

# Using VA nursing data to estimate the relationship between nurse staffing and patient outcomes

Shira Winter, PhD, RN, FNP-BC

Ciaran Phibbs, PhD

Susan Schmitt, PhD

February 16, 2022



# Acknowledgements and Disclosures

- Ann P. Bartel, PhD
- Pamela B. de Cordova, PhD, RN-BC
- Jack Needleman, PhD
- Patricia W. Stone, PhD, MHP, RN
- Lakshmi Ananth
  
- **Disclosure of funding:** Department of Veterans Affairs, Health Services Research & Development IIR 16-238 (SGW, JN, SKS, PWS, CSP). Robert Wood Johnson Foundation #53420 (APD, SKS, PWS, CSP). Agency for Healthcare and Research Quality 1K08-HS024339 (PDC).
- **Other disclosures:** The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs, AHRQ, or the United States government.
- **Conflicts of Interest:** The authors state no conflicts of interest.

# Background



# Terminology

- RN = Registered Nurse
- LPN = Licensed Professional Nurse
- UAP = Unlicensed Assistive Personnel
- Skill Mix = Combination of total nurse staffing across RN, LPN, and UAPs.
- HPPD = Nursing Hours Per Patient Day
  - i.e. ratio 1 nurse to 4 patients over 24 hours is an HPPD of 6
- LOS = Length of Stay

# Staffing and Safety

- National awareness for high-quality, safe care in hospitals
- Nurse staffing ratios linked to patient outcomes:
  - Mortality
  - "Failure to rescue"
  - Length of stay
  - Readmissions
  - Healthcare associated infections
- How is staffing tied to patient safety?
  - Errors of omission/missed care due to inadequate time and resources
    - Not ambulating or turning a patient at prescribed times due to competing clinical priorities
    - Insufficient teaching or discharge planning
    - Ineffective team communication or documentation

# Limitations to this Body of Research

Can we understand the true magnitude of the relationship between nurse staffing and patient outcomes?

- Imperfect controls for patient acuity
- Shift-specific and unit-specific effects
  - Aggregation: Year versus shift
  - Estimates based on one shift or on typical staffing and then extrapolating across multiple shifts
  - Aggregation of entire hospital's data (versus unit by unit)
- Incomplete control for other healthcare providers
- Smaller studies have used unit- and shift-specific longitudinal or panel data, and control for factors such as patient acuity, shift type, day of the week, and staffing mix.

# Aims

- How do data aggregation and different estimation methods affect estimates of the magnitude of the relationship between nurse staffing and patient outcomes?
  1. Month vs. Year
  2. Acute care vs. ICU vs. entire hospital
  3. Fixed effects vs. no fixed effects
    - Control for unobserved heterogeneity between units over time.

Hypothesis: Disaggregation and fixed effects are more accurate.

- Recent finding that exposure to shifts with inadequate staffing is associated with worse patient outcomes; aggregation of data masks shifts where staffing levels were below target.
- Unit work environment is associated with patient outcomes and with levels of nurse burnout.

# Methods

Study Type	Sample	Sample Size
Retrospective observational study using panel data	VA acute care or ICU patients October 2, 2002-September 30, 2006.	215 ICUs 438 acute care units Encompassing 143 VA facilities.



# Data Sources

## Patient Data

- Admission-level discharge abstracts
- Time present on each unit
- ICD diagnoses and procedure codes
- DRG for each unit

## Labor data: DSS (Decision Support System)

- Hours worked
- Type of nursing labor (RN/LPN/UAP/Contract Nurse).

# Variables

## Predictor Variable

- HPPD, separated by type of nursing staff

## Outcome Variable

- Residual log LOS.
  - Difference between observed and expected LOS.
    - Observed LOS based on Medicare are median LOS by DRG.
    - Log used to control for extreme outliers.
    - Residual used to control for reverse causality (i.e. patient acuity determining) staffing

- Patient age
- Elixhauser comorbidity index
- Surgical DRG at admission.

- Unit tenure
- Facility tenure
- Work experience

# Exclusion Criteria

---

Units with less than 100 patient days

---

HPPD <12 or >48 for ICUs; <3 and >15 acute care units.

