Health Care Workforce Shortages

Time:	Friday, January 10, 8:30 a.m. - 10:15 a.m.
Format:	Presentation and Discussion
Presenter:	Edward S. Salsberg, M.P.A. Director Center for Health Workforce Studies School of Public Health State University of New York at Albany Rensselaer, NY
Florida Panelist:	John O. Agwunobi, M.D., M.B.A. Secretary Florida Department of Health Tallahassee, FL
Objectives:	• Describe trends in the supply of nurses and other health professions now experiencing significant shortages. • Discuss research evidence regarding staffing levels, clinical outcomes and patient safety. • Identify policy levers that States might use to address these shortages and related concerns.

Materials:	• Salsberg presentation • AHRQ Research Relevant to Understanding the Impact of Working Conditions on Patient Safety. Fact Sheet. Agency for Healthcare Research and Quality. Rockville MD: 2002. • Aiken L, Clarke P, Sloane DM, Sochalski J, Silber JH. Hospital Nurse Staffing and Patient Mortality, Nurse Burnout, and Job Dissatisfaction. JAMA Vol. 288 No. 16. October 23/30, 2002. 1987-1993. • Needleman J, Buerhas P, Mattke S, Stewart M, Zelevinsky K. Nurse-Staffing Levels and the Quality of Care in Hospitals New England Journal of Medicine. Vol. 346 No. 22. May 30, 2002. 1715-1722. • In Our Hands: How Hospital Leaders Can Build A Thriving Workforce. American Hospital Association. Chicago IL: April, 2002. (Handout) • HRSA State Health Workforce Profiles: Florida. Health Resources and Services Administration. Washington DC: December, 2000. (Handout) • Bibliography prepared by Edward Salsberg • Agwunobi presentation

OVERHEADS

OVERHEADS

OVERHEADS

OVERHEADS

OVERHEADS

Edward S. Salsberg, M.P.A.

