

Reconciliation of Different Estimates of the Impact of Nurse Staffing on Patient Outcomes: The Effect of Data Aggregation and Estimation Methods; Evidence from the Veterans Affairs (VA) Healthcare System

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Research Team

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Background

- Growing body of evidence looking at the association of nurse staffing (and of specific aspects of nurse staffing) and patient outcomes
- Not surprising, nursing is a key component of inpatient care. They are the ones at the bedside 24/7.

How Nurse Staffing Affects Outcomes

- When nurses are short staffed, things don't get done and mistakes can happen
 - What Jack Needleman calls errors of omission and commission:
 - Not there, patient falls
 - Medication errors
 - Delay in discharge teaching
 - Miss early signs of an infection
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Dimensions of Nurse Staffing

- Number of nurses (HPBD)
 - Type of nurse (RN vs. LPN vs. Aide (more generally Unlicensed Assistive Personnel (UAP)))
 - Education, especially for RNs (AA vs. BSN)
 - Regular vs. contract employee
 - Experience (number of years as a nurse)
 - Experience on the unit (unit tenure)
 - Work Environment
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Variance in Findings

- While almost all of the studies find that nurse staffing matters, there is a lot of variance in the magnitude of the estimates
- Also, some conflicting results, especially for other measures of nurse staffing, such as the use of contract nurses, RN education levels, etc.

Variance in Findings May Matter

- Much policy discussion about nurse staffing
 - California, the extreme, with hard staffing requirements
- Given different findings, need to make sure that they are real before making policy
 - e.g., proposal to require all RNs to have a BSN, which would represent a huge increase in training and in training capacity

Previous work

- Linda Aiken and team at Penn, large body of work looking at staffing levels, RN education, contract nursing
 - Use survey data to get information on nurse staffing; includes question on the work environment
 - All analyses at hospital level; can't link nurses or patients to specific units
 - Cross-sectional data, mostly annual data for outcomes

Previous work – 2

- Vast majority of existing studies are cross-sectional. Limited number of panel data studies
 - Sochalski et al, 2008, California data. Compare cross-section and fixed-effects, found association with C-S, none with F-E
 - Mark & Harless, series of studies. Found effects with F-E, but they were smaller than those from C-S studies.

Previous work – 3

- Some studies with “micro” data; study-specific data collection from units
 - Have found that various aspects of nursing, including staffing levels and work environment associated with various patient outcomes, including “safety events” and preventable complications

Previous work – 4

- Sales, cross-section study of VA
 - Unit-level data for a big sample
 - RN staffing was associated with mortality for non-ICU acute care units, but no association for ICUs
 - Bias if data aggregated above the unit-level, given the very different staffing levels for ICUs vs. other acute care units

Previous work – 5

- Analysis of California nurse-staffing regulations
 - Evans & Kim. IV study, projected effects on outcomes would be limited
 - Cook Gaynor et al., and Bolton et al. With very different methods both found that the law had intended effects on staffing, but they didn't find any effects on outcomes
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Previous work – 6

- Needleman et al, 2010, Mayo Clinic
 - Shift-by-shift unit-level data
 - Compared number of nurses needed each shift with actual staffing
 - Counted patient exposure to shifts when unit short nurse(s)
 - Increased exposure to shifts with nursing shortage associated with increased mortality risk
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The Role of Relational Capital in Patient Care

- In a study of joint-replacement patients in nine hospitals, Gittell (2002) found that *relational coordination* (an index measuring frequency, timeliness, accuracy and problem-solving nature of communication, as well as shared goals, shared knowledge and mutual respect) *was positively correlated with patient-perceived quality of care and negatively correlated with length of stay*. Information on education and tenure of nursing staff was not provided in this study.

Focus Groups Among Nurses Who Changed Hospitals Found “Evidence” of Specific Human Capital

“Job change...decreased nurses control over their work because it affected their ability to perform tasks efficiently. In an unfamiliar workplace, self-confidence suffered as experienced nurses felt like novices. They had difficulty discovering where things were kept and how equipment worked. They had to adapt to unfamiliar cultural conventions about team work and procedures.”

