Hospital Nurse Staffing and Patient Mortality, Nurse Burnout, and Job Dissatisfaction

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T he past decade has been a turbulent time for US hospitals and practicing nurses. News media have trumpeted urgent concerns about hospital understaffing and a growing hospital nurse shortage.1-3 Nurses nationwide consistently report that hospital nurse staffing levels are inadequate to provide safe and effective care.4-6 Physicians agree, citing inadequate nurse staffing as a major impediment to the provision of high-quality hospital care.7 The shortage of hospital nurses may be linked to unrealistic nurse workloads.8 Forty percent of hospital nurses have burnout levels that exceed the norms for health care workers.4 Job dissatisfaction among hospital nurses is 4 times greater than the average for all US workers, and 1 in 5 hospital nurses report that they intend to leave their current jobs within a year.9

In 1999, California passed legislation mandating minimum hospital patient-to-nurse ratios for its hospitals, which goes into effect in July 2003. The California legislation was motivated by an increasing hospital nursing shortage and the perception that lower nurse retention in hospital practice was related to burdensome workloads and high levels of job-related burnout and job dissatisfaction. Stakeholder groups advocated widely divergent minimum ratios. On medical and surgical units, recommended ratios ranged from 3 to 10 patients for each nurse.9-11 In early 2002, California's governor announced that hospitals must have at least 1 licensed nurse for every 6 medical and surgical patients by July 2003.

Context The worsening hospital nurse shortage and recent California legislation mandating minimum hospital patient-to-nurse ratios demand an understanding of how nurse staffing levels affect patient outcomes and nurse retention in hospital practice.

Objective To determine the association between the patient-to-nurse ratio and patient mortality, failure-to-rescue (deaths following complications) among surgical patients, and factors related to nurse retention.

Design, Setting, and Participants Cross-sectional analyses of linked data from 10184 staff nurses surveyed, 232342 general, orthopedic, and vascular surgery patients discharged from the hospital between April 1, 1998, and November 30, 1999, and administrative data from 168 nonfederal adult general hospitals in Pennsylvania.

Main Outcome Measures Risk-adjusted patient mortality and failure-to-rescue within 30 days of admission, and nurse-reported job dissatisfaction and job-related burnout.

Results After adjusting for patient and hospital characteristics (size, teaching status, and technology), each additional patient per nurse was associated with a 7% (odds ratio [OR], 1.07; 95% confidence interval [CI], 1.03-1.12) increase in the likelihood of dying within 30 days of admission and a 7% (OR, 1.07; 95% CI, 1.02-1.11) increase in the odds of failure-to-rescue. After adjusting for nurse and hospital characteristics, each additional patient per nurse was associated with a 23% (OR, 1.23; 95% CI, 1.13-1.34) increase in the odds of burnout and a 15% (OR, 1.15; 95% CI, 1.07-1.25) increase in the odds of job dissatisfaction.

Conclusions In hospitals with high patient-to-nurse ratios, surgical patients experience higher risk-adjusted 30-day mortality and failure-to-rescue rates, and nurses are more likely to experience burnout and job dissatisfaction.
a ratio that will move to 1 to 5 when
the mandates are fully implemented.12

This study reports on findings from a
comprehensive study of 168 hospitals
and clarifies the impact of nurse staff-
ing levels on patient outcomes and fac-
tors that influence nurse retention.13 Spe-
cifically, we examined whether risk-
adjusted surgical mortality and rates of
failure-to-rescue (deaths in surgical pa-
tients who develop serious complica-
tions) are lower in hospitals where nurses
carry smaller patient loads. In addition,
we ascertained the extent to which more
favorable patient-to-nurse ratios are as-
associated with lower burnout and higher
job satisfaction among registered nurses.

We also estimated excess surgical deaths
associated with the different nurse staff-
ing ratios vigorously debated in Califor-

Finally, we estimated the impact of
nurse staffing levels proposed in Cali-
fornia on nurse burnout and dissatisfac-
tion among registered nurses.

METHODS

Patients, Data Sources, and Variables

Our study combines information about
hospital staffing and organization ob-
tained from nurse surveys with patient
outcomes derived from hospital dis-
charge abstracts and hospital character-
istics drawn from administrative data-
bases.14 The study protocol for linking
anonymized nurse data and handling de-
nominalized patient data was ap-
proved by the institutional review board
of the University of Pennsylvania.