BACKGROUND MATERIALS

BACKGROUND MATERIALS

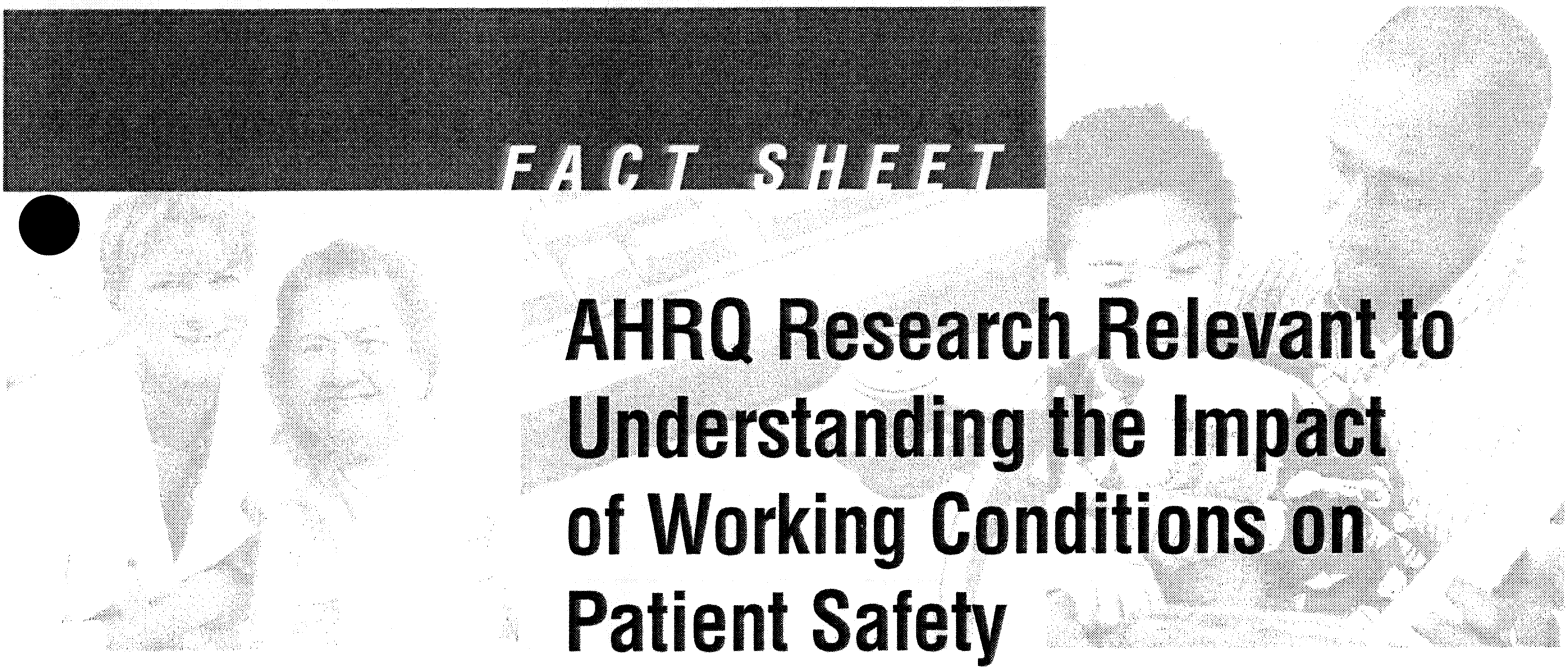
BACKGROUND MATERIALS

BACKGROUND MATERIALS

BACKGROUND MATERIALS

Edward S. Salsberg, M.P.A.

FACT SHEET



AHRQ Research Relevant to Understanding the Impact of Working Conditions on Patient Safety

Agency for Healthcare Research and Quality • 2101 East Jefferson Street • Rockville, MD 20852

www.ahrq.gov

AHRQ sponsors and conducts research that provides evidence-based information on health care out-comes; quality; and cost, use, and access. The information helps health care decisionmakers—patients and clinicians, health system leaders, and policymakers—make more informed decisions and improve the quality of health care services.

U.S. Department of Health and Human Services
Public Health Service

Background

Recent research initiatives from the Agency for Healthcare Research and Quality (AHRQ) have emphasized expanding the knowledge base on how the quality of the health care workplace affects the quality of health care provided—particularly how medical errors occur and how they can be addressed within the health care system. In 1999 and 2000, AHRQ and other Federal agencies of the Quality Interagency Coordination Task Force sponsored meetings on enhancing working conditions and patient safety in health care settings. Among the gaps in knowledge identified in these two conferences were:

- The need for an evidence-based understanding of the impact of specific improvements in the health care workplace on quality of care.
- The effect of staffing levels and organization of work on patient outcomes and health personnel, including those in outpatient care and home health settings.
- The effect of incentives and alternative work organization strategies to promote health care worker retention and adoption of new care methods to deliver high quality care.

AHRQ's Commitment to Research on Working Conditions

In fiscal year 2001, AHRQ received $10 million to support initiatives targeting health care workforce and quality improvements. Since that time, AHRQ has funded several major projects designed to examine the effects of working conditions on health care workers' ability to provide safe, high-quality care. These projects are intended to identify, characterize, and directly measure the effect of the health care work environment on the safety and quality of care provided by health care workers. AHRQ's work is critical to the larger initiative of the U.S. Department of Health and Human Services to improve patient safety and the quality of health care in the Nation.

Current Projects

AHRQ's portfolio of working conditions research is part of the agency's ongoing efforts to develop evidence-based information aimed at improving the quality of the U.S.

health care system. Projects and activities comprising AHRQ's working conditions activities are summarized below.

Impact of Nurses' Workload and Working Conditions

Impacts of unit-level nurse workload on patient safety. This project is examining the associations between the structure of hospital nurse staffing, patient turnover, and indicators of patient outcomes and safety (e.g., falls, pressure ulcers, restraint prevalence, and significant clinical events). The hospital nurse staffing elements under study include hours of direct care per patient day, skill mix of nurse caregivers, percent of contacted or agency staff, ratio of required to actual hours of care, and years of registered nurse post-licensure experience. (Principal Investigator: Nancy E. Donaldson, University of California-San Francisco; Grant No. HS11954).

Work environment for nurses and patient safety. Investigators will identify key aspects of the work environment for nurses—including extended hours and workload—that likely have an impact on patient safety, and identify potential improvements in health care working conditions that would likely result in enhancements in patient safety. (Principal Investigator: Ann Page, Institute of Medicine; Contract No. 282-99-0045).

Hospital nurses' working conditions and patient outcomes. This project is examining the relationship between nursing care delivery models, job strain, risk of injury, and hospital's use of overtime and contract nurses and the occurrence of adverse patient outcomes. (Principal Investigator: Jack Needleman, Harvard School of Public Health; Grant No. HS11988).

