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Nurses' Work Schedule Characteristics, Nurse Staffing, and Patient Mortality

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- ***Background:*** Although nurse staffing has been found to be related to patient mortality, there has been limited study of the independent effect of work schedules on patient care outcomes.
- ***Objective:*** To determine if, in hospitals where nurses report more adverse work schedules, there would be increased patient mortality, controlling for staffing.
- ***Methods:*** A cross-sectional design was used, with multilevel data from a 2004 survey of 633 nurses working in 71 acute nonfederal hospitals in North Carolina and Illinois. Mortality measures were the risk-adjusted Agency for Healthcare Research and Quality Inpatient Quality Indicators, and staffing data were from the American Hospital Association Annual Survey of hospitals. Principal components analysis was conducted on the 12 work schedule items to create eight independent components. Generalized estimating equations were used to examine the study hypothesis.
- ***Results:*** Work schedule was related significantly to mortality when staffing levels and hospital characteristics were controlled. Pneumonia deaths were significantly more likely in hospitals where nurses reported schedules with long work hours (odds ratio [OR] = 1.42, 95% confidence interval [CI] = 1.17–1.73, $p < .01$) and lack of time away from work (OR = 1.24, 95% CI = 1.03–1.50, $p < .05$). Abdominal aortic aneurysm was also associated significantly with the lack of time away (OR = 1.39, 95% CI = 1.11–1.73, $p < .01$). For patients with congestive heart failure, mortality was associated with working while sick (OR = 1.39, 95% CI = 1.13–1.72, $p < .01$), whereas acute myocardial infarction was associated significantly with weekly burden (hours per week; days in a row) for nurses (OR = 1.33, 95% CI = 1.09–1.63, $p < .01$).
- ***Discussion:*** In addition to staffing, nurses' work schedules are associated with patient mortality. This suggests that work schedule has an independent effect on patient outcomes.

- ***Key Words:*** mortality · patient outcomes · working conditions · work schedule

Data from various sources indicate that lower nurse staffing levels contribute to poor patient outcomes. Patient mortality has been one of the most frequently assessed outcomes because it is represented reliably in administrative data and is related conceptually to poor care. In some studies using Medicare data, higher nursing skill mix was associated with lower mortality (al-Haider & Wan, 1991; Hartz et al., 1989). Also, in studies using hospital data, a link between staffing and mortality was reported (Aiken, Clarke, Cheung, Sloane, & Silber, 2003; Person et al., 2004). In a recent meta-analysis, it was concluded that, overall, an increase in nurse staffing is related to improved patient outcomes (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007), yet the authors cautioned that there may be other factors such as nurse scheduling that could be related independently to patient care.

In U.S. hospitals, most nurses work extended schedules, that is, schedules that extend beyond the typical 9:00 A.M. to 5:00 P.M., Monday through Friday work day, because hospitals need to provide continuous nursing coverage. Extended work schedules for nurses can cause fatigue and performance deficits because of increased exposure to job demands and insufficient recovery time (Geiger-Brown & Trinkoff, 2010a). Nurses in one study reported being more fatigued on 12-hour shifts compared with 8-hour shifts (Iskra-Golec, Folkard, Marek, & Noworel, 1996). In contrast, in a study of nurses in 13 New York City hospitals, researchers compared 8- and 12-hour work shifts (Stone et al., 2006) and found that nurses on 12-hour shifts reported less emotional exhaustion with no differences in patient outcomes. Unfortunately, only 4 of 13 hospitals offered both shifts, so findings may reflect facility-level differences as opposed to within-hospital comparisons of nurses working 8- versus 12-hour shifts. Although the effects of such schedules on nurses' health (Trinkoff, Le, Geiger-Brown, & Lipscomb, 2007), turnover (Stordeur, D'Hoore, & the NEXT-Study Group, 2007), and errors (Rogers, Hwang, Scott, Aiken, & Dinges, 2004) have been documented, their impact on patient outcomes is largely unknown.