Hospitals. Data were collected on all
210 adult general hospitals in Pennsyl-
vania. Information about hospital char-
acteristics was derived from the 1999
American Hospital Association (AHA)
Annual Survey and the 1999 Pennsyl-
vania Department of Health Hospital
Survey.13,16 Ultimately, 168 of the 210
acute care hospitals had discharge data
for surgical patients in the targeted Di-
agnosis Related Groups (DRGs) dur-
ing the study period, as well AHA data,
and survey data from 10 or more staff
nurses. Six of the excluded hospitals
were Veterans Affairs hospitals, which
do not report discharge data to the state.
Twenty-six hospitals were excluded be-
because their administrative or patient out-
comes data could not be matched to our
surveys because of missing variables, pri-
marily because they reported their char-
acteristics or patient data as aggregate
multihospital entities. In 10 additional
small hospitals, the majority of which
had fewer than 50 beds, fewer than 10
nurses responded to the survey.

A nurse staffing measure was calcu-
lated as the mean patient load across all
staff registered nurses who reported
having responsibility for at least 1 but
fewer than 20 patients on the last shift
they worked, regardless of the special-
cy or shift (day, evening, night)
worked. This measure of staffing is
superior to those derived from admin-
istrative databases, which generally
include registered nurse positions that
do not involve inpatient acute care at
the bedside. Staffing was measured
across entire hospitals because there is
no evidence that specialty-specific staff-
ing offers advantages in the study of
patient outcome17 and to reflect the fact
that patients often receive nursing care
in multiple specialty areas of a hospi-
tal.

Direct measurement also avoided
problems with missing data common
to the AHA’s Annual Survey of hospi-
tals, which imputed staffing data in 1999
for 20% of Pennsylvania hospitals.

Three hospital characteristics were
used as control variables: size, teaching
status, and technology. Hospitals were

or smaller trainee:bed ratios (minor
teaching hospitals) and those with ra-
tios that were higher than 1:4 (major
teaching hospitals). Finally, hospitals
with facilities for open heart surgery
and/or major transplants were classi-
fied as high-technology hospitals and
contrasted with other hospitals.19

Nurses and Nurse Outcomes. Sur-
veys were mailed in the spring of 1999
to a 50% random sample of registered
nurses who were on the Pennsylvania
Board of Nursing rolls and resided in the
state. The response rate was 52%, which
compares favorably with rates seen in
other voluntary surveys of health pro-
essionals.20 Roughly one third of the
nurses who responded worked in hospi-
tals and included the sample of 10184
nurses described here. No special re-
recruiting methods or inducements were
used. Demographic characteristics of the
respondents matched the profile for
Pennsylvania nurses in the National
Sample Survey of Registered Nurses.21

Nurses employed in hospitals were asked
to use a list to identify the hospital in
which they worked, and then were que-
ried about their demographic character-
istics, work history, workload, job satis-
faction, and feelings of job-related
burnout. Questionnaires were returned
by nurses employed at each of the 210
Pennsylvania hospitals providing adult
acute care. To obtain reliable hospital-
level estimates of nurse staffing (the ra-
tio of patients to nurses in each hospi-
tal), attention was restricted to regist-
ned nurses holding staff nurse positions
involving direct patient care and to hos-
pitals from which at least 10 such nurses
returned questionnaires. In 80% of the
168 hospitals in the final sample, 20 or
more nurses provided responses to our
questionnaire. There were more than 50
nurse respondents from half of the hos-
pitals. We examined 2 nurse job out-
comes in relation to staffing: job satis-
faction (rated on a 4-point scale from very
dissatisfied to very satisfied) and burn-
out (measured with the Emotional Ex-
haustion scale of the Maslach Burnout
Inventory, a standardized tool).22,23

Patients and Patient Outcomes. Dis-
charge abstracts representing all admis-
charge records for each patient involved the use of rules developed by ex-

Previously existing comorbidities in-

Distinguishing complications from pre-

suggestive of 39 different clinical events.