Nurses' working conditions: effects on medication safety. The aim of this study is to describe how nurses' working conditions, workload (e.g., shift length and patient assignment), actions taken (e.g., adherence to standards and actions that prevent adverse drug effects), and organizational variables affecting nurses are related to the safety and quality of care they provide. Working conditions under study include physical environment, safety climate, automation, and staffing levels. (Principal Investigator: Ginnette A. Pepper, University of Colorado Health Sciences Center; Grant No. HS11966).

The relation of hospital workload to patient safety. This study is examining the association between hospital activity/workload and rates of adverse drug events to assess whether the workload should be limited or the processes during times of high workload pressure should be reengineered to improve patient safety. Investigators are also developing new methods for identifying adverse events using electronic medical records. (Principal Investigator: Joel S. Weissman, Massachusetts General Hospital; Grant No. HS12035).

Effects of Fatigue and Stress

Impacts of alcohol and fatigue on paramedic ALS skills. This project is assessing whether routine levels of fatigue and alcohol hangover among certified practicing emergency medical technician-paramedics (EMT-Ps) impair the judgment and/or performance of

the EMT-Ps in treating patients who need resuscitation, stabilization, or other advanced life support (ALS) services. (Principal Investigator: Les Becker, Pacific Institute for Research and Evaluation; Grant No. HS11750).

Effects of extended work hours on intensive care unit patient safety. Researchers are investigating the effects of fatigue experienced by hospital residents who work on-call shifts of over 30 hours vs. residents who work no more than 16 consecutive hours on the incidence of medical error rates in intensive care units (ICUs). (Principal Investigator: Charles A. Czeisler, Brigham and Women's Hospital, Boston; Grant No. HS12032).

Work environment: effects on quality of health care. This project is examining how the work environment affects medical errors and "near misses" in the hospital setting as well as how an intervention based on human factors principles affects quality of care. Among the work environment variables under study are staffing, employee satisfaction, employee perception of safety culture, work organization, fatigue, work injuries, body substance exposures. (Principal Investigator: Bradley Evanoff, Washington University School of Medicine; Grant No. HS11983).

Minimizing error, maximizing outcome: the physician worklife study II. This study is determining the role of physicians as mediators in the effect of the health care workplace environment on the quality of care as reflected in disease outcomes and medical errors, assessing the following key mediators: physician stress, satisfaction, and burnout. (Principal Investigator: Mark Linzer, University of Wisconsin School of Medicine; Grant No. HS11955).

Working conditions of surgery residents and quality of care. This study is investigating the relationship between resident stress factors (e.g., working hours, indebtedness, family issues and support services, the balance of service vs. education) and the occurrence of preventable adverse events. (Principal Investigator: Robert Mentzer, Jr., University of Kentucky; Grant No. HS12029).

Staff nurse fatigue and patient safety. This project is assessing how nurses' per-shift length of more than 8 hours affects patient safety and whether a fatigue countermeasures program for nurses that involves minimizing the effects of fatigue, sleep loss, and circadian rhythm disruption decreases errors. (Principal Investigator: Ann E. Rogers, University of Pennsylvania; Grant No. HS11963).

Working Conditions in Nursing Homes

Task design, motivation, and nursing home quality. This study is investigating the task design of nursing care jobs and job satisfaction among nurse aides, licensed practical nurses, and registered nurses to assess how job design characteristics are related to employee job satisfaction and care quality. (Principal Investigator: Victoria Parker, Boston University; Grant No. HS12031).

Organization change to improve nursing home environment. This study is assessing staff outcomes (e.g., injury rate, retention, and days off work), job satisfaction, and physical and emotional health to evaluate the impact of a global organizational intervention aimed at enhancing the ability and motivation of nursing home employees to improve residents' care and safety. (Principal Investigator: Jules Rosen, University of Pennsylvania Medical Center; Grant No. HS11976).

Nursing home working conditions and quality of care. This study is examining the relationship between working conditions (e.g., culture and environment, staff interaction, and staffing) and organizational performance measures. These measures include Minimum Data Set Quality Indicators, State survey citations and complaints filed with the State, and perceived effectiveness. (Principal Investigator: Jill Scott, University of Colorado Health Sciences Center; Grant No. HS12028).

Reducing Adverse Events

Quality care and error reduction in rural hospitals. This project is assessing the organizational factors that influence rural health care providers through a 3-year multi-method intervention study to reduce errors by improving the identification and discussion of medical errors, near misses, and adverse events. (Principal Investigator: Ann Cook, University of Montana; Grant No. HS11930).