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Currently, most U.S. hospitals exclusively use 12-hour shifts (Geiger-Brown & Trinkoff, 2010a). Although many nurses like these schedules because of the compressed nature of the workweek (e.g., three 12-hour shifts vs. five 8-hour shifts), this schedule as well as shift work in general have been shown to lead to sleep deprivation (Geiger-Brown & Trinkoff, 2010a). Nursing staff working nights also face two major sleep challenges: getting insufficient sleep because long work hours reduce sleep opportunity and getting inadequate or poor quality sleep because of circadian misalignment from shift work. Alertness not only has a strong circadian element but also depends on having an adequate duration of quality sleep (Akerstedt, Folkard, & Portin, 2004; Arnedt, Owens, Crouch, Stahl, & Carskadon, 2005; Shen, Barbera, & Shapiro, 2006). In addition, nurses who work night shifts have notoriously poor sleep including inadequate quantity and quality of sleep and resultant fatigue and illness (Geiger-Brown & Trinkoff, in press; Surani, Subramanian, Babbar, Murphy, & Aguilar, 2008). Acute or chronic sleep deprivation is associated with deficits in neurobehavioral functioning such as reduced or impaired vigilance, reaction time, memory, psychomotor coordination, information processing, and decision-making ability (Dinges et al., 1997; van Dongen, Maislin, Mullington, & Dinges, 2003). Because the alertness and vigilance required in nursing depends upon having an adequate duration of quality sleep (Geiger-Brown & Trinkoff, 2010a; Surani et al., 2008), long work hours can impact nursing care and can increase the potential for error (Hinshaw, 2006).

Similarly, among physicians, fatigue has been attributed to increased errors as the number of hours worked increases (Gaba & Howard, 2002). To combat this situation, the medical profession has taken steps to limit the hours a physician in training may work (Jagsi & Surender, 2004). However, there have been only voluntary recommendations for nurses that they limit their work hours to no more than 60 per week or 16 in a 24-hour period (Institute of Medicine, 2004). Ironically, physician work hour limits have led to task shifting; work hours among nurses may be increasing to compensate for reduced physician hours (Trinkoff, Geiger-Brown, Brady, Lipscomb, & Muntaner, 2006).

The conceptual framework tying nurse-level working condition factors with hospital-level patient outcomes is based on balance theory. Balance theory is a human factors or systems engineering approach intended to measure organization-level conditions, incorporating data from individual employees (Gurses & Carayon, 2007). According to this theory, job performance is affected adversely by an imbalance of excessive demands with more positive aspects of the job (Carayon & Smith, 2000). On the basis of balance theory, many factors in nurses' work environments may affect their performance and patient outcomes. However, except for staffing, other aspects of the nurses' work environment that can affect nursing care practices, such as work schedule characteristics, have not been examined substantially in relation to patient outcomes and hence deserve further study. It was hypothesized that, in hospitals where nurses report more adverse work schedules, mortality rates will reflect poorer quality care.

Methods

A cross-sectional design was used, incorporating data from nurses and from the hospital where they worked. Patient outcome and staffing data from 71 acute care nonfederal hospitals in Illinois and North Carolina were merged with survey data from 633 nurses working in these hospitals. The nurse survey data came from the Nurses Worklife and Health Study, Part 3 (Trinkoff, Geiger-Brown, et al., 2006). The Nurses Worklife and Health Study was conducted originally as a three-wave longitudinal study of nurse injury in relation to work schedule and job demands. Out of 5,000 randomly selected registered nurses (RNs) in the two states, 4,229 were sent surveys and 2,624 returned usable questionnaires in Wave 1. Follow-up responses in Waves 2 and 3 were received, from 85% and 86%, respectively, of Wave 1 nurses.

For this analysis, responses were included from nurses working in hospitals with four or more RNs responding to the survey in Wave 3, averaging nine nurses per facility. This technique has been used similarly in surveys of hospital administrators and managers (e.g., Singer et al., 2003). Only nurses who had been in their job for at least 1 year were included in this analysis.