Our Previous Paper (AEJ)

- Longitudinal, monthly, unit-level data from a large sample (4 years)
 - First study to use panel data to jointly examine the effects of:
 - Staffing levels
 - Skill mix
 - Unit tenure
 - RN education & experience
 - Use of contract nurses
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Use common VA dataset to examine effects of data aggregation and estimation methods

- Compare fixed-effects vs. OLS estimates
- Vary observations, unit-moth, unit-year, hospital-month, hospital-year
- Do these differences yield different results?

VA Nurse Staffing Data

- DSS, VA's comprehensive hospital activity-based accounting system
 - Monthly data on inpatient nurse staffing for each unit, by type (RN, LVN, aide) tracked at the unit level. Tracked from payroll. Adjusts paid vs. worked hours, and tracks use of contract nurses
 - Partial adjustment for floating (averages)
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Other Characteristics of Nurses

- We extracted other nursing characteristics from VA payroll data (PAID). Including:
 - VA tenure (VA & facility start date)
 - Unit tenure (how long RN working on unit)
 - Education (AA vs. BSN RNs)
 - Shift differentials

Discharge Data

- Separate record for each unit, can link to physical units
- Controls for patient risk (age, co-morbidities, surgical cases, DRG)
- Nursing sensitive PSIs (selected infectious due to medical care, failure to rescue, post-operative PE or DVT, decubitus ulcer) and mortality

Use LOS as a combined indicator

- LOS goes up when adverse events happen
- LOS also goes up when nursing work doesn't get done in a timely manner
- Can show that LOS is not endogenous to HPPD
- HPPD variance driven by nursing hours and admissions, LOS has virtually no effect
- Individual LOS, unit-level HPPD
- Individuals cross units, use 1st unit HPPD

Means

	Acute	ICU
Total HPPD	7.9	18.2
LPN %	23.5	1.2
Aide %	16.2	2.3
Contract %	3.1	1.7
% RNs with BSN	38.5	44.7
% RN Tenure >5 years	38.2	50.1

Empirical Model

- $LOS_{it} = \alpha_1(\text{Nursing HPPD})_{jt} + \alpha_2(\text{skill mix})_{jt} + \alpha_3(\text{tenure/other human capital})_{jt} + \alpha_4 \text{contract}_{jt} + \alpha_5 \text{admissions}_{jt} + \alpha_6 \text{DRG}_{it} + \alpha_7 \text{AGE}_{it} + \alpha_7 \text{Elixhauser}_{it} + \alpha_8 \text{Surgical DRG}_{it} + \text{Month} + \lambda_i + \varepsilon_{it}$
- i =patients, j =units, t =month
- λ_j Hospital*unit fixed effects
- Results robust to using LOS/expected LOS

Summary of AEJ Results

- Staffing matters, RN effect bigger than LPN or UAP
- Tenure matters, effect about 1/3 to 1/2 size of RN HPBD
- No gain from adding contract nurses
- Didn't find any effect of BSN, once experience and unit tenure controlled for
- Tenure effects up to unit average of 10 years, then flat

Mortality/PSI Models

- With low event rates, most estimates in expected direction but not statistically significant
- Some significant results for combined endpoint of PSI or mortality

Comparison of methods and data aggregation, lots of combinations

- Given slides, restrict to subset
 - Total HPBD
 - % LPN
 - % UAP
 - % contract nurses

Fixed-Effects Estimates, Acute Care Units, Monthly vs. Annual Data, Dependent Variable $\ln(\text{LOS})$

	Month	Year
Total Nursing HPBD	-0.031*	-0.015*
% LPN Hours	-0.041	-0.088
% UAP Hours	0.088*	0.138*
% Contract Hours	0.310	0.270*

Fixed-Effects Estimates, ICUs, Monthly vs. Annual Data, Dependent Variable $\ln(\text{LOS})$