---

Monthly observations with incomplete data (1-2% of observations).

---

Administrative nurses

---

Nurses who performed non-direct patient care activities

---

# Analysis

Descriptive statistics for unit-level staffing characteristics (HPPD) and patient characteristics

- Month/year
- Acute care/ICU/hospital

Multivariate ordinary least squares regression

- Month/year
- Acute care/ICU/hospital
- Fixed effects/non fixed effect

# Results

**Overall Sample (n=1,586,991)**

	Mean	Standard Deviation	Minimum	Maximum	Standard Deviation Between	Standard Deviation Within
<b>Length of Stay</b>	6.08	8.91	1	359	1.72	8.80
<b>Age</b>	65.72	12.68	18	109	2.21	12.51
<b>Elixhauser</b>	1.45	1.09	0	10	0.25	1.07

**ICUs<sup>1</sup> (n=422,754)**

<b>Length of Stay</b>	6.48	10.57	1	359	1.76	10.44
<b>Age</b>	65.45	12.02	18	108	1.95	11.88
<b>Elixhauser</b>	1.43	1.09	0	9	0.26	1.06

**Acute Care Units (n=1,207,935)**

<b>Length of Stay</b>	5.64	7.55	1	348	4.04	7.30
<b>Age</b>	65.68	12.85	18	109	2.61	12.67
<b>Elixhauser</b>	1.44	1.07	0	10	0.35	1.05

## Annual Nursing HPPD

	Mean	Standard Deviation	Minimum	Maximum
<b>Overall Hospital</b>	<b>11.79</b>	5.82	2.55	42.97
<b>ICU<sup>1</sup></b>	<b>18.45</b>	3.72	12.55	42.97
<b>Acute</b>	<b>8.02</b>	2.40	2.55	22.06

## Monthly, Unit-Level Staffing

Overall Hospital				
<b>HPPD</b>	<b>12.66</b>	6.03	2.11	59.04
<b>RN HPPD</b>	<b>10.21</b>	7.06	0.65	47.63
<b>% LPN<sup>3</sup></b>	0.14	0.15	0	0.77
<b>%UAP</b>	0.10	0.11	0	0.60
ICUs				
<b>HPPD</b>	<b>18.98</b>	4.63	12.02	59.04
<b>RN HPPD</b>	<b>17.93</b>	3.88	12.01	47.63
<b>% LPN<sup>3</sup></b>	0.01	0.04	0	0.04
<b>% UAP</b>	0.02	0.04	0	0.43
Acute Care				
<b>HPPD</b>	<b>10.47</b>	5.27	2.11	54.17
<b>RN HPPD</b>	<b>7.51</b>	5.86	0.65	41.72
<b>% LPN<sup>3</sup></b>	0.19	0.15	0	0.77
<b>% UAP</b>	0.13	0.12	0	0.60

How Different Levels of Data Aggregation Affect the Estimates of the Effect of Nurse Staffing on Patient Length of Stay (With robust standard errors but **without fixed effects**)

	Acute Month N=1,157,959	Acute Year N=1,159,709	ICUs <sup>1</sup> Month N=412,114	ICUs <sup>1</sup> Year N=419,764	Hospital Month <sup>1</sup> N=1,593,294	Hospital Year N=1,593,294
<b>Nursing Hours Per Patient Day (RN)</b>	<b>-0.030*** (0.001)</b>	<b>-0.015*** (0.003)</b>	<b>-0.009*** (0.001)</b>	<b>-0.006*** (0.002)</b>	<b>-0.017*** (0.002)</b>	-0.007 (0.005)
<b>Percent of Nursing Hours Provided by LPNs</b>	0.076** (0.034)	0.029 (0.072)	0.278** (0.138)	0.239 (0.216)	0.370 (0.056)	0.144 (0.156)
<b>Percent of Nursing Hours Provided by Unlicensed Assistive Personnel</b>	0.217*** (0.034)	0.250*** (0.069)	0.211** (0.090)	0.172 (0.172)	0.210*** (0.062)	0.341*** (0.122)
<b>Percent of Nursing Hours Provided by Contract Nurses</b>	0.340*** (0.041)	0.284*** (0.083)	0.143* (0.085)	0.111 (0.141)	0.260*** (0.049)	0.270** (0.132)
<b>R-squared</b>	<b>0.121</b>	<b>0.121</b>	<b>0.144</b>	<b>0.142</b>	<b>0.126</b>	<b>0.124</b>