Work Schedule

Work schedule variables were derived from the Standard Shiftwork Index, which has been used internationally to standardize self-report measures used in shift-work research (Barton, Spelten, Totterdell, Smith, & Folkard, 1995; Folkard, Spelten, Totterdell, Barton, & Smith, 1995). Three experts from the National Institute for Occupational Safety and Health with a career focus on work schedules examined the survey for content validity (Trinkoff, Le, Geiger-Brown, Lipscomb, & Lang, 2006). Work schedule data were derived from the following variables: (a) hours worked per day, (b) hours worked per week, (c) weekends worked per month, (d) number of breaks lasting 10 minutes or more including meals during a workday, and (e) shift rotation. To take into account newer work schedule characteristics occurring among nurses, seven additional items were included, for a total of 12 variables: how often nurses worked (a) 13 hours or more at a stretch, (b) with less than 10 hours off between shifts, (c) on a scheduled day off or vacation day, (d) while sick, (e) with mandatory overtime, (f) required on call, and (g) the usual number of days worked in a row (Trinkoff, Le, et al., 2006).

While completing the survey, nurses were asked to consider their typical work schedule for the past 6 months on average. The use of a 6-month period minimized the chance that participants would provide an unusual or atypical work experience (Barton et al., 1995; Folkard et al., 1995). Nurses were asked to report the hours they actually worked including overtime, as opposed to what they were scheduled to work (Schernhammer et al., 2001; Trinkoff, Le, et al., 2006). Hours worked per day were defined as the number of hours worked at a stretch, so that it was possible for this item to exceed 24 hours.

Staffing Data

Staffing data were obtained from the American Hospital Association Annual Survey of Hospitals, including data on full- and part-time RNs and licensed practical nurses (LPNs).

The National Quality Forum nurse-sensitive indicators, including staffing and skill mix (National Quality Forum, 2010), were used. Staffing was calculated as nursing (RN + LPN) hours per patient day as devised by Kane et al. (2007), which assumes there are 37.5 work hours per week and 48 weeks per year (excluding vacation, holidays, and sick time). An adjustment formula of inpatient to outpatient gross revenues was applied to account for inpatient staffing (Mark, Harless, McCue, & Xu, 2004). The RN proportion, used to measure skill mix, was calculated by dividing RN hours by the total hours for both RNs plus LPNs.

Hospital characteristic variables such as ownership and teaching status were examined; only 2 of 71 hospitals were for-profit hospitals; this did not vary sufficiently to add ownership to the analysis. Teaching status was constructed using data on resident physician FTEs. Finally, state (Illinois or North Carolina) and teaching status were included in the analysis as control variables (Currie, Mehdi, & MacLeod, 2005; Jones, 2004).

Mortality

Mortality was measured from discharge data using the Agency for Healthcare and Quality (AHRQ) In-patient Quality Indicators (IQIs) because these indicators have been shown to be related conceptually to nursing care (Davies et al., 2001). The AHRQ IQIs include mortality rates for certain medical conditions. To calculate hospital-level mortality, the discharge data were applied to the AHRQ IQIs Windows version 3.2, with risk adjustment using the All Payer-Refined Diagnostic Review Groups. Outcomes were selected that were relevant to nursing.

In addition, to provide valid estimates, Healthcare Cost and Utilization Project selection rules were followed, and some IQIs (those with extremely low rates of occurrence [e.g., esophageal and pancreatic resection] as well as those with denominators that were too small) were eliminated because of rarity. The IQIs included in this analysis were pneumonia, congestive heart failure (CHF), acute myocardial infarction (AMI) and stroke, and postsurgical procedures related to abdominal aortic aneurysm (AAA) repair and craniotomy.

Analysis

All data analysis was performed using Predictive Analytics Software (PASW) (Version 17.0; SPSS/IBM Inc., Somers, NY). Univariate, descriptive statistical analyses were conducted; the mean and the standard deviation values of the key variables were calculated and compared with state and national data. Principal components analysis was conducted on the 12 work schedule items to remove correlations across the items and to create independent components. Construction of independent components for work schedule addressed the multicollinearity issues in the follow up GEE modeling. Sampling adequacy was good (Kaiser–Meyer–Olkin = .67). Components accounting for 82% of the variance for the underlying dimension were retained in the analysis. Component scores were then derived for each of the eight components (Table 1). Work schedule variables all contained less than 10% missing data, with the percentage of missing data ranging from 1.7% to 7.9%.