Working conditions and adverse events in home health care. This project is examining the relationships among the organizational work place (with an emphasis on the team environment), the workforce, worker productivity, and preventable adverse events in the home health care setting. (Principal Investigator: Penny Feldman,

Visiting Nurse Service of New York; Grant No. HS11962).

Making sure: an ethnographic study of health professionals' work. This project is an ethnographic study of care practices of health professionals to explore the impact of changing working conditions on their ability to provide safe and effective patient care. (Principal Investigator: Paul Gorman, Oregon Health & Science University; Grant No. HS12003).

Association of working conditions with prescribing errors in primary care settings. This study is evaluating the association of rates of "risky prescribing events" with both structural and functional characteristics of the primary care practices of two managed care organizations. Events to be examined include prescribing of risky drug combinations, violations of black-box warnings, and failure to monitor with laboratory tests when indicated. (Principal Investigator: Douglas W. Roblin, Kaiser Permanente, Georgia; Contract No. 290-00-0015).

Integrated delivery systems solutions for transferring medication data across patient care settings. This study is investigating the implementation and diffusion of an information technology solution at a single integrated delivery site for the transmission of complete and accurate medication information across care settings. (Principal Investigator: Lucy A. Savitz, Research Triangle Institute; Contract No. 290-00-0018).

Organizational Climate and Culture

Collaborative clinical culture and quality of care. This project is linking measures of organizational culture and workforce characteristics with an extensive set of standardized, routinely collected measures of quality of care to assess the impact of workforce integration on practitioner satisfaction and morale. (Principal Investigator: Sheldon Greenfield, Tufts University; Grant No. HS11991).

The effects of financial incentives in medical group practices and the work environment on the quality of care. This project is assessing the influence of physician financial incentives in medical group practices and physician work environment on clinical errors to determine if low-cost practices achieve that status at the expense of quality. (Principal Investigator: John Kralewski, University of Minnesota; Contract No. 290-00-0017).

Outcomes of ICU working conditions. Investigators are examining the effect of varied working conditions (e.g., workforce staffing and organizational climate) in ICUs on elderly patient safety outcomes and the safety of health care workers. Patient safety outcomes to be assessed are nosocomial infections, length of stay, mortality, and disposition at discharge; worker safety variables under study include musculoskeletal injuries, blood/body fluid exposure, sick days, and disability days. (Principal Investigator: Patricia Stone, Columbia University; Grant No. HS13114).

Do organizational factors influence both patient and worker safety? This project is assessing how staffing and other organizational parameters act as risk factors for injury for both patients and workers in acute and long-term care facilities. (Principal Investigator: Alison Trinkoff, University of Maryland at Baltimore; Grant No. HS11990).

The impact of nursing unit characteristics on outcomes. Researchers are assessing the impact of workplace factors on the safety and health outcomes of patients discharged from acute care nursing units. A simulation model of the best mix of nursing unit characteristics to achieve the highest level of patient outcomes in light of constant patient and hospital factors is also being developed. (Principal Investigator: Joyce Verran, University of Arizona; Grant No. HS11973).

Organizations, work environment, and quality of care. This multilevel project is studying the impact of organizational and work design factors on health care quality (both patient safety and satisfaction) through employee working conditions and employee health (mental and physical), fatigue, and satisfaction in community-based health clinics. (Principal Investigator: Nicholas Warren, University of Connecticut Health Center; Grant No. HS11969).

Relationship of provider group characteristics to quality of care and medication errors in ambulatory care settings. Researchers are assessing the effect of selected medical provider group characteristics (e.g., provider mix, rural/urban location, and financial arrangement with the health plan) on quality of care and patient safety in staff model and contracted network medical groups of two mixed model participating health maintenance organizations. (Co-Principal Investigators: Leif Solberg, HealthPartners, and Floyd Frost, Lovelace Respiratory Research Institute; Contract No. 290-00-0015).