Ninth Revision, Clinical Modification

International Classification of Diseases,

fied by scanning discharge abstracts for

Diagnosis and procedure fields that were

ICD-9-CM

Codes in the dis-

charge abstracts (eg, diabetes mellitus), as well as a series of interaction
terms. The final set of control variables
was determined by a selection process
that paralleled an approach used and re-
ported previously.27-29 The C statistic
(area under the receiver operating char-
acteristic curve) for the mortality risk ad-
justment model was 0.89.30

Data Analysis

Descriptive data show how patients and
nurses in our sample were distributed
across the various categories of hospi-
tals defined by staffing levels and other
characteristics. Logistic regression mod-
els were used to estimate the effects
of staffing on the nurse outcomes (job dis-
satisfaction and burnout) and 2 patient
outcomes (mortality and failure-to-
rescue). We computed the odds of
nurses being moderately or very dissatis-
fied with their current positions and
reporting a level of emotional exhaus-
tion (burnout) above published norms
for medical workers and of patients ex-
periencing mortality and failure-to-
rescue under different levels of regis-
tered nurse staffing, before and after
control for individual characteristics and
hospital variables. For nurse out-
comes, we adjusted for sex, years of ex-
perience in nursing, education (bacca-
laureate degree or above vs diploma or
associate degree as highest credential in
nursing), and nursing specialty. For
analyses of patient outcomes, we con-
rolled for the variables in our risk ad-
justment model, specifically, demo-
graphic characteristics of patients, nature
of the hospital admission, comorbid-
ties, and relevant interaction terms. For
analyses of both patient and nurse out-
comes, we adjusted for hospital size,
teaching status, and technology.

All logistic regression models were es-
imated by using Huber-White (rob-
ust) procedures to account for the clus-
tering of patients within hospitals and
adjust the SEs of the parameter esti-
mates appropriately.31,32 Model calibra-
tion was assessed with the Hosmer-
Lemeshow statistic.33 We used direct
standardization to illustrate the magni-
tude of the effect of staffing by estimat-
ing the difference in the numbers of
deaths and episodes of failure-to-
rescue under different staffing sce-
narios. Using all patients in the study and
using the final fully-adjusted model, we
estimated the probability of death and
failure-to-rescue for each patient un-
der various patient-to-nurse ratios (ie,
4, 6, and 8 patients per nurse) with all
other patient characteristics un-
changed. We then calculated the differ-
ences in total deaths under the differ-
ent scenarios.34 Confidence intervals
(CIs) for these direct standardization es-
timates were derived with the Δ method
described by Agresti.35 All analyses were
performed using STATA version 7.0
(STATA Corp, College Station, Tex), and
P<.05 was considered statistically sig-
ificant in all analyses.

RESULTS

Characteristics of Hospitals,
Nurses, and Patients

Distributions of hospitals with various
characteristics, distributions of nurses
surveyed, and patients whose out-
comes were studied are shown in

Box. Surgical Patient Diagnosis Related Groups Included in the Analyses of Mortality and Failure-to-Rescue

<table>
<thead>
<tr>
<th>General Surgery</th>
<th>Orthopedic Surgery</th>
<th>Vascular Surgery</th>
</tr>
</thead>
</table>

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TABLE 1. Study Hospitals, Surgical Patients Studied, and Nurse Respondents in Hospitals

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Hospitals (N = 168)</th>
<th>Patients (N = 232 342)</th>
<th>Nurses (N = 10 184)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staffing, patients per nurse</td>
<td>≤4</td>
<td>20 (11.9)</td>
<td>41 414 (17.8)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>64 (38.1)</td>
<td>111 752 (48.1)</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>41 (24.4)</td>
<td>48 120 (20.7)</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>29 (17.3)</td>
<td>21 360 (9.2)</td>
</tr>
<tr>
<td></td>
<td>≥8</td>
<td>14 (8.3)</td>
<td>9696 (4.2)</td>
</tr>
<tr>
<td>Size, No. of beds</td>
<td>≤100</td>
<td>41 (24.4)</td>
<td>16 123 (6.9)</td>
</tr>
<tr>
<td></td>
<td>101-250</td>
<td>95 (56.6)</td>
<td>110 510 (47.6)</td>
</tr>
<tr>
<td></td>
<td>≥251</td>
<td>32 (19.1)</td>
<td>105 709 (45.5)</td>
</tr>
<tr>
<td>Technology</td>
<td>Not high</td>
<td>121 (72.0)</td>
<td>103 824 (44.7)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>47 (28.0)</td>
<td>128 518 (55.3)</td>
</tr>
<tr>
<td>Teaching status</td>
<td>None</td>
<td>107 (63.7)</td>
<td>98 937 (42.6)</td>
</tr>
<tr>
<td></td>
<td>Minor</td>
<td>44 (26.2)</td>
<td>80 127 (34.5)</td>
</tr>
<tr>
<td></td>
<td>Major</td>
<td>17 (10.1)</td>
<td>53 278 (22.9)</td>
</tr>
</tbody>
</table>

*Percentages may not add up to 100 because of rounding.