To investigate the relationship between nurses' work schedules and patient mortality and to describe it using the best model, binomial logistic models with generalized estimating equation (GEE) methods were tested. Using GEE, it was possible to account for within-hospital correlation arising from the nested nature of the data (first level = nurse and second level = hospital). Before using GEE, the original work schedule items were examined for missing completely at random using Little's test. Findings supported missing completely at random, indicating that GEE using pairwise deletion for missing data was appropriate ($\chi^2 = 264.83$, $df = 236$, $p = .096$; Roth, 1994). Staffing was included along with skill mix in all models because this was felt to be the most conservative estimate of the independent effect of work schedule on mortality. The eight component scores extracted from work schedule were used as explanatory variables for the given outcome variables. As outcome rates were not distributed normally, they were divided into quartiles, and study hospitals with rates that met or exceeded the 75th percentile were defined as hospitals with higher than expected mortality within the sample. This method has been used successfully in other outcomes studies (Kane et al., 2007; Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2001). Binomial logistic models were therefore generated for each of the six outcomes (mortality from pneumonia, AAA, CHF, AMI, stroke, and craniotomy), with state and hospital teaching status included in all models as potentially confounding variables. Institutional review board approval from University of Maryland Baltimore was obtained.

Results

Study hospitals had higher levels of staffing and skill mix than overall acute general hospitals in Illinois and North Carolina, although differences were not significant: study hospitals averaged 7.5 hours ($SD = 2.3$) of RNs and LPNs (licensed hours) per patient day, approximately 1.3 times the overall Illinois and North Carolina level, which was 5.7 hours ($SD = 2.5$). Skill mix, measured by RN proportion, was also higher in study hospitals (94.7% RNs) than in Illinois and North Carolina overall (88.9%). Of the 71 study hospitals, almost half (47.9%) were teaching hospitals (i.e., had resident physicians). This was significantly higher than for Illinois and North Carolina hospitals overall (31.2% teaching hospitals; $\chi^2 = 7.36$, $p < .01$).

Study nurses averaged 43.9 years of age, compared with 43.4 years on average reported for U.S. hospital nurses (Health Resources and Services Administration [HRSA], 2006). Study nurses also were more racially diverse (15% non-White) than national hospital nurses (7%). The proportion of nurses with a Bachelor's degree or higher was 60% compared with approximately 50% in all hospital nurses in national data (HRSA, 2006). For shifts worked, almost half of the nurses reported working shifts other than during the day as part of their typical schedule. Among the nurses, 13% reported mandatory overtime, yet more than 40% had required on call as part of their jobs, indicating that the majority had some form of required additional hours, above those which they were already scheduled to work (Table 2).

For patient outcome data, risk-adjusted rates of selected IQIs were summarized in Table 3. When comparing risk-adjusted

TABLE 1. Principal Components Analysis of Work Schedule Characteristics

	Components								
	1	2	3	4	5	6	7	8	% Variance Explained
Component 1: long work hours									
Hours worked per workday	***.83***	.30	−.04	.04	−.07	.07	−.04	−.08	21.49
Work 13 hours or more	***.81***	.04	.02	.34	.06	.00	.13	.05	
Component 2: off shift and weekends									
Shift rotation	.20	***.82***	.05	−.03	−.11	−.08	.06	.03	13.25
Weekends worked per month	.09	***.78***	−.17	.21	.08	.14	−.08	−.01	
Component 3: weekly burden									
Usual number of days worked in a row	−.29	−.04	***.82***	.07	−.02	−.09	.00	.06	9.67
Hours worked per week	.30	−.06	***.79***	.03	.04	.11	.05	−.10	
Component 4: lack of time away									
Work on scheduled day off or vacation	.08	.05	.00	***.89***	−.10	.07	−.02	.01	8.74
<10 hours off between shifts	.34	.16	.16	***.61***	.16	−.05	.14	−.05	
Component 5: mandatory overtime									
Mandatory overtime	.00	−.04	.02	−.01	***.98***	.00	.10	.00	8.06
Component 6: working while sick									
Work while sick	.04	.04	.02	.04	.00	***.98***	.04	.03	7.76
Component 7: required on call									
On call required	.06	−.01	.04	.07	.10	.04	***.98***	−.04	6.91
Component 8: insufficient work breaks									
No. breaks lasting 10 minutes or more	−.03	.01	−.03	−.01	.00	.03	−.03	***.99***	6.53

Note. Bolded items represent loadings greater than 0.60; rotation method: varimax.

rates in study hospitals (N = 71) with national benchmarks, data were similar, with the exception of rates of AAA: In study hospitals, the rate averaged 50.81 deaths per 1000 patients (SE = 7.87) versus 66.33 (SE = 1.15) nationally. Nonetheless, the cut points for rates above the 75th percentile that were used for analysis well exceeded U.S. benchmarks for all IQIs.