Learning From Other Industries

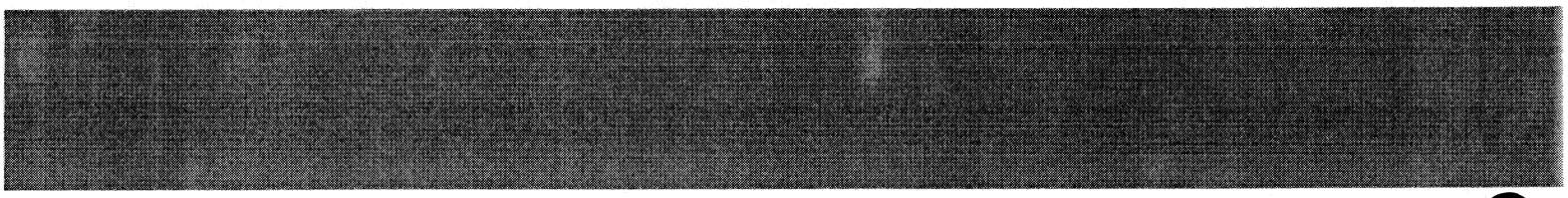
Effect of health care working conditions on patient safety. This Evidence-based Practice Center (EPC) project summarizes a systematic review of available published literature assessing the evidence of the link between working conditions and patient safety and quality of care using a wide range of published evidence from other disciplines, such as human factors research, social sciences, and aviation. (Principal Investigator: David Hickham, Oregon Health & Science University; EPC Project Director: Mark Helfand; Contract No. 290-97-0018).

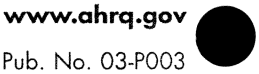
For More Information

For more information on AHRQ's projects related to the effects of working conditions on quality of care and patient safety, visit the AHRQ Web site (www.ahrq.gov) or contact:

Helen Burstin, M.D., M.P.H.
Director
AHRQ Center for Primary Care Research
Phone: 301-594-1357
Email: hburstin@ahrq.gov

Ronda Hughes, Ph.D., M.H.S., R.N.
Health Scientist Administrator
AHRQ Center for Primary Care Research
Phone: 301-594-0198
Email: rhughes@ahrq.gov





www.ahrq.gov

AHRQ Pub. No. 03-P003
October 2002

ORIGINAL CONTRIBUTION

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

Linda H. Aiken, PhD, RN
Sean P. Clarke, PhD, RN
Douglas M. Sloane, PhD
Julie Sochalski, PhD, RN
Jeffrey H. Silber, MD, PhD

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.

JAMA. 2002;288:1987-1993 www.jama.com

THE 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.[4]

In 1999, California passed legislation mandating 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,

For editorial comment see p 2040.

Author Affiliations: Center for Health Outcomes and Policy Research, School of Nursing (Drs Aiken, Clarke, Sloane, and Sochalski), Leonard Davis Institute of Health Economics (Drs Aiken, Clarke, Sochalski, and Silber), Department of Sociology (Dr Aiken), Population Studies Center (Drs Aiken, Sloane, and Sochalski), and Departments of Pediatrics and Anesthesia, School of Medicine (Dr Silber), University of Pennsylvania, Philadelphia; and Center for Outcomes Research, Children's Hospital of Philadelphia, Philadelphia, Pa (Dr Silber).
Corresponding Author and Reprints: Linda H. Aiken, PhD, RN, Center for Health Outcomes and Policy Research, University of Pennsylvania, 420 Guardian Dr, Philadelphia, PA 19104-6096 (e-mail: laiken@nursing.upenn.edu).

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 staffing levels on patient outcomes and factors that influence nurse retention.[13] Specifically, we examined whether risk-adjusted surgical mortality and rates of failure-to-rescue (deaths in surgical patients who develop serious complications) 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 associated with lower burnout and higher job satisfaction among registered nurses. We also estimated excess surgical deaths associated with the different nurse staffing ratios vigorously debated in California. Finally, we estimated the impact of nurse staffing levels proposed in California on nurse burnout and dissatisfaction, 2 precursors of turnover.[13] Our findings offer insights into how more generous registered nurse staffing might affect patient outcomes and inform current debates in many states regarding the merits of legislative actions to influence staffing levels.

METHODS

Patients, Data Sources, and Variables

Our study combines information about hospital staffing and organization obtained from nurse surveys with patient outcomes derived from hospital discharge abstracts and hospital characteristics drawn from administrative databases.[14] The study protocol for linking anonymized nurse data and handling denominalized patient data was approved by the institutional review board of the University of Pennsylvania.