TABLE 2. Characteristics of Nurses (N = 10 184) in the Study Hospitals

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>9425 (84.1)</td>
</tr>
<tr>
<td>BSN degree or higher</td>
<td>3980 (39.6)</td>
</tr>
<tr>
<td>Years worked as a nurse, mean (SD)</td>
<td>13.8 (9.8)</td>
</tr>
<tr>
<td>Clinical specialty</td>
<td></td>
</tr>
<tr>
<td>Medical and surgical</td>
<td>3158 (31.0)</td>
</tr>
<tr>
<td>Intensive care</td>
<td>1992 (19.6)</td>
</tr>
<tr>
<td>Operating/recovery room</td>
<td>996 (9.8)</td>
</tr>
<tr>
<td>Other</td>
<td>4026 (39.6)</td>
</tr>
<tr>
<td>High emotional exhaustion</td>
<td></td>
</tr>
<tr>
<td>Dissatisfied with current job</td>
<td>3926 (43.2)</td>
</tr>
</tbody>
</table>

*Sample size for individual characteristics varied because of missing data. BSN indicates bachelor of science in nursing. High emotional exhaustion refers to levels of emotional exhaustion above the published "high" norm for medical workers.** Dissatisfied with current job combines nurses who reported being either very dissatisfied or a little dissatisfied.

TABLE 1. Fifty percent of the hospitals had patient-to-nurse ratios that were 5:1 or lower, and those hospitals discharged 65.9% of the patients in the study and employed 64.4% of the nurses we surveyed. Hospitals with more than 250 beds accounted for a disproportionately share of both patients and nurses (45.5% and 43.4%, respectively). Although high-technology hospitals accounted for only 28.0% of the institutions studied, more than half (55.3%) of the patients discharged and 53.8% of nurses surveyed were from high-technology hospitals. A majority of the patients studied and nurses surveyed were drawn from the 61 hospitals (36.3%) that reported postgraduate medical trainees in 1999.

As shown in TABLE 2, 94.1% of the nurses were women and 39.6% held a baccalaureate degree or higher. The mean (SD) work experience in nursing was 13.8 years (9.8). Thirty-one percent of the nurses in the sample worked on medical and surgical general units, while 19.6% and 9.8% worked in intensive care and perioperative settings, respectively. Forty-three percent of the nurses had high burnout scores and a similar proportion were dissatisfied with their current jobs.

Of the 232 342 patients studied, 53 813 (23.2%) experienced a major complication not present on admission and 45 355 (2.0%) died within 30 days of admission. The death rate among patients with complications was 8.4%. The surgical case types and clinical characteristics of the patient cohort are shown in TABLE 3. Slightly more than half of patients (51.2%) were classified in an orthopedic surgery DRG, with the next largest group of patients (36.4%) undergoing digestive tract and hepatobiliary surgeries. Chronic medical conditions, with the exception of hypertension, were relatively uncommon among these patients. Patients who experienced complications and were included in our analyses of failure-to-rescue were similar to the broader group of patients in our mortality analyses with respect to their comorbidities, but orthopedic surgery patients were less prominently represented among patients with complications than in the overall sample.

Staffing and Job Satisfaction and Burnout

Higher emotional exhaustion and greater job dissatisfaction in nurses were strongly and significantly associated with patient-to-nurse ratios. TABLE 4 shows odds ratios (ORs) indicating how much more likely nurses in hospitals with higher patient-to-nurse ratios were to exhibit burnout scores above published norms and to be dissatisfied with their jobs. Controlling for nurse and hospital characteristics resulted in a slight increase in these ratios, which in both cases indicated a pronounced effect of staffing. The final adjusted ORs indicated that an increase of 1 patient per nurse to a hospital’s staffing level increased burnout and job dissatisfaction by factors of 1.23 (95% CI, 1.13-1.34) and 1.15 (95% CI, 1.07-1.25), respectively, or by 23% and 15%. This implies that nurses in hospitals with 8:1 patient-to-nurse ratios would be 2.29 times as likely as nurses with 4:1 patient-to-nurse ratios to show high emotional exhaustion (ie, 1.23 to the 4th power for additional patients per nurse = 2.29) and 1.75 times as likely to be dissatisfied with their jobs (ie, 1.15 to the 4th power for 4 additional patients per nurse = 1.75).

