




BMJ Open Patient outcomes and cost savings associated with hospital safe nurse staffing legislation: an observational study

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ABSTRACT

Objective To evaluate variation in Illinois hospital nurse staffing ratios and to determine whether higher nurse workloads are associated with mortality and length of stay for patients, and cost outcomes for hospitals.

Design Cross-sectional analysis of multiple data sources including a 2020 survey of nurses linked to patient outcomes data.

Setting: 87 acute care hospitals in Illinois.

Participants 210 493 Medicare patients, 65 years and older, who were hospitalised in a study hospital. 1391 registered nurses employed in direct patient care on a medical–surgical unit in a study hospital.

Main outcome measures Primary outcomes were 30-day mortality and length of stay. Deaths avoided and cost savings to hospitals were predicted based on results from regression estimates if hospitals were to have staffed at a 4:1 ratio during the study period. Cost savings were computed from reductions in lengths of stay using cost-to-charge ratios.

Results Patient-to-nurse staffing ratios on medical-surgical units ranged from 4.2 to 7.6 (mean=5.4; SD=0.7). After adjusting for hospital and patient characteristics, the odds of 30-day mortality for each patient increased by 16% for each additional patient in the average nurse's workload (95% CI 1.04 to 1.28; p=0.006). The odds of staying in the hospital a day longer at all intervals increased by 5% for each additional patient in the nurse's workload (95% CI 1.00 to 1.09, p=0.041). If study hospitals staffed at a 4:1 ratio during the 1-year study period, more than 1595 deaths would have been avoided and hospitals would have collectively saved over \$117 million.

Conclusions Patient-to-nurse staffing ratios vary considerably across Illinois hospitals. If nurses in Illinois hospital medical–surgical units cared for no more than four patients each, thousands of deaths could be avoided, and patients would experience shorter lengths of stay, resulting in cost-savings for hospitals.

INTRODUCTION

Despite substantial evidence that high registered nurse (RN) workloads are related to patient mortality—among other adverse patient outcomes^{1–4}—no US states, except for California,⁵ have implemented minimum

Strengths and limitations of this study

- Study design, staffing and outcome measures are similar to previously published studies evaluating the link between nurse staffing and patient outcomes.
- Staffing measures collected as prepolicy implementation baseline data to quantify the scope of the variation in staffing within Illinois state, and the impact of staffing variation on the public's health.
- Patient-to-nurse staffing measures are derived directly from staff nurses on medical and surgical units.
- Patient outcomes are risk-adjusted 30-day mortality and hospital length of stay.
- The cross-sectional study design precludes causal statements about the relationship of nurse staffing and patient outcomes.

hospital nurse staffing requirements. While many US states have pursued legislation to regulate hospital nurse staffing levels, support for such regulation is dampened for three primary reasons: (1) lack of prepolicy data documenting significant variation of hospital nurse staffing ratios across the state debating staffing regulation, (2) lack of local, timely evidence demonstrating variation in nurse staffing adversely affects patient outcomes and (3) an underdeveloped business case to justify the fiscal investments required to staff greater numbers of nurses at the bedside.

In this study, we address each of these three concerns using 2020 data from a large sample of 87 hospitals in Illinois where legislation to mandate patient-to-nurse staffing ratios is actively being debated (HB 2604 *Safe Patient Limits Act*).⁶ We project the number of deaths and hospital days that could be avoided, if Illinois hospitals staffed medical–surgical nurses at the 4:1 patient per nurse ratio proposed in the legislation. Because reductions in patient length of stays have economic implications



for hospitals, we estimate the potential cost savings to hospitals through reduced lengths of stay if hospitals moved to the 4:1 staffing ratio.

This is the first study to report local and timely evidence about staffing variation in a large sample of hospitals across Illinois, and the consequences of staffing variation for patient outcomes and costs of care to directly inform public policy efforts actively under consideration. The main objectives of this study are to evaluate variation in Illinois hospital nurse staffing ratios and to determine whether higher nurse workloads are associated with mortality and length of stay for patients, and cost outcomes for hospitals.