Hospitals. Data were collected on all 210 adult general hospitals in Pennsylvania. Information about hospital characteristics was derived from the 1999 American Hospital Association (AHA) Annual Survey and the 1999 Pennsylvania Department of Health Hospital Survey.[15,16] Ultimately, 168 of the 210 acute care hospitals had discharge data for surgical patients in the targeted Diagnosis Related Groups (DRGs) during 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 because their administrative or patient outcomes data could not be matched to our surveys because of missing variables, primarily because they reported their characteristics 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 calculated 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 specialty or shift (day, evening, night) worked. This measure of staffing is superior to those derived from administrative 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 staffing offers advantages in the study of patient outcome[17] and to reflect the fact that patients often receive nursing care in multiple specialty areas of a hospital. Direct measurement also avoided problems with missing data common to the AHA's Annual Survey of hospitals, 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 grouped into 3 size categories: small (≤100 hospital beds), medium (101-250 hospital beds), and large (≥251 hospital beds). Teaching status was measured by the ratio of resident physicians and fellows to hospital beds, which has been suggested as superior to university affiliations and association memberships as an indicator of the intensity of teaching activity.[18] Hospitals with no postgraduate trainees (nonteaching) were contrasted with those that had 1:4 or smaller trainee:bed ratios (minor teaching hospitals) and those with ratios that were higher than 1:4 (major teaching hospitals). Finally, hospitals with facilities for open heart surgery and/or major transplants were classified as high-technology hospitals and contrasted with other hospitals.[19]

Nurses and Nurse Outcomes. Surveys 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 professionals.[20] Roughly one third of the nurses who responded worked in hospitals and included the sample of 10 184 nurses described here. No special 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 queried about their demographic characteristics, work history, workload, job satisfaction, 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 ratio of patients to nurses in each hospital), attention was restricted to registered nurses holding staff nurse positions involving direct patient care and to hospitals 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 hospitals. We examined 2 nurse job outcomes in relation to staffing: job satisfaction (rated on a 4-point scale from very dissatisfied to very satisfied) and burnout (measured with the Emotional Exhaustion scale of the Maslach Burnout Inventory, a standardized tool).[22,23]

Patients and Patient Outcomes. Discharge abstracts representing all admis-

sions to nonfederal hospitals in Pennsylvania from 1998 to 1999 were obtained from the Pennsylvania Health Care Cost Containment Council. These discharge abstracts were merged with Pennsylvania vital statistics records to identify patients who died within 30 days of hospital admission to control for timing of discharge as a possible source of variation in hospital outcomes. We examined outcomes for 232342 patients between the ages of 20 and 85 years who underwent general surgical, orthopedic, or vascular procedures in the 168 hospitals from April 1, 1998, to November 30, 1999. Surgical discharges were selected for study because of the availability of well-validated risk adjustment models.[24-29] The number of patients discharged from the study hospitals ranged from 75 to 7746. Only the first hospital admission for any of the DRGs listed in the BOX for any patient during the study period was included in the analyses.

In addition to 30-day mortality, we examined failure-to-rescue (deaths within 30 days of admission among patients who experienced complications).[24-29] Complications were identified by scanning discharge abstracts for *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) codes in the secondary diagnosis and procedure fields that were suggestive of 39 different clinical events. Distinguishing complications from previously existing comorbidities involved the use of rules developed by expert consensus and previous empirical work, as well as examination of discharge records for each patient's hospitalizations 90 days before the surgery of interest for overlap in secondary diagnosis codes.[27-29] Examples of complications included aspiration pneumonia and hypotension/shock. Patients who died postoperatively were assumed to have developed a complication even if no complication codes were identified in their discharge abstracts.

Risk adjustment of mortality and failure-to-rescue for patient characteristics and comorbidities was accomplished by using 133 variables, including age, sex, surgery types, and dummy variables indicating the presence of chronic preexisting health conditions reflected in the *ICD-9-CM* codes in the discharge 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 reported previously.[27-29] The *C* statistic (area under the receiver operating characteristic curve) for the mortality risk adjustment model was 0.89.[30]

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

General Surgery
146-155, 157-162, 164-167, 170, 171, 191-201, 257-268, 285-293, 493, and 494

Orthopedic Surgery
209-211, 213, 216-219, 223-234, 471, 491, and 496-503

Vascular Surgery
110-114, 119, and 120

Data Analysis

Descriptive data show how patients and nurses in our sample were distributed across the various categories of hospitals defined by staffing levels and other characteristics. Logistic regression models were used to estimate the effects of staffing on the nurse outcomes (job dissatisfaction and burnout) and 2 patient outcomes (mortality and failure-to-rescue). We computed the odds of nurses being moderately or very dissatisfied with their current positions and reporting a level of emotional exhaustion (burnout) above published norms for medical workers and of patients experiencing mortality and failure-to-rescue under different levels of registered nurse staffing, before and after control for individual characteristics and hospital variables. For nurse outcomes, we adjusted for sex, years of experience in nursing, education (baccalaureate degree or above vs diploma or associate degree as highest credential in nursing), and nursing specialty. For analyses of patient outcomes, we controlled for the variables in our risk adjustment model, specifically, demographic characteristics of patients, nature of the hospital admission, comorbidities, and relevant interaction terms. For analyses of both patient and nurse outcomes, we adjusted for hospital size, teaching status, and technology.