Findings comparing hospitals with higher than expected mortality (those above the 75th percentile for the IQIs vs. all other hospitals) adjusted for staffing and skill mix, state, and hospital teaching status are presented in Table 4. Consistent with the study hypothesis, in which adverse work schedule was proposed to increase the odds of mortality, outcomes with odds ratios greater than 1.0 support the hypothesis. Pneumonia deaths were significantly more likely to occur in hospitals where nurses reported schedules that included long work hours (odds ratio [OR] = 1.42, 95% confidence interval [CI] = 1.17–1.73, $p < .01$) and lack of time away from work (OR = 1.24, 95% CI = 1.03–1.50, $p < .05$). Deaths from AAA also were associated significantly with lack of time away (OR = 1.39, 95% CI = 1.11–1.73, $p < .01$). For CHF, mortality was associated with working while sick (OR = 1.39, 95% CI = 1.13–1.72, $p < .01$), whereas AMI was associated significantly with weekly burden for nurses (OR = 1.33, 95% CI = 1.09–1.63, $p < .01$). For staffing, the analysis showed significantly lower licensed staffing in high-mortality hospitals for pneumonia, CHF, and stroke, whereas lower skill mix was related significantly to AMI and craniotomy. Teaching status was not related to any of the outcome indicators.

Discussion

In addition to staffing, nurses' work schedules are associated independently with patient mortality. The work schedule component most frequently related to mortality was that of lack of time away from the job. This has been found also to be important for nurse injury and fatigue because nurses need time off to rest and recuperate to protect their health. Similarly, the lack of recovery time may affect performance. Geiger-Brown and Trinkoff (2010a), in the Nurses' Sleep Study, showed that nurses working long hours in successive shifts averaged only 5.5 hours of sleep between shifts.

In previous studies, long hours were shown to be related to nurse fatigue and health, suggesting that they also affect performance or ability to practice. The continued vigilance required of nurses can be affected by excessive work hours, limiting their ability to detect adverse changes in patients in time to address them and prevent consequences. This could have profound consequences for patient safety and health.

The impact of working conditions on patient mortality in the context of staffing was examined in this study. The finding that work schedule can impact patient outcomes is new and important and should lead to further work. Of the

TABLE 2. Sample Distribution of Nurses' Work Schedule Characteristics (*N* = 633)

Characteristics	
Hours worked per day (range = 0–25)	10.3 ± 2.3
Hours worked per week (range = 3.5–96.0)	37.3 ± 11.8
No. weekends worked per month (range = 0–4)	1.4 ± 1.3
No. breaks lasting ≥10 min including meals during a workday (range = 0–3)	1.6 ± 0.8
Shift	
Evening only	49 (8.0)
Day only	328 (53.4)
Day + evening	77 (12.5)
Day + nights	15 (2.4)
Night + evening or all three	50 (8.1)
Night only	95 (15.5)
Work ≥13 hours at a stretch	
Never/NA	196 (32.7)
Few times a year	211 (35.2)
Once a month	54 (9.0)
Every other week	28 (4.7)
Once a week	44 (7.3)
More than once a week	67 (11.2)
Work <10 hours off between shifts	
Never/NA	323 (55.2)
Few times a year	167 (28.5)
Once a month	35 (6.0)
Every other week	12 (2.1)
Once a week	18 (3.1)
More than once a week	30 (5.1)
Work on a scheduled day off/vacation day	
Never/NA	199 (34.0)
Few times a year	286 (48.9)
Once a month	50 (8.5)
Every other week	32 (5.5)
Once a week	10 (1.7)
More than once a week	8 (1.4)
Work while sick	
Never/NA	126 (21.6)
Few times a year	425 (72.9)
Once a month	22 (3.8)
Every other week	5 (0.9)
Once a week	2 (0.3)
More than once a week	3 (0.5)
Mandatory overtime	
Never/NA	538 (87.1)
Yes, with more than an 8-hour notice	23 (3.7)
Yes, with 2- to 8-hour notice	12 (1.9)
Yes, with less than a 2-hour notice	45 (7.3)
Required on call/How often called into work	
Never/NA	360 (57.9)
Yes, but never called in	16 (2.6)
Yes, few times a year	113 (18.2)
Yes, approximately once a month	80 (12.9)
Yes, approximately once a week	38 (6.1)
Yes, more than once a week	15 (2.4)
Usual number of days worked in a row (range = 0–50)	3.5 ± 2.6