Background

Nurses are the around-the-clock surveillance system of hospitals; closely monitoring changes in patients' clinical condition and administering treatments and care as appropriate. When nurses care for fewer patients at time, they are able to spend more time at each patient's bedside, and as a result, patients are less likely to experience an adverse outcome such as a hospital-acquired infection,⁷ poor glycaemic control,⁸ readmission⁹ and even death.^{10–14} The clinical benefits of nurse staffing have primarily been studied in adult medical and surgical populations, but have also been observed in special populations including babies in neonatal intensive care units¹⁵ and children;¹⁶ and may also be key to reducing racial disparities in outcomes.^{9,17–19} The benefits of better nurse staff extend to nurses as well; with nurses in better-staffed hospitals reporting less burnout, less job dissatisfaction and being less likely to intend to leave their employer.^{10,20}

An emerging body of research evidence articulates the human and economic consequences of adverse patient outcomes that result from hospital nurse understaffing. For example, an analysis of hospital nurse staffing among New York hospitals found that if hospitals staffed medical–surgical units with four patients per nurse, as opposed to the average hospital ratio of 6.3 patients per nurse, then thousands of deaths could have been avoided and many hundreds of millions of dollars saved through shorter lengths of stay and avoided readmissions.²¹ The same study²² showed that improving nurse staffing in New York hospitals would have reduced deaths among sepsis patients more than a policy passed earlier that mandated adherence to a standardised set of services for sepsis patients. A study of adult medical patients showed that patients in hospitals with better nurse resources had better outcomes including less mortality, fewer readmissions and shorter lengths of stay—at no difference in cost, when compared with similar patients in hospitals with poorer resources.²³ These study findings have been corroborated in surgical patients;^{24,25} and find that improving nurse staffing would avoid adverse outcomes with sizeable cost savings to hospitals.²⁶

Despite the social and economic case for improving hospital nurse staffing, California remains the only US state to have implemented required staffing standards.

Passed in 1999 and implemented in 2004, the California legislation resulted in improved staffing, with the greatest improvements observed among safety-net hospitals.²⁷ Compared with other states which did not implement safe staffing requirements, patients in California hospitals experienced lower mortality and failure-to-rescue rates.^{5,28} The California experience serves as an example of a successfully implemented and sustained state-wide policy mandate for safe hospital staffing and patient care.

DATA AND METHODS

Design

This observational study of hospitals and patients uses multiple linked data sources including Medicare patient claims data, American Hospital Association (AHA) data of hospital characteristics and a survey of RNs to provide data on hospital nurse staffing ratios on medical and surgical units.

Patient sample

The patient sample includes persons insured by Medicare who were 65 years and older (the qualifying age for Medicare—the US federal government health insurance programme) and who were admitted to an acute care hospital in Illinois in 2018. Data on Medicare patients were obtained from the Centers for Medicare and Medicaid Services (CMS) MEDPAR files. Patients admitted for psychiatric reasons and drug/alcohol use were excluded, as were patients with lengths of stay greater than 60 days. Each unique patient was assigned an index hospitalisation, created by selecting the first admission during the study period. The analytic sample included only these index hospitalisations, which accounted for roughly half of all the Medicare hospitalisations in Illinois during the study period.

Hospital sample

Short-term acute care and critical access hospitals that had medical and surgical direct care nurses who responded to the survey of nurses were included. The survey of nurses was sent via email to all actively licensed RNs in the state of Illinois (n=168001). Data collection ran from 16 December 2019 to 24 February 2020. Nurse responses were anonymous, but nurses were asked to report the name of their employer, thus allowing responses from nurses working in the same hospitals to be aggregated together to create hospital-level measures of patient-to-nurse staffing ratios. Our data collection method relies on nurses as key informants of their hospital.²⁹ Thus, while we directly survey nurses, our interest is in hospital-level organisational measures, in this case, patient-to-nurse staffing ratios.

The nurse response rate was 18% of the 168001 RNs surveyed, which is anticipated considering endemic difficulties with survey response rates³⁰ and the fact that our sampling frame consisted of 100% of licensed nurses in the state, only a fraction of whom are employed in

hospitals, which was the focus of our study. A similar survey conducted in other states yielded comparable response rates. In the broader multistate study, the survey implemented a double-sampling approach to evaluate for potential non-response bias. The results demonstrated that nurse reports of patient-to-nurse staffing ratios were no different among nurses who responded to the main survey and those that responded to the non-respondent survey.²⁹ Thus despite an 18% response rate, evidence suggests that even if non-response bias were present, it likely does not affect the validity of the resultant staffing estimates.