All logistic regression models were estimated by using Huber-White (robust) procedures to account for the clustering of patients within hospitals and adjust the SEs of the parameter estimates appropriately.[31,32] Model calibration was assessed with the Hosmer-Lemeshow statistic.[33] We used direct standardization to illustrate the magnitude of the effect of staffing by estimating the difference in the numbers of deaths and episodes of failure-to-rescue under different staffing scenarios. 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 under various patient-to-nurse ratios (ie, 4, 6, and 8 patients per nurse) with all other patient characteristics unchanged. We then calculated the differences in total deaths under the different scenarios.[34] Confidence intervals (CIs) for these direct standardization estimates 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 significant in all analyses.

RESULTS

Characteristics of Hospitals, Nurses, and Patients

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

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

Characteristic	No. (%) Hospitals (N = 168)	Patients (N = 232 342)	Nurses (N = 10 184)
Staffing, patients per nurse			
≤4	20 (11.9)	41 414 (17.8)	1741 (17.1)
5	64 (38.1)	111 752 (48.1)	4818 (47.3)
6	41 (24.4)	48 120 (20.7)	2114 (20.8)
7	29 (17.3)	21 360 (9.2)	1106 (10.9)
≥8	14 (8.3)	9696 (4.2)	405 (4.0)
Size, No. of beds			
≤100	41 (24.4)	16 123 (6.9)	842 (8.3)
101-250	95 (56.6)	110 510 (47.6)	4927 (48.4)
≥251	32 (19.1)	105 709 (45.5)	4415 (43.4)
Technology			
Not high	121 (72.0)	103 824 (44.7)	4706 (46.2)
High	47 (28.0)	128 518 (55.3)	5478 (53.8)
Teaching status			
None	107 (63.7)	98 937 (42.6)	4553 (44.7)
Minor	44 (26.2)	80 127 (34.5)	3435 (33.7)
Major	17 (10.1)	53 278 (22.9)	2196 (21.6)

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

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

Characteristic	No. (%)
Women	9425 (94.1)
BSN degree or higher	3980 (39.6)
Years worked as a nurse, mean (SD)	13.8 (9.8)
Clinical specialty	
Medical and surgical	3158 (31.0)
Intensive care	1992 (19.6)
Operating/recovery room	998 (9.8)
Other	4026 (39.6)
High emotional exhaustion	3926 (43.2)
Dissatisfied with current job	4162 (41.5)

*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.[20] 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 disproportionate 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 4535 (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 4 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 4 patients per nurse, we would expect 2.3 (95% CI, 1.1-3.5) additional deaths per 1000 patients and 8.7 (95% CI, 3.9-13.5) additional deaths per 1000 patients with complications. If the staffing ratio in all hospitals was 8 patients per nurse rather than 6 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*

Characteristic	No. (%)	
	All Patients (N = 232 342)	Patients With Complications (n = 53 813)
Men	101 624 (43.7)	25 619 (47.6)
Age, mean (SD)	59.3 (16.9)	64.2 (15.7)
Emergency admissions	63 355 (27.3)	21 541 (40.0)
Deaths within 30 days of admission	4535 (2.0)	4535 (8.4)
Major Diagnostic Categories (MDCs)		
General surgery		
Diseases and disorders of the digestive system (MDC 6)	54 919 (23.6)	19 002 (35.3)
Diseases and disorders of the hepatobiliary system (MDC 7)	29 660 (12.8)	6804 (12.6)
Diseases and disorders of the skin, subcutaneous tissue, and breast (MDC 9)	12 771 (5.5)	3010 (5.6)
Endocrine, nutritional, metabolic diseases, and disorders (MDC 10)	4853 (2.1)	1535 (2.9)
Orthopedic surgery		
Diseases and disorders of the musculoskeletal system (MDC 8)	118 945 (51.2)	17 403 (32.3)
Vascular surgery		
Diseases and disorders of the circulatory system (MDC 5)	11 194 (4.8)	6059 (11.3)
Medical history (comorbidities)		
Congestive heart failure	11 795 (5.1)	5735 (10.7)
Arrhythmia	3965 (1.7)	1765 (3.3)
Aortic stenosis	2248 (1.0)	848 (1.6)
Hypertension	79 827 (34.4)	20 648 (38.4)
Cancer	28 558 (12.3)	9074 (16.9)
Chronic obstructive pulmonary disease	19 819 (8.5)	7612 (14.2)
Diabetes mellitus (insulin and noninsulin dependent)	31 385 (13.5)	9597 (17.8)
Insulin-dependent diabetes mellitus	3607 (1.6)	1755 (3.3)

