Center
for
Health Outcomes
and Policy Research

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A Policy Evaluation of Proposed Pennsylvania Hospital Nurse Staffing Legislation: A Center for Health Outcomes and Policy Research White Paper

Nurses play a critical role in ensuring patient safety and quality care while providing care to patients in various settings including hospitals.[1] Numerous studies have shown that hospitals in which nurses care for fewer patients each have better patient outcomes including lower mortality rates for patients, lower readmission rates, and shorter length of stay (LOS).[2–5] The benefit of better staffing also extends to nurses. Hospitals with better nurse staffing have lower rates of nurse burnout, less job dissatisfaction, and nurses are less likely to intend to leave their employer.[6,7]

California is the only state to have enacted minimum staffing ratio requirements for hospital nurses.[8] Since the implementation of staffing ratio legislation in 2004, patient outcomes such as mortality and failure-to-rescue improved in California hospitals.[8,9] In Pennsylvania, legislation to mandate patient-to-nurse staffing ratios is being debated.[10] A 4:1 patient-per-nurse ratio in medical-surgical units is being proposed. The Center for Health Outcomes and Policy Research has studied the outcomes of nurse staffing variation in Pennsylvania hospitals for 30 years providing a wealth of information to inform whether the pending legislation is needed and whether it is likely to be in the public's interest.

Methods

Study Design and Data

Data were obtained from multiple sources including a NIH-funded CHOPR survey of a 30% random sample of all RNs in Pennsylvania in 2016 linked with the 2016 American Hospital Association (AHA) Annual Survey, and patient outcomes from the 2016 Pennsylvania Health Care Cost Containment Council (PHC4) database on hospital patient discharge data.

The AHA Annual Survey included information on hospital characteristics such as size, teaching status, and technology availability. The PHC4, which collected hospital discharge data on all inpatient admissions, was used to identify patients who were discharged from Pennsylvania hospitals in 2016. Nurse surveys included details about the name of the employing hospital, unit assignment (e.g., medical, and surgical), and patient-to-registered nurse (RN) staffing assignment during their most recent shift worked. The name of surveyed nurses' employing hospital and the type of unit each nurse worked on allowed us to create hospital-level measures of actual patient-to-nurse staffing ratios from responses of RNs working in the same hospitals. Further details about the methodology are discussed elsewhere.[11,4]

Sample

Inpatients aged 65 to 99 years who had an admission for medical or surgical reasons were included in this analysis. We excluded outpatients, labor and delivery, and psychiatric patients as

well as patients receiving palliative care or with Do Not Resuscitate (DNR) orders. The sample of hospitals included 115 adult non-federal acute care hospitals in Pennsylvania.

Measures

Patient-to-nurse staffing ratio was the independent variable for our study. As part of the survey, RNs were asked how many patients and RNs providing direct care were on their unit on their last shift. The ratios of patients to nurses reported by direct-care medical-surgical RNs during their last shift were aggregated within hospitals. This yields a superior measure of actual staffing levels than other sources of nurse staffing information.[2]

Patient outcomes, derived from PHC4 data, included in-hospital mortality, length of stay (LOS), and readmissions within 30 days of discharge. In-hospital mortality was defined as a death occurring during the first 30 days of the hospitalization. LOS is the patient's length of stay in the hospital and excluded patients transferred from other acute hospitals as well as long-term patients with LOS of more than 30 days. Readmissions were restricted to the first admission within the period to avoid double counting and are defined as a hospital admission occurring within 30 days from discharge from the index hospitalization among patients who were discharged alive.

Covariates. We controlled for variables including information on patient and hospital characteristics. Patient characteristics included age, sex, transfer status, 28 Elixhauser comorbidities, and dummy variables for each surgical or medical diagnostic-related group (DRG). Hospital characteristics including size, teaching status, and technology status were obtained from AHA Annual Survey. Hospital size was defined by the number of licensed beds (small ≤100 beds; medium 101–250 beds; large >250 beds). Teaching status was based on the ratio of medical residents or fellows to hospital beds (nonteaching, no medical trainees; minor teaching, 0–4 per bed; major teaching, ≥4 per bed). High-technology hospitals were defined as hospitals that performed major organ transplants and/or open-heart surgery. The region of hospitals was also obtained from AHA Annual Survey, and the variable was categorized as metro, micro, and rural.