How Different Levels of Data Aggregation Affect the Estimates of the Effect of Nurse Staffing on Patient Length of Stay (With robust standard errors and **with fixed effects**)

	Acute Month N=1,157,959	Acute Year N=1,159,709	ICUs <sup>1</sup> Month N=412,114	ICUs <sup>1</sup> Year N=419,764	Hospital Month <sup>1</sup> N=1,593,294	Hospital Year N=1,593,294
Nursing Hours Per Patient Day (RN)	-0.030*** (0.002)	-0.013*** (0.004)	-0.009*** (0.001)	-0.006*** (0.002)	-0.015*** (0.002)	-0.005 (0.005)
Percent of Nursing Hours Provided by LPNs <sup>2</sup>	0.028 (0.044)	-0.025 (0.083)	0.112 (0.204)	0.219 (0.224)	-0.195*** (0.063)	0.024 (0.188)
Percent of Nursing Hours Provided by unlicensed assistive personnel	0.172*** (0.041)	0.219*** (0.077)	0.146 (0.099)	0.148 (0.178)	0.058 (0.063)	0.272** (0.128)
Percent of Nursing Hours Provided by Contract Nurses	0.356*** (0.044)	0.276*** (0.088)	0.078 (0.091)	0.082 (0.143)	0.199*** (0.049)	0.255* (0.132)
R-squared	0.111	0.12	0.141	0.014	0.105	0.123

# Discussion



## Aggregation Over Time

Attenuation bias may influence results to the level that the null of no association cannot be rejected.

More discrete time periods of analysis (month, day, or shift) can capture otherwise unobserved variation, such as changes in work environment or seasonal changes.



## Aggregation Across Units

Hospital-wide data may not actually reflect workload, hours of direct care, and patient turnover.



## Controls for Unobserved Heterogeneity

Adding fixed effects to the statistical model can be used to attempt to account for hidden variability, such as hospital level of acuity, patient turnover, and unit culture, which may be difficult or impossible to measure.

# Limitations

Nursing hours were measured by hours worked, rather than hours of direct patient care.

Fixed effects may not fully account for the unknowable differences between units and hospitals.

Generalizability limited outside the VA.

Over or underestimating the effect of contract nurses.

While findings with data from several years ago may have limitations, the methods used in this analysis are enduring.