	Month	Year
Total Nursing HPBD	-0.016*	-0.008*
% LPN Hours	0.215	0.123
% UAP Hours	0.217	0.016
% Contract Hours	0.333*	0.091

Fixed-Effects Estimates, Hospital, Monthly vs. Annual Data, Dependent Variable $\ln(\text{LOS})$

	Month	Year
Total Nursing HPBD	-0.011*	-0.007*
% LPN Hours	-0.194*	0.018
% UAP Hours	0.138*	0.225*
% Contract Hours	0.180*	0.268*

Fixed-Effects Estimates, Acute Care Units vs. ICUs, Monthly vs. Annual Data, Dependent Variable ln(LOS)

	Acute Month	Acute Year	ICU Month	ICU Year
Total Nursing HPBD	-0.031*	-0.015*	-0.016*	-0.008*
% LPN Hours	-0.041	-0.088	0.215	0.123
% UAP Hours	0.088*	0.138*	0.217	0.016
% Contract Hours	0.310*	0.270*	0.333*	0.091

Fixed-Effects vs. No FE, Acute Care Units, Monthly vs. Annual Data, Dependent Variable ln(LOS)

	FE Month	FE Year	No FE Month	No FE Year
Total Nursing HPBD	-0.031*	-0.015*	-0.017*	-0.021*
% LPN Hours	-0.041	-0.088	-0.002	0.125*
% UAP Hours	0.088*	0.138*	0.198	0.312
% Contract Hours	0.310*	0.270*	-0.100*	-0.202*

Fixed-Effects vs. No FE, ICUs, Monthly vs. Annual Data, Dependent Variable ln(LOS)

	FE Month	FE Year	No FE Month	No FE Year
Total Nursing HPBD	-0.016*	-0.008*	-0.007*	-0.008*
% LPN Hours	0.215	0.123	0.105	0.539*
% UAP Hours	0.217	0.016	0.192*	0.245*
% Contract Hours	0.333*	0.091	0.122	0.157*

Fixed-Effects vs. No FE, Hospital, Monthly vs. Annual Data, Dependent Variable ln(LOS)

	FE Month	FE Year	No FE Month	No FE Year
Total Nursing HPBD	-0.011*	-0.007*	-0.032*	-0.017*
% LPN Hours	-0.194*	0.018	0.297*	0.079*
% UAP Hours	0.138*	0.225*	0.561*	0.468*
% Contract Hours	0.180*	0.268*	-0.088	0.399*

Fixed-Effects, Acute Care Units, Sort by Quartile of Total Nurse HPBD, Dependent Variable ln(LOS)

	1 st Quartile	2 nd Quartile	3 rd Quartile	4 th Quartile
Total Nursing HPBD	-0.027*	-0.037*	-0.035*	-0.022*
% LPN Hours	0.062	-0.048	0.269*	0.114
% UAP Hours	0.221*	0.235*	0.262*	0.107
% Contract Hours	0.415*	0.331*	0.438*	0.488*

Conclusions – Data Aggregation

- The estimates are sensitive to data aggregation; point estimates move in both directions in response to aggregation
- Given that aggregation masks variance, intuition says less aggregation is better but data harder to find. Ideally at shift/patient level, e.g., Needleman study

Conclusions - Estimation Methods

- We know that there is unobserved heterogeneity; estimates that don't control for this are clearly biased
- Fixed-effects at least partially address the unobserved heterogeneity, but only provide estimates of the marginal effects; levels are important also

Conclusions – Reconciliation of Different Results

- In our sample, aggregation and estimation method explain the Bartel vs. Aiken result for contract nurses
- Didn't show here, but can explain the RN education (BSN) differences, effect goes away in our model once experience and unit tenure are controlled for

Conclusions – Reconciliation of Different Results

- Estimates of the effects of staffing hours clearly affected by aggregation and estimation method. These explain at least some of the differences in results

Additional work in progress

- Add more years of data, 2007-2013 in processing to existing 2003-2006
- Further investigation into the causes of the sensitivity of the estimates to method and aggregation