Data Analyses. We calculated the descriptive statistics, including the frequency, mean, and standard deviation patient characteristics (i.e., age, sex, transfer status, 28 Elixhauser comorbidities, and patient outcomes) across medical and surgical patient categories. We also calculated descriptive analyses for hospital characteristics (i.e., size, teaching status, technology status, and region) and across groups of hospitals with different staffing levels (i.e., above 4:1 and above 5:1 patient-to-nurse

Results

There were 115 Pennsylvania hospitals with all 3 required sources of information. The average medical-surgical staffing ratios ranged across hospitals from 3.25 to 11 patients per nurse. Exhibit 1 shows hospital characteristics across different staffing levels (i.e., above 4:1 and above 5:1 patient-to-nurse staffing ratios). About 39% of the hospitals had 250 beds or more, 16% were major teaching hospitals, and 44% of hospitals were characterized as low-technology hospitals. In addition, 4% of the study hospitals were rural. Our staffing findings show that 110

hospitals or 96% of PA hospitals are staffing worse than the proposed 1:4 minimum ratio proposed in PA HB106. If the minimum ratio was 1:5, 67 hospitals or 58% of hospitals are staffed worse than the required minimum.

Exhibit 2 shows patient characteristics and outcomes. Almost 55% of the patients were female, and 6% of the patients were transferred. The most common comorbidities were hypertension (72%), fluid and electronic disorders (32%), diabetes without complications (25%), and chronic pulmonary disease (24%). The same percentage of medical and surgical patients (3%) died in the hospital within 30 days of admission. About 13% of the medical patients and 9% of surgical patients were readmitted within 30 days. The average LOS, excluding patients who died, were transferred or stayed beyond 60 days, was 4.68 days (SD = 3.61) for medical patients and 5.34 days on average for surgical patients (SD = 4.63).

Exhibit 3 shows the findings of our unadjusted and adjusted regression models. After adjusting for hospital and patient characteristics, the odds of in-hospital mortality for each patient increased by a factor of 1.07 (or 7%) for each additional medical patient (OR 1.07, 95% CI 1.01 - 1.14; p = .034) and by a factor of 1.08 (or 8%) for each additional surgical patient (OR 1.08, 95% CI 1.01 - 1.14; p = .024) added to the average nurse's workload. For the adjusted 30-day readmission outcomes, we also found similar findings. The odds of 30-day readmission for each patient increased by a factor of 1.02 (or 2%) for each additional medical patient (OR 1.02, 95% CI 1.00 - 1.04; p = .015) and by a factor of 1.04 (or 4%) for each additional surgical patient (OR 1.04, 95% CI 1.01 - 1.07; p = .023) added to the average nurse's workload. Lastly, for LOS-adjusted models, we found significant findings for only medical patients. The odds of staying in the hospital a day longer for medical patients increased by a factor of 1.02 (or 2%) for each additional patient in the nurse's workload (IRR 1.02, 95% CI 1.02 - 1.04, p = .035).

Exhibit 4 shows the adjusted effects to estimate the number of lives that would have been saved and the amount of money that might have been saved by hospitals from shorter LOS and avoided readmissions, if medical-surgical staffing had been 4:1. We estimated that at least 1,162 deaths annually could have been avoided in Pennsylvania hospitals for the 4:1 staffing ratio and 459 deaths if medical-surgical staffing had been 5:1. Improving staffing ratios to the 4:1 ratio was projected to reduce 30-day readmission by 775 and by 306 cases if the ratio were 5:1. In addition, improving patient per nurse staffing to 4:1 was estimated to reduce patient LOS by over approximately 39,969 days and by 14,146 days for a 5:1 ratio. The LOS reduction would collectively save Pennsylvania hospitals over $93 million per year if medical-surgical staffing had been 4:1 and over $33 million per year for the 5:1 ratio.

Discussion

Our study demonstrates that patient-to-nurse staffing ratios on medical-surgical units vary widely across 115 adult non-federal acute care hospitals in Pennsylvania. The average medical-surgical nurse provides care to 5.6 patients, and nurses' workloads range across hospitals from 3.3 patients per nurse to as many as 11.0. We found each additional patient added to a nurse's workload was significantly associated with higher odds of in-hospital mortality, 30-day readmission, among medical-surgical patients, and longer LOS among medical patients.

