Integrating Electronic Health Records and Human Resource Information Systems to Examine the Impact of Nurses’ Characteristics on Outcomes: An Application to Pediatric Post-Surgical Care

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Introduction

Inadequately managed post-surgical care can trigger complications, including a longer length of stay (LOS), higher readmissions, and ultimately increased healthcare costs¹,². Studies have investigated the impact of nurses’ experience and skills, and the nursing team’s composition on patient outcomes, but these studies were mainly based on administrative, claims, and self-reported survey data, which does not accurately measure the unique characteristics of the nursing team at various time points across the continuous care process³,⁴. Electronic Health Record (EHR) documentation of assessments and interventions (e.g. medication administration records) can be used to quantify nursing activities across patient populations⁵. Linking nursing characteristics extracted from human resources information systems (HRIS) with EHR data further enriches the ability to test hypotheses related to the impact of nursing characteristics on patient outcomes. The purpose of this study was to link EHR and related HRIS datasets to examine the associations between nursing team experience and education on LOS and evaluate this association at different time intervals of post-surgical care.

Methods

This study is based on retrospective EHR data from inpatient post-surgical patients at the large urban pediatric hospital and the individual nurses who were staffed to care for them from January 2015 to December 2016. The study cohort was restricted to post-operative patients (48 hours) with documented assessments. A logistic regression approach was used to test the associations between nursing-team-related characteristics and LOS, controlling for the effect of clinical and resource use, patient care location, and socio-demographic factors. The binary outcome variable was created based upon the ratio of actual LOS relative to the estimated All Patients Refined Diagnosis Related Groups (APR-DRG) LOS. Post-surgical care was grouped into eight-hour intervals starting at the postoperative period. For each of the six-time intervals, several nursing team-related explanatory variables were created representing care activity (number EHR particulars related to medication administrations and flowsheet documentation), team experience (average value for years of experience of all the nurses involved with care), and education level. In addition, APR-DRG Relative Weight and APR-DRG Severity Index were used to represent the difference in clinical and resource use between patients. Patients’ socio-demographic variables (age at visit, gender) and care location (nursing unit) were considered as other potential covariates.

Results

The study sample consisted of 6172 pediatric encounters with 1396 nurses involved with documentation of pain assessments and medication administrations. Among the caregiving nurses, the majority (53.36%) had more than five years of experience, and also the majority (73.16%) had bachelor's or graduate-level education. As shown in Figure 1-A, the level of nursing activity was highest immediately post-surgery and dropped significantly after the first 8-hour interval for all care locations and continued to slightly decrease to the last interval. The hospital uses 12-hour shift staffing which could be attributed to the variability seen with experience. The highest experienced nurses were
assigned immediately post-surgery (12-hour day shift) and dropped at the 2nd 8-hour interval (night shift) in most locations (Figure 1-B). This trend was replicated with a rise at the 3rd 8-hour interval (day shift) and 5th 8-hour interval (Night shift).

![Figure 1](image)

**Figure 1.** Variation in nursing activity and nursing team experience between care locations.

Among the patients, 40.65% had longer LOS relative to their APR-DRG LOS benchmarks. Logistic regression parameter estimates showed that controlling for other covariates, the patients with longer LOS were associated with more experienced (p<.001, odds ratio=1.015) teams providing care during the first eight hours. Experience of the nursing team during the second day, at 4th (with p=.07, odds ratio=1.008), 5th (with p=.03, odds ratio=1.011), and 6th (with p=.04, odds ratio=1.009) 8-hour intervals were found to be associated with differences in LOS outcomes. Even though our results did not reveal a strong association between educational level and LOS at most time intervals, it showed marginal evidence that having nurses with higher levels of education (with p=.08, odds ratio=0.890) at the start of the second day (at the time interval 4) is associated with shorter LOS.

**Discussion**

The data came from a single pediatric hospital with a high proportion of experienced (>5 years) and highly educated nursing staff limiting the generalizability to other settings. Yet our study demonstrates the feasibility of using EHR data combined with other data sources to examine the impact of individual and team characteristics on health outcomes. Furthermore, the association or correlation with other variables and factors identified, especially with regards to the timing of care delivery, could be used as inputs for developing nursing assignment models to efficiently use available nursing human resources.

**References**


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