Our data further indicate that, although 43% of nurses who report high burnout and are dissatisfied with their jobs intend to leave their current job within the next 12 months, only 11% of the nurses who are not burned out and who remain satisfied with their jobs intend to leave.

Staffing and Patient Mortality and Failure-to-Rescue

Among the surgical patients studied, there was a pronounced effect of nurse staffing on both mortality and mortality following complications. Table 4 also shows the relationship between nurse staffing and patient mortality and failure-
to-rescue (mortality following complications) when other factors were ignored, after patient characteristics were controlled, and after patient characteristics and other hospital characteristics (size, teaching status, and technology) were controlled. Although the ORs reflecting the nurse staffing effect were somewhat diminished by controlling for patient and hospital characteristics, they remained sizable and significant for both mortality and failure-to-rescue (1.07; 95% CI, 1.03-1.12 and 1.07; 95% CI, 1.02-1.11, respectively). An OR of 1.07 implies that the odds of patient mortality increased by 7% for every additional patient in the average nurse’s workload in the hospital and that the difference from 4 to 6 and from 4 to 8 patients per nurse would be accompanied by 14% and 31% increases in mortality, respectively (ie, 1.07 to the 2nd power = 1.14 and 1.07 to the 4th power = 1.31).

These effects imply that, all else being equal, substantial decreases in mortality rates could result from increasing registered nurse staffing, especially for patients who develop complications. Direct standardization techniques were used to predict excess deaths in all patients and in patients with complications that would be expected if the patient-to-nurse ratio for all patients in the study were at various levels that figure prominently in the California staffing mandate debates. If the staffing ratio in all hospitals was 6 patients per nurse rather than 8 patients per nurse, we would expect 2.6 (95% CI, 1.2-4.0) additional deaths per 1000 patients and 9.5 (95% CI, 3.8-15.2) additional deaths per 1000

### Table 3. Characteristics of the Surgical Patients Included in Analyses of Mortality and Failure-to-Rescue

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. (%)</th>
<th>All Patients (N = 232 342)</th>
<th>Patients With Complications (n = 53 813)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, mean (SD)</td>
<td>59.3 (16.9)</td>
<td>64.2 (15.7)</td>
<td></td>
</tr>
<tr>
<td>Emergency admissions</td>
<td>63 355 (27.3)</td>
<td>21 541 (40.0)</td>
<td></td>
</tr>
<tr>
<td>Deaths within 30 days of admission</td>
<td>45 355 (2.0)</td>
<td>45 355 (8.4)</td>
<td></td>
</tr>
<tr>
<td><strong>Major Diagnostic Categories (MDCs)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>General surgery</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diseases and disorders of the digestive system (MDC 6)</td>
<td>54 919 (23.6)</td>
<td>19 002 (35.3)</td>
<td></td>
</tr>
<tr>
<td>Diseases and disorders of the hepatobiliary system (MDC 7)</td>
<td>29 660 (12.8)</td>
<td>6804 (12.6)</td>
<td></td>
</tr>
<tr>
<td>Diseases and disorders of the skin, subcutaneous tissue, and breast (MDC 9)</td>
<td>12 771 (5.5)</td>
<td>3010 (5.6)</td>
<td></td>
</tr>
<tr>
<td>Endocrine, nutritional, metabolic diseases, and disorders (MDC 10)</td>
<td>4853 (2.1)</td>
<td>1535 (2.9)</td>
<td></td>
</tr>
<tr>
<td><strong>Orthopedic surgery</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diseases and disorders of the musculoskeletal system (MDC 8)</td>
<td>118 945 (51.2)</td>
<td>17 403 (32.3)</td>
<td></td>
</tr>
<tr>
<td><strong>Vascular surgery</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diseases and disorders of the circulatory system (MDC 5)</td>
<td>11 194 (4.8)</td>
<td>6059 (11.3)</td>
<td></td>
</tr>
<tr>
<td><strong>Medical history (comorbidities)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>11 795 (5.1)</td>
<td>5735 (10.7)</td>
<td></td>
</tr>
<tr>
<td>Arrhythmia</td>
<td>3965 (1.7)</td>
<td>1765 (3.3)</td>
<td></td>
</tr>
<tr>
<td>Aortic stenosis</td>
<td>2248 (1.0)</td>
<td>848 (1.6)</td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>79 827 (34.4)</td>
<td>20 648 (38.4)</td>
<td></td>
</tr>
<tr>
<td>Cancer</td>
<td>28 558 (12.3)</td>
<td>9074 (16.9)</td>
<td></td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>19 819 (8.5)</td>
<td>7612 (14.2)</td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus (insulin and noninsulin dependent)</td>
<td>31 385 (13.5)</td>
<td>9997 (17.8)</td>
<td></td>
</tr>
<tr>
<td>Insulin-dependent diabetes mellitus</td>
<td>3607 (1.6)</td>
<td>1755 (3.3)</td>
<td></td>
</tr>
</tbody>
</table>