Note. Values are presented as mean ± *SD* and *n* (%).

significant work schedule components, work hours and a lack of time off also have been shown to be related to nurse injuries when examined prospectively (Trinkoff, Le, et al., 2006). In addition, schedule may affect nurse retention because the recent National Sample Survey of Registered Nurses found that 45% of RNs who took jobs outside of nursing cited burnout or stressful work followed by 41% citing scheduling or too many hours as their main reasons for leaving nursing (HRSA, 2006). Similarly, others have found that nurses prefer working in facilities with predictable work hours and schedules, supportive climates, and appropriate patient loads (Stordeur et al., 2007). These components that help retain nurses are also likely to benefit the quality of patient care.

Limitations

The study nurses more educated than overall hospital nurses in national data, indicating a need for caution in generalizing the study findings. Because the hospitals included in this study were more likely to be teaching hospitals, the findings may not be generalizable to all hospitals. In addition, conditions in children's and psychiatric hospitals may differ from those studied (a sample of acute care, general hospitals for adult inpatients). Furthermore, some work schedule components did not show an association with mortality. The lack of unit-level data that could provide additional detail about the work schedules may have restricted the ability to find associations. Additional study using a unit-level approach would be beneficial.

For the nurse survey data, all information on scheduling came from self-report and thus may be affected by recall and other potential biases. On the other hand, at the time data were collected, there was no indication that the information would be related to patient outcomes, limiting any inclination to overstate schedule problems. Because the analysis was cross-sectional, both predictors and outcomes are based on data from 2004; it therefore does not allow for assessment of the temporal sequence of the predictors and outcomes. In addition, this study constitutes a secondary data analysis, a design with limitations because of the inability to capture variables that were not part of the primary data collection or to influence selection of the actual measures that were used. For example, variables covering aspects of the work environment such as

TABLE 3. Comparison of Risk-Adjusted Rates (per 1,000) in Study Hospitals With Benchmark

	Benchmark Total (United States)[a]	Study Hospitals (N = 71)[b]					
	M (*SE*)	*n*	*M*	*SE*	Min	Max	75th Percentile
Pneumonia	55.20 (0.22)	71	58.54	2.11	27.59	118.58	68.14
AAA	66.33 (1.15)	69	50.81	7.87	0.00	413.94	69.71
CHF	40.00 (0.18)	71	41.36	1.58	12.32	74.20	50.57
AMI	82.99 (0.33)	70	82.21	2.92	36.02	143.10	100.29
Stroke	108.41 (0.36)	71	112.95	3.64	32.57	196.46	135.10
Craniotomy	68.80 (0.64)	62	68.33	4.81	0.00	216.77	91.31

Note. AAA = abdominal aortic aneurysm; CHF = congestive heart failure; AMI = acute myocardial infarction.
[a]Adjusted rates by patient and hospital characteristics. Retrieved from http://hcupnet.ahrq.gov/HCUPnet.jsp?Id=4EC86273A5BF9229&Form=SelNISQIs&JS=Y&Action=%3E%3ENext%3E%3E&_DB=IQINIS04.
[b]Adjusted using the All Payer-Refined Diagnostic Review Groups.

transport or delivery support, technology, and the built environment were not available.