Because this is a study of hospitals and the patients in them, the nurse survey response rate is of somewhat lesser importance than the degree to which the survey achieved adequate representation of hospitals (via a high hospital response rate) and the patients in them. We excluded hospitals that were long-term rehabilitation hospitals, psychiatric facilities or free-standing children's hospitals. Based on the remaining acute care hospitals, our analytic sample of 87 hospitals represented 86.5% of Medicare index admissions in the state and roughly two-third of the short-term acute care hospitals in Illinois. We have less representation of critical access hospitals since we were not able to obtain data from enough nurses in those small facilities to reliably estimate staffing ratios.

Patient-to-nurse staffing

Surveyed nurses were asked to report whether they were working in direct patient care or indirect care positions (eg, management); which type of unit they worked on and how many patients they were assigned to care for on their most recent shift. Only data from direct care RNs who reported working their most recent shift on a medical or surgical unit were used to create our measure of staffing. Responses were then aggregated to create a hospital-level measure of medical–surgical patient-to-nurse staffing. The survey also asked nurses to report how many patients they could safely care for in their job setting.

Patient outcomes

Patient outcome measures included 30-day mortality and hospital length of stay. 30-day mortality was defined as a death occurring 30-days from date of admission and included deaths that occurred outside of the hospital. Hospital length of stay was defined as total number of days in the hospital during the index admission.

Cost outcomes

Cost savings were estimated using Medicare-specific cost-to-charge ratios using patient-level charge data from the MEDPAR files. Cost savings from reductions in length of stay were computed by first estimating the predicted reduction in patient days if hospitals staffed at the 4:1 ratio, then applying the reduction to total charges and then converting to costs using the hospital-level Medicare-specific cost-to-charge ratios from CMS Impact Files.

Risk-adjustment

Hospital risk-adjustment variables included hospital size, defined by number of beds, from the AHA Annual Survey. Patient covariates included patient age, sex, Elixhauser comorbidities,³¹ dummy variables for diagnostic-related groups—and in models estimating effects of staffing on length of stay, patient discharge disposition status.

Statistical analysis

Descriptive statistics were used to show medical–surgical nurse staffing ratios, and the numbers of patients and nurse survey respondents in the 87 study hospitals. Patient characteristics (eg, age, sex, transfer status, comorbidities) as well as percentage of patients who died within 30-days of admission and average (and SD) length of stay are reported. We also show percentages of nurses who reported that the number of patients they cared for during their last shift exceeded the number of patients they felt they could safely care for. Prior to accounting for confounding factors, we show variation in patient mortality rates and lengths of stay among hospitals with different staffing levels (ie, <5, 5≤6, ≥6 patients per nurse).

Multilevel random-effects logistic regression models and zero-truncated negative binomial regression models were used to estimate the association between nurse staffing with 30-day mortality and length of stay, respectively. These associations were estimated before and after accounting for potentially confounding hospital and patient characteristics. Using adjusted estimates from our regression models, we estimated how many deaths could have been avoided and how much money could have been saved (from shorter lengths of stay) were hospitals to staff medical–surgical nurses at the levels proposed in the legislation (4:1 patients per nurse). STATA was used to perform the analyses. This study received IRB approval from the University of Pennsylvania (Protocol #834307).

Patient and public involvement

No patient involved.

RESULTS

Our analytic sample included 210 493 Medicare beneficiaries in 87 Illinois hospitals (table 1). Staffing estimates were derived from an average of 16 direct care medical–surgical nurse respondents per hospital, with as many as 68 nurse respondents in larger hospitals. Medical–surgical staffing ratios ranged from 4.2 to 7.6 patients per nurse, with the lower bound just above the four patients per nurse proposed in the legislation. The average staffing ratio in Illinois hospitals was 5.4 and somewhat higher (5.6) among smaller hospitals than larger hospitals (5.3).