*Patients who died postoperatively were assumed to have developed a complication even if no complication codes were identified in their discharge abstracts.

### Table 4. Patient-to-Nurse Ratios With High Emotional Exhaustion and Job Dissatisfaction Among Staff Nurses and With Patient Mortality and Failure-to-Rescue

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Unadjusted</th>
<th>Adj. for Nurse or Patient Characteristics</th>
<th>Adj. for Nurse or Patient and Hospital Characteristics</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nurse outcomes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High emotional exhaustion</td>
<td>1.17 (1.10-1.26)</td>
<td>&lt;.001</td>
<td>1.17 (1.10-1.26)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Job dissatisfaction</td>
<td>1.11 (1.03-1.19)</td>
<td>.004</td>
<td>1.12 (1.04-1.19)</td>
<td>.001</td>
</tr>
<tr>
<td><strong>Patient outcomes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>1.14 (1.08-1.19)</td>
<td>&lt;.001</td>
<td>1.09 (1.04-1.13)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Failure-to-rescue</td>
<td>1.11 (1.06-1.17)</td>
<td>.004</td>
<td>1.09 (1.04-1.13)</td>
<td>.001</td>
</tr>
</tbody>
</table>

*Odds ratios, indicating the risk associated with an increase of 1 patient per nurse, and confidence intervals were derived from robust logistic regression models that accounted for the clustering (and lack of independence) of observations within hospitals. Nurse characteristics were adjusted for sex, experience (years worked as a nurse), type of degree, and type of unit. Patient characteristics were adjusted for the patient’s Diagnosis Related Groups, comorbidities, and significant interactions between them. Hospital characteristics were adjusted for high technology, teaching status, and size (number of beds).
patients with complications. Staffing hospitals uniformly at 8 vs 4 patients per nurse would be expected to entail 5.0 (95% CI, 2.4-7.6) excess deaths per 1000 patients and 18.2 (95% CI, 7.7-28.7) excess deaths per 1000 complicated patients. We were unable to estimate excess deaths or failures associated with a ratio of 10 patients per nurse (one of the levels proposed in California) because there were so few hospitals in our sample staffed at that level.

**COMMENT**

Registered nurses constitute an around-the-clock surveillance system in hospitals for early detection and prompt intervention when patients’ conditions deteriorate. The effectiveness of nurse surveillance is influenced by the number of registered nurses available to assess patients on an ongoing basis. Thus, it is not surprising that we found nurse staffing ratios to be important in explaining variation in hospital mortality. Numerous studies have reported an association between more registered nurses and lower hospital mortality, but often as a by-product of analyses focusing directly on some other aspect of hospital resources such as ownership, teaching status, or anesthesiologist direction. Therefore, a simple search for literature dealing with the relationship between nurse staffing and patient outcomes yields only a fraction of the studies that have relevant findings. The relative inaccessibility of this evidence base might account for the influential Audit Commission in England concluding recently that there is no evidence that more favorable patient-to-nurse ratios result in better patient outcomes.

Our results suggest that the California hospital nurse staffing legislation represents a credible approach to reducing mortality and increasing nurse retention in hospital practice, if it can be successfully implemented. Moreover, our findings suggest that California officials were wise to reject ratios favored by hospital stakeholder groups of 10 patients to each nurse on medical and surgical general units in favor of more generous staffing require-ments of 5 to 6 patients per nurse. Our results do not directly indicate how many nurses are needed to care for patients or whether there is some maximum ratio of patients per nurse above which hospitals should not venture. Our major point is that there are detectable differences in risk-adjusted mortality and failure-to-rescue rates across hospitals with different registered nurse staffing ratios.