Conclusion

Work schedule has an independent effect on patient mortality. Attention to work schedule is now warranted on the basis of the impact of scheduling on patients as well as nurses. Therefore, policies should be refocused on the work schedule as a means of improving patient care and nursing working conditions. Recommendations include offering alternatives to 12-hour shifts, so that nurses can be less sleep-deprived when they come to work (Geiger-Brown & Trinkoff, 2010a). Employers are reluctant to do so because 12-hour shifts are perceived to be popular. Such popularity is deceptive because nurses who do not like these hours leave hospital positions (Stordeur et al., 2007). Furthermore, when shorter workdays are offered, nurses need to be allowed to leave in a timely manner, or their workday could extend toward 12 hours

TABLE 4. Adjusted Odds of Elevated Patient Mortality by Nurse Staffing and Work Schedule Characteristics[a]

	Pneumonia		AAA		CHF		AMI		Stroke		Craniotomy	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
State, Illinois[b]	0.39	0.09–1.68	0.71	0.21–2.42	2.25	0.59–8.56	0.33	0.09–1.26	0.08**	0.02–0.46	0.09**	0.01–.055
Teaching status[c]	3.34	0.75–14.85	0.40	0.10–1.61	1.16	0.22–6.05	1.31	0.36–4.82	0.68	0.13–3.52	1.91	0.37–9.95
Skill mix, RN proportion	0.99	0.88–1.12	0.88	0.78–1.00	1.02	0.92–1.13	0.89*	0.79–1.00	1.12	0.97–1.29	0.85*	0.74–0.97
Staffing, licensed hours per patient day	0.62**	0.46–0.84	1.04	0.72–1.51	0.48**	0.29–0.77	0.88	0.63–1.23	0.43**	0.28–0.68	0.84	0.56–1.26
Work schedule												
Long work hours	1.42**	1.17–1.73	1.02	0.77–1.35	1.25	0.99–1.59	0.79*	0.62–1.00	1.01	0.80–1.27	0.82	0.68–1.00
Off shift and weekends	0.93	0.80–1.08	0.99	0.83–1.19	0.87	0.72–1.04	1.08	0.89–1.32	0.99	0.81–1.20	1.14	1.00–1.31
Weekly burden	1.10	0.95–1.27	1.08	0.89–1.31	0.87	0.72–1.05	1.33**	1.09–1.63	0.87	0.68–1.12	1.02	0.82–1.27
Lack of time away	1.24*	1.03–1.50	1.39**	1.11–1.73	0.90	0.70–1.15	0.96	0.72–1.28	0.88	0.70–1.12	1.04	0.79–1.36
Mandatory overtime	1.13	0.89–1.43	0.95	0.75–1.19	0.91	0.72–1.15	0.90	0.70–1.16	1.00	0.78–1.28	0.81	0.58–1.14
Working while sick	1.20	0.97–1.49	0.89	0.73–1.08	1.39**	1.13–1.72	1.05	0.78–1.41	1.13	0.84–1.52	0.94	0.81–1.09
Required on call	0.96	0.73–1.27	0.87	0.66–1.14	0.75	0.55–1.03	1.14	0.84–1.56	0.95	0.67–1.36	0.76	0.54–1.06
Insufficient work breaks	0.96	0.79. 1/18	1.03	0.85–1.23	0.97	0.78–1.21	0.92	0.74–1.14	1.05	0.87–1.27	1.10	0.87–1.39

Note. OR = odds ratio; CI = confidence intervals; AAA = abdominal aortic aneurysm; CHF = congestive heart failure; AMI = acute myocardial infarction.
[a]Reference category: hospitals with mortality rates below the 75th percentile for each outcome.
[b]Reference, North Carolina.
[c]Reference, non-teaching hospital.
*$p < .05$.
**$p \leq .01$.

while a 5-day per week expectation is maintained (Geiger-Brown & Trinkoff, 2010b). In addition, nurses need to be able to take breaks (completely relieved breaks) combined with the opportunity to take strategically placed naps because these can improve vigilance and alertness (Purnell, Feyer, & Herbison, 2002). Fatigue risk-management software is also beneficial as part of a comprehensive program for designing more healthful schedules for nurses, as has been used in other industries (Geiger-Brown & Trinkoff, 2010b). Finally, research should include work schedule variables to understand more accurately the impact of work environment on patient outcomes. ▼

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