Among the study patients, 5.8% died within 30-days of admission and the average length of stay was 4.1 days, with a SD of 3.7 days (online supplemental table 1). Forty percent of the patients were 80 years of age or older, and 56% were female. The most common comorbidities included hypertension, fluid and electrolyte

Table 1 Hospital size, numbers of patients and nurse respondents and patient-to-nurse staffing ratios among 87 Illinois study hospitals

Hospital characteristics	Number of hospitals	Percent of hospitals	Medical-surgical staffing (patients per nurse)			Range in staffing		
			Mean	SD	Median	Minimum	Maximum	
Hospital size								
≤100 beds	9	10.3	5.6	0.8	5.2	4.2	6.5	
101–250 beds	32	36.8	5.5	0.8	5.3	4.4	7.6	
>250 beds	46	52.9	5.3	0.6	5.2	4.2	6.7	
Total	87	100.0	5.4	0.7	5.3	4.2	7.6	
Patients discharged from 87 study hospitals								
Patients	Number		Mean	SD	Median	Minimum	Maximum	
	210493		2420	1821	1933	100	11470	
Nurses completing surveys in 87 study hospitals								
Medical-surgical nurses	Number		Mean	SD	Median	Minimum	Maximum	
	1391		16	12.9	12	5	68	

Table 2 Percent of nurses reporting that the number of patients assigned to them during the last shift exceeded the number they could safely care for

Number of patients assigned on last shift	Whether number assigned exceeds number RN reports could safely care for		
	Does not exceed % (no.)	Exceeds % (no.)	Total % (no.)
Four or fewer	82.7 (253)	17.3 (53)	100 (306)
Five	41.6 (211)	58.4 (296)	100 (507)
Six or more	33.0 (142)	67.0 (288)	100 (430)
Total	48.8 (606)	51.2 (637)	100 (1243)

Note. 148 of the 1391 nurses did not provide a response about how many nurses they could safely care for. Thus, the analytic sample in table 2 is 1243 nurses for whom the relevant data were available. RN, registered nurse.

disorders, chronic pulmonary disease and renal failure. Nurses reported safety concerns related to the number of patients they cared for during their last shift (table 2). Half of nurses (51.2%) reported that their patient assignment during their last shift exceeded the number they assessed they could safely care for. Two-thirds of nurses (67.0%) who were assigned 6 or more patients assessed that workload was unsafe. Most nurses (82.7%) who were assigned four or fewer patients assessed that patient assignment constituted a safe workload.

Prior to adjusting for confounding variables of the hospitals and patients, we found that patient mortality and lengths of stay in hospitals varied with different nurse staffing ratios (table 3). The average 30-day mortality rate among hospitals with an average staffing ratio of <5 patients per nurse was lower (5.6%) compared with mortality among hospitals where nurses cared for between 5≤6 patients (6.1%) and ≥6 patients (6.1%). Lengths of stay were shorter in hospitals where nurses cared for fewer patients at a time (4.0 days in hospitals with <5 patients per nurse, vs 4.1 days in hospitals with 5≤6 patients per nurse, vs 4.5 days in hospitals with ≥6 patients per nurse).

Table 4 presents the effect of nurse staffing on mortality and length of stay. After adjusting for hospital and patient characteristics, the odds of 30-day mortality for each patient increased by a factor of 1.16 (or 16%) for each additional patient added to the average nurse's workload (OR 1.16, 95% CI 1.04 to 1.28; p 0.006). The odds

Table 3 Average mortality and lengths of stay for patients in hospitals with different patient-to-nurse staffing ratios

Patient-to-nurse ratio	N	30-day mortality Mean (SD)	Length of stay Mean (SD)
<5	24	5.6% (1.4%)	4.0 (0.55)
5≤6	44	6.1% (1.2%)	4.1 (0.52)
≥6	19	6.1% (2.0%)	4.5 (1.27)
Total	87	6.0% (1.5%)	4.2 (0.77)

Table 4 Effect of medical–surgical patient-to-nurse staffing on patient outcomes

Patient outcome	Coefficient	Unadjusted models	Fully adjusted models
30-day mortality	OR (95% CI)	1.15 (1.06 to 1.26)	1.16 (1.04 to 1.28)
	P> z	0.001	0.006
Length of stay	Incident rate ratio (95% CI)	1.00 (0.95 to 1.06)	1.05 (1.00 to 1.09)
	P> z	0.909	0.041