In our sample of 168 Pennsylvania hospitals in which the mean patient-to-nurse ratio ranged from 4:1 to 8:1, 4535 of the 232 342 surgical patients with the clinical characteristics we selected died within 30 days of being admitted. Our results imply that had the patient-to-nurse ratio across all Pennsylvania hospitals been 4:1, possibly 4000 of these patients may have died, and had it been 8:1, more than 5000 of them may have died. While this difference of 1000 deaths in Pennsylvania hospitals across the 2 staffing scenarios is approximate, it represents a conservative estimate of preventable deaths attributable to nurse staffing in the state. Our sample of patients represents only about half of all surgical cases in these hospitals, and other patients admitted to these hospitals are at risk of dying and similarly subject to the effects of staffing. Moreover, in California, which has nearly twice as many acute care hospitals and discharges and an overall inpatient mortality rate higher than in our sample in Pennsylvania (2.3% vs 2.0%), it would be reasonable to expect that the difference of 4 fewer patients per nurse might result in 2000 or more preventable deaths throughout a similar period.

Our results further indicate that nurses in hospitals with the highest patient-to-nurse ratios are more than twice as likely to experience job-related burnout and almost twice as likely to be dissatisfied with their jobs compared with nurses in the hospitals with the lowest ratios. This effect of staffing on job satisfaction and burnout suggests that improvements in nurse staffing in California hospitals resulting from the new legislation could be accompanied by declines in nurse turnover. We found that burnout and dissatisfaction predict nurses’ intentions to leave their current jobs within a year. Although we do not know how many of the nurses who indicated intentions to leave their jobs actually did so, it seems reasonable to assume that the 4-fold difference in intentions across these 2 groups translated to at least a similar difference in nurse resignations. If recently published estimates of the costs of replacing a hospital medical and surgical general unit and a specialty nurse of $42 000 and $64 000, respectively, are correct, improving staffing may not only save patient lives and decrease nurse turnover but also reduce hospital costs.

Additional analyses indicate that our conclusions about the effects of staffing and the size of these effects are similar under a variety of specifications. We allowed the effect of nurse staffing to be nonlinear (using a quadratic term) and vary in size across staffing levels (using dummy variables and interaction terms) and found no evidence in this sample of hospitals that additional registered nurse staffing has different effects at differing staffing levels. Limiting our analyses to general and orthopedic surgery patients and eliminating vascular surgery patients (who have higher mortality and complication rates) did not affect our conclusions and effect-size estimates. Also, our findings were not changed by restricting attention to inpatient deaths vs deaths within 30 days of admission. Results were unaffected by restricting analyses to patients who were discharged after our staffing measures were obtained, rather than to the patients who were discharged from 9 months before to 9 months following the nurse surveys that produced our staffing measures. They were also unchanged by restricting the sample of nurses from which we derived our staffing measures to medical and surgical nurses, as opposed to all staff nurses. Finally, they were neither altered by adjusting for patient-toLicensed practical nurse ratios and patient-to-licensed assistive personnel ratios (neither of which were related to patient outcomes) nor affected by excluding the
hospitals in our sample with smaller numbers of patients or nurses.

One limitation of this study is the potential for response bias, given a 52% response rate. We find no evidence that the nurses in our sample were disproportionately dissatisfied with their work relative to Pennsylvania staff nurses from the National Sample Survey of Registered Nurses (a national probability-based sample survey performed in 2000). Furthermore, with respect to demographic characteristics (sex, age, and education) included in both surveys, our sample of nurses also closely resembles those participating in the National Sample Survey of Registered Nurses. We are confident that these results are not specific to this particular sample of nurses. Ultimately, longitudinal data sets will be needed to exclude the possibility that low hospital nurse staffing is the consequence, rather than the cause, of poor patient and nurse outcomes.

Our findings have important implications for 2 pressing issues: patient safety and the hospital nurse shortage. Our results document sizable and significant effects of registered nurse staffing on preventable deaths. The association of nurse staffing levels with the rescue of patients with life-threatening conditions suggests that nurses contribute importantly to surveillance, early detection, and timely interventions that save lives. The improved registered nurse staffing also extend to the larger numbers of hospitalized patients who are not at high risk for mortality but nevertheless are vulnerable to a wide range of unfavorable outcomes. Improving nurse staffing levels may reduce alarming turnover rates in hospitals by reducing burnout and job dissatisfaction, major precursors of job resignation. When taken together, the impacts of staffing on patient and nurse outcomes suggest that by investing in registered nurse staffing, hospitals may avert both preventable mortality and low nurse retention in hospital practice.

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