If all Pennsylvania hospitals were staffed in medical and surgical units at the proposed rate in pending legislation, a conservative estimate of the number of hospital deaths avoided annually is 1,162 avoided deaths. This is a conservation estimate as this analysis looks only at lower odds of death among elderly patients and patients of all ages in hospitals are at higher risk of death when nurses care for more than 4 patients each. Moreover, improving staffing ratios could reduce patient LOS by approximately 39,969 days. The cost projection was based on Kaiser Family Foundation estimates for the year 2016 in Pennsylvania. Based on their estimates the hospital-adjusted expenses per inpatient day was $2,332 per patient. The LOS reduction would collectively save Pennsylvania hospitals over $93 million per year if medical-surgical staffing had been 4:1. Even though the proposed legislation is aiming for a 4:1 ratio, the estimates for avoidable deaths and cost savings at a ratio of no greater than 5 patients per nurse are also substantial.

The cost analysis does not include nurse burnout and turnover that are due to hospital 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.[7] Nurse burnout has been linked with worse patient outcomes including mortality and longer LOS.[14] Research shows that a poor work environment is associated with burnout among nurses, ultimately influencing their decision to leave their jobs.[14,16] Turnover of nurses is costly for hospitals as replacing a single bedside nurse can cost $88,000.[15]

Conclusions

Nurse staffing on medical and surgical units in Pennsylvania hospitals averaged 5.6 patients per nurse and ranged from 3.3 patients per nurse to as many as 11 patients per nurse. This large variation in nurse staffing among Pennsylvania hospitals is associated with adverse outcomes for patients, nurses, and the financial health of hospitals. Few Pennsylvania hospitals are currently meeting the minimum nurse staffing levels which would be required by the proposed legislation. We found that each additional patient in a nurses' workload was associated with 16% higher odds of death and longer lengths of stay. If Pennsylvania hospitals staffed medical and surgical units at the ratio proposed in the legislation, we project over a thousand hospital deaths a year would be avoided each year and patients would experience shorter lengths of stay resulting in hundreds of millions of dollars in cost-savings for hospitals that would offset the costs necessary to hire additional nurses. These results present strong scientific evidence that the proposed ratio legislation is in the public's interest.

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Exhibit 1

Characteristics of the 114 Pennsylvania Hospitals

	Total hospitals (n =114)		**Above 4:1 Staffing Ratio (n = 110)**		**Above 5:1 Staffing Ratio (n = 67)**	
	(n) %	Mean (SD)	(n) %	Mean (SD)	(n) %	Mean (SD)
Total	115 (100)	5.58 (1.40)	110 (96)	5.67 (1.37)	67 (58)	6.33 (1.38)
Hospital size						
=< 100 beds	16 (14)	6.31 (1.47)	16 (100)	6.31 (1.47)	12 (75)	6.83 (1.32)
101-250 beds	54 (46)	5.83 (1.53)	52 (96)	5.91 (1.49)	37 (69)	6.40 (1.52)
>250 beds	45 (39)	5.02 (0.96)	42 (93)	5.11 (0.94)	18 (40)	5.86 (0.98)
Teaching status						
Nonteaching	52 (46)	5.82 (1.28)	52 (100)	5.82 (1.28)	35 (67)	6.33 (1.28)
Minor teaching	45 (39)	5.62 (1.62)	43 (96)	5.72 (1.60)	25 (56)	6.56 (1.63)
Major teaching	18 (16)	4.79 (0.68)	15 (83)	4.99 (0.56)	7 (39)	5.51 (0.18)
Technology						
Low	50 (44)	6.12 (1.51)	50 (100)	6.12 (1.51)	37 (74)	6.60 (1.48)
High	65 (57)	5.17 (1.15)	60 (92)	5.29 (1.11)	30 (46)	5.99 (1.19)
Region						
Metro	96 (83)	5.39 (1.19)	91 (95)	5.48 (1.16)	53 (55)	6.10 (1.15)
Micro	14 (12)	6.91 (2.05)	14 (100)	6.91 (2.05)	11 (79)	7.47 (1.96)
Rural	5 (4)	5.53 (1.08)	5 (100)	5.53 (1.08)	3 (60)	6.16 (1.38)

Notes. High technology refers to hospitals that capable of performing open heart surgery and/or organ transplants.

