurse-sensitive outcomes were applied.

Nurse staffing was tracked on a daily basis by skill level. The comprehensive staffing data included both acuity-recommended and actual staffing data enabling comparisons to outcomes using hours per patient day, hours per workload and evaluation of recommended versus actual levels. Unit staffing demographics such as RN turnover, vacancy, agency and float pool rates were also collected, as well as RN staff experience levels, tenure, certification and education levels. Patient clinical profile indicators such as length of stay, ADL status and other care need indicators were also collected as part of the daily acuity assessment.

The QuadraMed acuity system provided daily measurement of patient volume and workload as well as the assessment/collection of recommended and actual daily nurse staffing by skill level. The QuadraMed system also became the data collection tool and repository of the patient outcome and additional staffing demographic data.

The resulting staffing-to-outcomes database contained over 6,000 daily records with patient volume, clinical profile, workload, outcomes and corresponding nurse staffing levels. Monthly records incorporating certain staffing demographic fields along with aggregated patient, staffing and outcomes data were also developed (n=294). Finally, unit records including staffing demographic fields that were collected only once during the study (e.g., RN turnover levels) were developed with aggregated patient, outcomes and staffing data (n=49).

**Analysis methods**

For the study, the independent variables included various measures of staffing levels—overall levels, levels by skill mix and recommended to actual variance. Staffing demographics such as RN education level, experience level and level of certification were also utilized as independent variables. Patient clinical profile indicators were also studied as independent variables. The nurse-sensitive patient outcomes were the dependent variables. Patient volume and workload were utilized as study controls.
Basic correlation analysis was used on the aggregated data sets to examine the effects of staffing demographic data on outcomes levels. Analysis of variance (ANOVA) was used to examine the effects of staffing levels (above recommended, at recommended and below recommended) and occurrence of nurse-sensitive patient outcomes. ANOVA techniques were also used to examine the relationship between patient clinical indicators and occurrence of nurse-sensitive patient outcomes. Logistic regression was also performed using the significant factors from the ANOVA analyses to attempt to model the predictors of nurse-sensitive patient outcomes.

Findings
Analysis of the overall dataset revealed many significant relationships between staffing and nurse sensitive patient outcomes. Several significant correlations were found between staffing demographics and outcomes. Significant staffing variances were found on days where the outcome occurred versus non-occurrence days. In addition, several patient clinical indicators were found to be predictive of risk for patient falls and medication errors.

Patient Falls:
Several relationships between patient falls and staffing/staff demographics were found. The study found nurse staffing levels significantly affected the incidence of patient falls. More specifically, on days when units staffed below the levels recommended by the acuity system, falls were 1.4 times more likely to occur than when the units staffed at or above recommended levels (95% confidence interval: 1.2-1.6).

Examination of a representative oncology unit revealed that on days when the unit staffed:

- Significantly less than the level the acuity system recommended, the likelihood of a fall occurring was 6.7 percent (less than 95 percent of recommended staffing hours)
- Close to the level the acuity system recommended, the likelihood of a fall was 1.2 percent
- Above the acuity system’s recommendation (greater than 105 percent), no falls were reported

The study also found that a higher:

- Utilization of agency and float pool nurses correlated with higher fall rates
- Percentage of BSN staff correlated with lower fall rates
- Amount of staff with one or more years of experience on the unit or in the specialty correlated with lower fall rates
Several patient clinical characteristics were found to be predictive of fall risk in the study. These included: patient ADL needs, patient cognitive status and patient behavioral/emotional management needs.

**Medication Errors:**

Consistent with patient falls, the study also found a relationship between nurse staffing and the incidence of medication errors. While incidence of patient falls related to overall nurse staffing levels (RN, LPN and UAP), medication errors were found to be related to RN staffing levels.

On days when the units operated with fewer RN hours than the level recommended by an acuity system, more medication errors were observed. Specifically, when units staffed below the RN levels recommended by the acuity system, medication errors were 2.0 times more likely to occur than when the units staffed at RN levels at or above the levels recommended by the acuity system (95% confidence interval: 1.5-2.4).

Examination of a representative surgical unit revealed that on days when the unit staffed at RN levels:

- Under the level recommended by the acuity system, the likelihood of a medication error was 13.0 percent
- Close (within five percent) to the level recommended by the system, the incidence rate dropped to 2.0 percent
- Greater than the level recommended by the system, the likelihood of a medication error was 1.8 percent

In addition to RN staffing variances, the study found the patient’s length of time in the unit also affected the medication error rate. In the first 24 hours of the patient’s admission to a unit, the likelihood of a medication error was 1.95 percent. The risk dropped to 0.87 percent when the patient had been in the unit between 24 and 72 hours, and dropped even further, to 0.79 percent, once a patient had been in the unit more than 72 hours.

Along with patient length of stay, clinical indicators such as intensity of medication activity and required frequency of assessment were also predictive of risk for medication errors.
Hospital-Associated Pressure Ulcers:

Although the study of HAPU rates proved more difficult due to timing the onset of pressure ulcers and the multiple staffing environments faced by patients with inter-unit transfers, some relationships with staffing were found. Higher use of float pool nurses was positively correlated to HAPU rates. Staffing variances in RN hours per workload (Actual Staffing—Recommended staffing) were mildly negatively correlated to HAPU rates, suggesting adequate RN staffing may help lower the incidence of pressure ulcers.

Implications

While hospitals have always strove to minimize negative patient outcomes, the introduction of Value-Based Purchasing has made reducing negative outcomes critical to both ensuring patient safety and ensuring hospital financial viability. The new reimbursement models have led many healthcare organizations to seek strategies for enhancing nursing care delivery to improve patient outcomes.

A consistent finding of the QuadraMed study was that measures of variance between actual and recommended staffing were frequently predictive of nurse-sensitive outcomes, suggesting that effectively staffing to meet workload may be a viable tool for managing outcomes. Further, staffing above acuity-based recommended levels (overstaffing) did not significantly reduce negative outcomes beyond staffing at acuity-recommended levels (right-staffing).

To staff effectively, organizations must quantify patient workload by both hour of day and day of week and set core staffing patterns to match workload demands. Additionally, the use of a centralized staffing office, implementation of non-standard work shifts and development of a viable float pool may help organizations effectively flex staffing to meet workload fluctuations.

The focus on nursing staff development and retention may also help mitigate adverse patient outcomes as the study documented correlations to patient outcomes with RN tenure, education and use of agency and float pool. To mitigate fall risk, nurse managers should provide additional management and oversight to support the unit when the use of agency nurses, inexperienced nurses, and float staff is necessitated. By identifying the critical transition periods when medication errors are most likely to occur, managers can increase focus on identifying effective patient hand-off, medication reconciliation, chart checks and rounding processes to minimize medication errors.

Beyond suggesting effective staffing and staff policies to minimize negative patient outcomes, the study also identified methods to proactively assess risk for negative outcome occurrence. By identifying both staffing situations and patient characteristics predictive of negative outcomes, risk levels can be evaluated. For example, when

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scheduled nursing staffing is below the recommended levels and a higher proportion of the patient population has increased cognitive or behavior management needs, higher risk of patient falls is indicated. For medication errors, having scheduled RN staff below the recommended level and a higher proportion of new admit or transfer-in patients would signify increased risk.

Proactively identifying risk factors should enable managers to effectively direct nursing resources to mitigate negative patient outcomes.