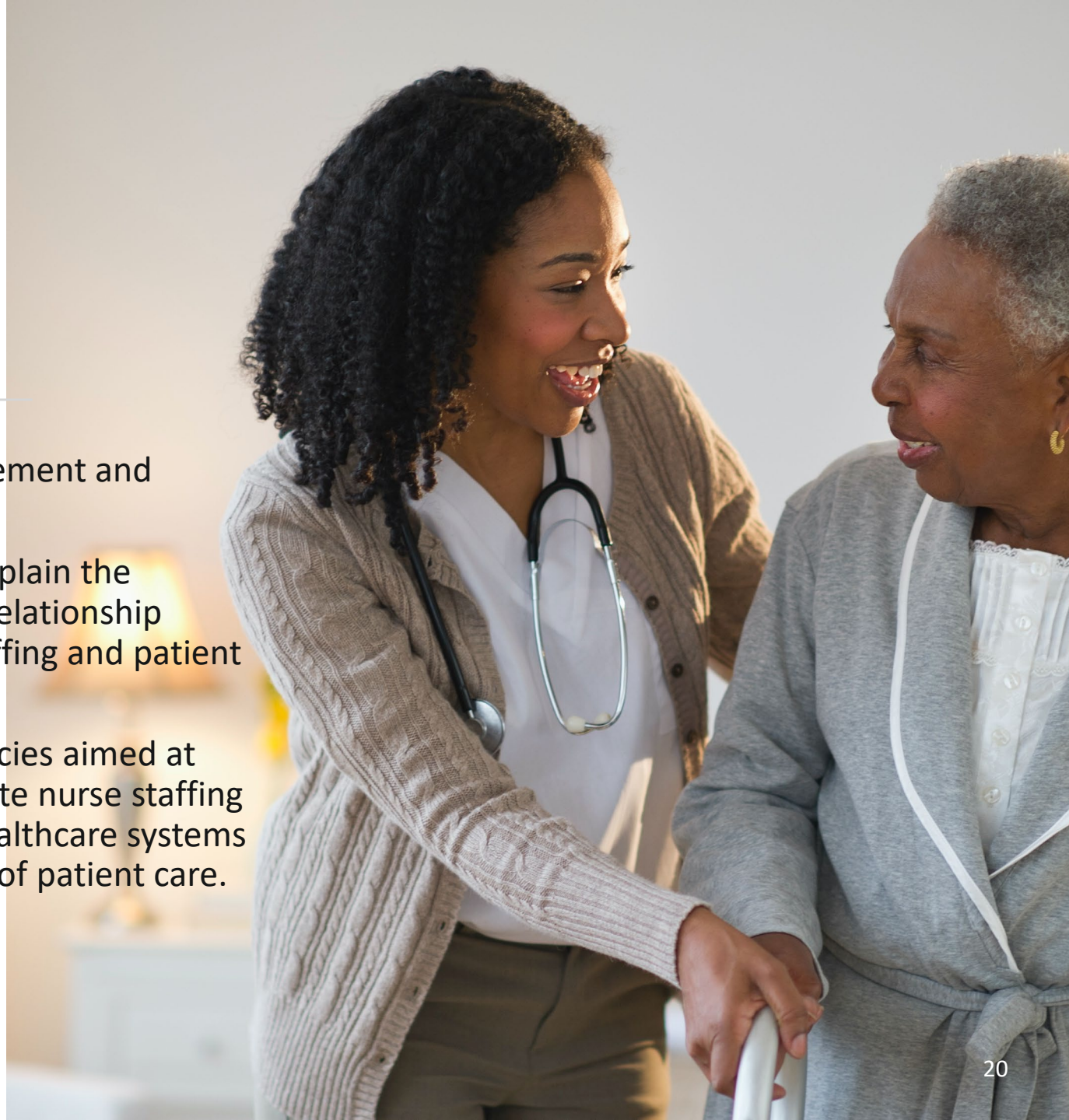


## Conclusion

---

More objective measurement and estimation may:

- ❖ more accurately explain the magnitude of the relationship between nurse staffing and patient outcomes.
- ❖ better support policies aimed at ensuring appropriate nurse staffing in hospitals and healthcare systems to improve quality of patient care.



# Thank you

Contact: [shira.winter@mountsinai.org](mailto:shira.winter@mountsinai.org)