Abbreviations. N: number, SD: standard deviation

Exhibit 2

Characteristics of the Medical and Surgical Patients in the 115 Pennsylvania Hospitals

	All Participants (n = 522,775)	**Medical Patients (n = 391,700)**	**Surgical Patients (n = 134,075)**
Patient Characteristics			
Age, n (%)			
65-69	104,130 (20)	69,528 (18)	34,602 (26)
70-74	99,150 (19)	68,763 (18)	30,387 (23)
75-79	94,463 (18)	68,418 (17)	26,045 (19)
80-84	91,356 (17)	70,471 (18)	20,885 (16)
85-89	80,939 (15)	66,343 (17)	14,596 (11)
90+	55,737 (11)	48,177 (12)	7,560 (6)
Sex, n (%)			
Male	237,616 (45)	174,142 (44)	63,474 (47)
Female	288,159 (55)	217,558 (56)	70,601 (53)
Transfer status, n (%)			
Not transferred in	496,401 (94)	371,285 (95)	125,116 (93)
Transferred in	29,374 (6)	20,415 (5)	8,959 (7)
Common comorbidities, n (%)			
Hypertension	377,247 (72)	278,736 (71)	98,551 (73)
Fluid and electrolyte disorders	168,158 (32)	134,504 (34)	33,654 (25)
Diabetes without complications	133,686 (25)	103,085 (26)	30,301 (23)
Chronic Pulmonary Disease	127,652 (24)	100,117 (26)	27,535 (21)

Exhibit 2 (continued)

Renal failure	120,256 (23)	94,881 (24)	25,375 (19)
Deficiency anemias	106,469 (20)	83,316 (21)	23,153 (17)
Hypothyroidism	103,526 (20)	79,605 (20)	23,921 (18)
Congestive heart failure	93,608 (18)	78,993 (20)	14,615 (11)
Depression	66,436 (13)	51,587 (13)	14,849 (11)
Obesity	62,845 (12)	42,661 (11)	20,184 (15)
Patient Outcomes			
In-hospital mortality, n (%)	17,236 (3.28)	13,565 (3.46)	3,671 (3.46)
30-day readmission, n (%)	30,087 (11.90)	21,356 (13.31)	8,731 (9.45)
Length of stay, mean (SD)	4.87 (3.94)	4.68 (3.61)	5.34 (4.63)

Abbreviations. N: number, M: median, SD: standard deviation

Exhibit 3

Effect of Medical Surgical Staffing (Patient-to-Nurse Ratio) on Medical and Surgical Patient Outcomes

Patient Outcome	Medical Patients				Surgical Patients			
	Unadjusted Models		Fully Adjusted Models		Unadjusted Models		Fully Adjusted Models	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
In-hospital mortality	0.99 (0.93 - 1.05)	.741	1.07 (1.01 - 1.14)	.033	0.92 (0.84 - 1.01)	.079	1.08 (1.01- 1.14)	.023
30-day readmission	1.00 (0.98 - 1.02)	.879	1.02 (1.00- 1.04)	.016	1.00 (0.96 - 1.04)	.913	1.04 (1.01- 1.07)	.023
	IRR (95% CI)	*P*	IRR (95% CI)	*P*	IRR (95% CI)	*P*	IRR (95% CI)	*P*
Length of stay	1.00 (0.97- 1.02)	.795	1.02 (1.00 - 1.03)	.036	0.97 (0.94- 1.01)	.122	1.01 (0.99- 1.03)	.514

Abbreviations. OR: odds ratio, CI: confidence interval

Exhibit 4

Lives Saved and Cost Savings from Reduced Readmissions and Shorter Lengths of Stay with Staffing Ratios

	Medical-Surgical Patients		
Variables for the Estimated Lives Saved and Cost Savings	**Mortality**	**30-Day Readmission**	**Length of Stay**
Number of patients at risk of experiencing outcomes	525,725	252,781	542,866
Observed number of patients experiencing outcomes	17,236	30,087	
Expected number of patients experiencing outcomes with 4:1 patient/nurse ratio	16,074	29,312	
Difference between observed and expected patients experiencing outcomes	1,162	775	
Expected number of patients experiencing outcomes with 5:1 patient/nurse ratio	16,777	29,781	
Difference between observed and expected patients experiencing outcomes	459	306	
Observed number of patient days			2,642,369
Expected number of patient days with 4:1 patient/nurse ratio			2,602,400
Difference between observed and expected patient days			39,969
Expected number of patient days with 5:1 patient/nurse ratio			2,628,223
Difference between observed and expected patient days			14,146

Exhibit 4 (continued)

Projected savings in payments with 4:1 patient/nurse ratio	93,207,708
Projected savings in payments with 5:1 patient/nurse ratio	32,988,472

Notes. The cost projection was based on Kaiser Family Foundation estimates for the year 2016 in Pennsylvania. Based on their estimates the hospital adjusted expanses per inpatient day was $2,332 per patient.