Note. 30-day mortality outcomes are estimated from 196270 patients and excludes DRGs with <5 cases and admissions by transfer. Hospital controls included number of beds. Patient controls included age, sex, comorbidities and dummy variables for DRG. Length of stay outcomes are estimated from 210493 and excludes DRGs with zero deaths and patients transferring in or out. Hospital controls included number of beds. Patient controls included age, sex, comorbidities, dummy variables for DRG and discharge disposition of death or transfer. DRG, diagnostic-related groups.

of staying in the hospital a day longer at all intervals increased by a factor of 1.05 (or 5%) for each additional patient in the nurse’s workload (IRR 1.05, 95% CI 1.00 to 1.09, p 0.041).

Using these results from the adjusted regression models, we estimated the number of deaths that would have been avoided if hospitals staffed at the four patients per nurse recommendation in the proposed policy (as opposed to the observed ratio which was greater than four patients per nurse in all hospitals and nearly eight patients per nurse in some of them). Roughly 1595 deaths could have been avoided among Medicare beneficiaries in the study hospitals during the 1-year study period. Improving staffing ratios to the 4:1 ratio was projected to reduce patient lengths of stay by over 40 000 days. These reductions in lengths of stay would collectively save Illinois hospitals over \$117 million per year (table 5).

Table 5 Deaths avoided and cost savings from shorter lengths of stay with 4:1 staffing ratios

Variables used to estimate deaths avoided and cost savings	Mortality	Length of stay
Number of patients at risk of experiencing outcomes	196270	210493
Observed number of patients who died	11370	
Number of patients expected to die with 4:1 patient/nurse ratio	9775	
Difference between observed and expected deaths	1595	
Observed number of patient days		867694
Expected number of patient days with 4:1 patient/nurse ratio		826784
Difference between observed and expected patient days		40910
Observed total charges		\$11 798 193 318
Projected reduction in total charges		\$486 714 034
Projected cost savings		\$117 557 590

Note. Data from 84 short-term acute care hospitals were used in the projection of cost savings from reduced lengths of stay. Three critical access hospitals were excluded from the cost-saving analyses reported in table 5 because critical access hospitals do not report cost-to-charge ratios needed to compute cost savings.

DISCUSSION

Studying a large sample of 87 acute care hospitals in Illinois, we found considerable variation in medical–surgical nurse staffing ratios, ranging from 4.2 to 7.6 patients per nurse. The average hospital staffing across the state (outside intensive care settings) was 5.4 patients per nurse, which is nearly 1.5 patients above the recommended staffing levels proposed in the HB 2604 *Safe Patient Limits Act*.⁶ Half (51.2%) of nurses reported their patient assignment during their last shift was unsafe; and among nurses assigned four or fewer patients, only 17.3% found that staffing ratio to be unsafe.

Staffing conditions were associated with adverse health outcomes for Medicare patients, including mortality and longer lengths of stay. Each additional patient in a nurse’s workload increased the odds of patient death by 16%. If the study hospitals had been staffing medical–surgical nurses at the proposed ratio during the 1-year study period, we projected that 1595 deaths would have been avoided just among Medicare patients. Had our study considered patients of all ages who would benefit from improved nurse staffing, we anticipate considerably more deaths would have been avoided.

The odds of Medicare patients staying in the hospital a day longer increased by 5% for each additional patient in the nurse’s workload. Hospitals would have collectively saved over \$117 million annually from length of stay reductions just among Medicare patients—cost savings which could be reinvested into financing safer nurse staffing ratios. These findings are consistent with other research conducted in New York hospitals³² and internationally^{33 34} which show that patients in hospitals with better nurse staffing have shorter lengths of stay as well as fewer readmissions, both of which translate to avoided costs. Studies conducted in Queensland Australia and Chile demonstrate that the magnitude of the cost savings associated with better nurse staffing were in excess of the costs of hiring more nurses;^{33 34} a



illustration of the value proposition for increasing nurse staffing.