# References

- Aiken, L. H., Clarke, S. F., Sloane, D. M. et. al. Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. *Journal of the American Medical Association* 2002; 288: 1987-1993.
- Aiken, L. H., Sloane, D. M., Bruyneel, L. et. al. Nurse staffing and education and hospital mortality in nine European countries: a retrospective observational study. *Lancet* 2014; 383(9931): 1824-1830.
- Bartel, A. P., Beaulieu, N. D., Phibbs, C. S. et. al. Human capital and productivity in a team environment: evidence from the healthcare sector. *American Economic Journal. Applied Economics* 2014; 6: 231.
- Donaldson, N., Bolton, L. B., Aydin, C. et. al. Impact of California's licensed nurse-patient ratios on unit-level nurse staffing and patient outcomes. *Policy, Politics, & Nursing Practice* 2005; 6(3): 1-12.
- Griffiths, P., Recio-Saucedo, A., Dall'Ora, C., et. al. The association between nurse staffing and omissions in nursing care: a systematic review. *Journal of Advanced Nursing* 2018; 74(7): 1474-1487.
- Kane, R. L., Shamiyan, T. A., Mueller, C., et. al. The association of registered nurse staffing levels and patient outcomes: systematic review and meta-analysis. *Medical Care* 2007; 45(12): 1195-1204.
- Mark, B. A., Harless, D. W., Spetz, J. et. al. California's minimum nurse staffing legislation: results from a natural experiment. *Health Services Research* 2013; 48(2): 435-454.
- Needleman, J., Buerhaus, P., Pankratz, S., et. al. Nurse staffing and inpatient hospital mortality. *The New England Journal of Medicine* 2011; 364: 1037-1045.
- Needleman, J., Buerhaus, P., Mattke, S., et. al. Nurse-staffing levels and the quality of care in hospitals. *The New England Journal of Medicine* 2002; 346: 1715-1722.
- Olley, R., Edwards, I., Avery, M., & Cooper, H. Systematic review of the evidence related to mandated nurse staffing ratios in acute care hospitals. *Australian Health Review* 2019; 43(3): 288-293.
- Sales, A., Sharp, N., Li, Y. F., et. al. The association between nursing factors and patient mortality in the Veterans Health Administration: the view from the nursing unit level. *Medical Care* 2008; 46(9): 938-945.
- Shang, J., Needleman, J., Liu, F., et. al. Nurse staffing and healthcare-associated infection, unit-level analysis. *The Journal of Nursing Administration* 2019; 49(5): 260-265.
- Shekelle, P. G. Nurse-patient ratios as a patient safety strategy: a systematic review. *Annals of Internal Medicine* 2013; 158(5 Part 2): 404-409.
- Stone, P. W., Mooney-Kane, C., Larson, E. L., et. al. Nurse working conditions and patient safety outcomes. *Medical Care* 2007; 45: 571-578.
- Agency for Healthcare Research and Quality. *Advancing Patient Safety: a decade of evidence, design and implementation*. 2018. Available at: <https://www.ahrq.gov/patient-safety/resources/advancing.html>. Accessed September 23, 2020.
- Lasater, K. B., Sloane, D. M., McHugh, M.D. et. al. Evaluation of hospital nurse-to-patient staffing ratios and sepsis bundles on patient outcomes [published online ahead of print, 2020 Dec 10]. *Am J Infect Control*. 2020:S0196-6553(20)31038-5. Doi: 10.1016/j.ajic.2020.12.002
- Ball, J. E., Griffiths, P., Rafferty, A. M. et. al. A cross-sectional study of 'care left undone' on nursing shifts in hospitals. *Journal of Advanced Nursing* 2016; 72(9): 2086-2097.

# Questions?

For more information visit the HERC website at [www.herc.research.va.gov](http://www.herc.research.va.gov)

Email us at [HERC@va.gov](mailto:HERC@va.gov)

Call us at (650) 617-2630



# **Overview of VA Data Sources That Can Be Used to Determine Nurse Staffing**

**Very brief overview, with comments about  
some of the strengths and limitations.**



# Nurse Staffing Data Sources in VA

- **Managerial Cost Accounting (MCA, formerly DSS) National Data Extracts (NDEs)**
  - Account Level Budgeter (ALB) NDE. Provides monthly total nursing labor hours, by labor type (RN, LPN/LVN, Aide, Contract) and ALB cost center. Inpatient nursing units have separate costs centers by type of unit.

# Nurse Staffing Data Sources in VA

## ■ PAID

- VA Payroll data – Provides work hours by pay period for individual nurses, including overtime hours and night/weekend premium hours.
- Time and Leave Unit (TLU) can be used to identify assigned work unit. Restricted to Federal employees (no contract nurses)

# Nurse Staffing Data Sources in VA

- **Bar Coded Medication Administration (BCMA) Data**
  - BCMA data records the date and time that a specific medication was administered to a specific patient. Includes ID of nurse administering medication. Can be used to identify the nurses working each shift. Limitation; doesn't work for units that use subset of nurses to administer medications.

# Nurse Staffing Data Sources in VA

- **Managerial Cost Accounting (MCA, formerly DSS) National Data Extracts (NDEs)**
  - Account Level Budgeter (ALB) NDE.  
Provides monthly total nursing labor hours, by labor type (RN, LPN/LVN, Aide, Contract) and ALB cost center. Inpatient nursing units have separate costs centers by type of unit.