In the current study, estimates of avoidable deaths and cost savings are conservative. Our analysis used roughly half of the annual Medicare hospitalisations in Illinois state since we restricted the sample to index hospitalisations. Other studies show that patients of all ages benefit from improved hospital nurse staffing.^{16 35} Thus, if the staffing policy were to be enacted, the human and economic benefits would likely be much greater. Additionally, our cost savings analysis is conservative because it does not account for the savings that may be realised from reductions in nurse burnout and turnover that result from chronic understaffing. In a previously published paper on nurse staffing in Illinois hospitals, we showed that hospital understaffing is associated with poor nurse outcomes including burnout, job dissatisfaction and intent to leave.^{20 36} Nurse burnout has been linked with worse patient outcomes including mortality and longer lengths of stay³⁷ and intent to leave is associated with turnover.^{38–40} Turnover of nurses is cost consequential for hospitals, with estimates of replacing a single bedside nurse ranging from \$20 561⁴¹ to \$88 000.⁴² Although evidence demonstrates that cost savings can be achieved—via shorter lengths of stay and reduced readmissions—from staffing more nurses at the bedside, future research could expand the scope of the economic consequences of improving nurse staffing in terms of other patient and nurse outcomes with their associated cost savings.

Strengths and limitations

This study uses hospital medical–surgical nurse staffing data collected in 2020 to inform current staffing policy debates in Illinois. Rarely is timely, rigorous and objective evidence, analysed by an independent team of researchers, available to inform policy in this way. Reporting lags in claims data meant that the most recent available data on patients were from 2018. Although the hospital staffing and patient data do not coincide, hospital nurse staffing has changed little in the last decade.⁴³ Thus, the staffing estimates obtained in 2020 likely resemble those in 2018. While our study included most large and medium size hospitals in Illinois, which account for most hospitalised patients in the state, smaller hospitals including critical access hospitals are underrepresented in the study. The cross-sectional study design precludes causal statements about the relationship between nursing staffing and patient outcomes.

Implications for policy decision-making

A recent US Harris Poll⁴⁴ suggests that 90% of the US public favour requiring hospitals to meet minimum safe nurse staffing standards. Our study finds uneven nurse staffing among Illinois hospitals which poses unfavourable consequences for patients and hospitals. If Illinois enacted the *Safe Patient Limits Act*, our analysis suggests thousands of deaths per year could be avoided.

Additionally, hospitals could save substantially through reductions in patients' lengths of stay associated with improving nurse staffing. These savings could be reinvested into the costs of employing additional nurses.

Enacting the *Safe Patient Limits Act* would likely create opportunities for more nurses to enter the workforce, raising questions about where these nurses would be drawn from. There is currently no widespread shortage of actively licensed RNs. Nurse graduations are at an all-time high, with enough nurses entering the workforce annually to more than replace retirements.⁴⁵ California, the only state to enact nurse staffing ratio mandates similar to what is being proposed in Illinois, has successfully implemented the ratios despite have a lower nurse-to-population ratio compared with Illinois (11.3 RNs per 1000 population in California; 16.7 RNs per 1000 population in Illinois).⁴⁶ Finally, the Nurse Licensure Compact, which is state legislation to permit nurses to hold a multistate US license is currently under consideration in Illinois.⁴⁷ Passing such legislation would enable nurses licensed in any of the 34 states currently in the Compact to practice in any other Compact state, without the burden of having to obtain an additional license. Such legislation permits greater mobility of nurses to practice across state lines. Thus, trends in the nursing workforce and the opportunity for Illinois to join the Nurse Licensure Compact suggest it is unlikely that passing mandated safe nurse staffing legislation would result in nursing shortages that would negatively affect access to care or care quality.

CONCLUSIONS

Nurse staffing on medical and surgical units in Illinois hospitals averaged 5.4 patients per nurse and ranged from as few as 4.2 patients per nurse to as many as to 7.6. These estimates suggest that few Illinois hospitals are currently meeting the minimum staffing levels which would be required by the *Safe Patient Limits Act* currently under consideration. We found that each additional patient in a nurses' workload was associated with 16% higher odds of death and longer lengths of stay. If Illinois hospitals staffed medical and surgical units at the ratio proposed in the legislation, we project thousands of deaths could be avoided each year and patients would experience shorter lengths of stay resulting in hundreds of millions of dollars in cost-savings for hospitals.

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