*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*

	Odds Ratio (95% Confidence Interval)					
	Unadjusted	P Value	Adjusted for Nurse or Patient Characteristics	P Value	Adjusted for Nurse or Patient and Hospital Characteristics	P Value
Nurse outcomes						
High emotional exhaustion	1.17 (1.10-1.26)	<.001	1.17 (1.10-1.26)	<.001	1.23 (1.13-1.34)	<.001
Job dissatisfaction	1.11 (1.03-1.19)	.004	1.12 (1.04-1.19)	.001	1.15 (1.07-1.25)	<.001
Patient outcomes						
Mortality	1.14 (1.08-1.19)	<.001	1.09 (1.04-1.13)	<.001	1.07 (1.03-1.12)	<.001
Failure-to-rescue	1.11 (1.06-1.17)	.004	1.09 (1.04-1.13)	.001	1.07 (1.02-1.11)	<.001

*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.[19,27,36-42] 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.[43]

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 requirements 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 232342 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 $42000 and $64000, respectively, are correct, improving staffing may not only save patient lives and decrease nurse turnover but also reduce hospital costs.[44]

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-to-licensed practical nurse ratios and patient-to-unlicensed 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).[21] 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 benefits of 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.

Author Contributions: *Study concept and design:* Aiken, Clarke, Sloane, Sochalski, Silber.
Acquisition of data: Aiken, Clarke, Sochalski, Silber.
Analysis and interpretation of data: Aiken, Clarke, Sloane, Silber.
Drafting of the manuscript: Aiken, Clarke, Sloane, Silber.
Critical revision of the manuscript for important intellectual content: Aiken, Clarke, Sloane, Sochalski, Silber.
Statistical expertise: Clarke, Sloane, Silber.
Obtained funding: Aiken, Sloane, Sochalski.
Administrative, technical, or material support: Aiken, Clarke, Sochalski, Silber.
Study supervision: Aiken, Clarke, Silber.
Funding/Support: This study was supported by grant R01 NR04513 from the National Institute of Nursing Research, National Institutes of Health.
Acknowledgment: We thank Paul Allison, PhD, from the University of Pennsylvania for statistical consultation, and Xuemei Zhang, MS, Wei Chen, MS, and Orit Even-Shoshan, MS, from the Center for Outcomes Research at the Children's Hospital of Philadelphia for their assistance.

REFERENCES

1. Stolberg SG. Patient deaths tied to lack of nurses. *New York Times*. August 8, 2002:A18.
2. Parker-Pope T. How to lessen impact of nursing shortage on your hospital stay. *Wall Street Journal*. March 2, 2001:B1.
3. Trafford A. Second opinion: less care for patients. *Washington Post*. August 20, 2002:HE01.
4. Aiken LH, Clarke SP, Sloane DM, et al. Nurses' reports on hospital care in five countries. *Health Aff (Millwood)*. 2001;20:43-53.
5. Henry J. Kaiser Family Foundation. Survey of physicians and nurses. Available at: http://www.kff.org/content/1999/1503. Accessed March 22, 2002.
6. Shindul-Rothschild J, Berry D, Long-Middleton E. Where have all the nurses gone? final results of our Patient Care Survey. *Am J Nurs*. 1996;96:25-39.
7. Commonwealth Fund. Doctors in five countries see decline in health care quality. *Commonwealth Fund Quarterly*. 2000;6:1-4.
8. Joint Commission on Accreditation of Healthcare Organizations. Health care at the crossroads: strategies for addressing the evolving nursing crisis, 2002. Available at: http://www.jcaho.org/news+room/news+release+archives/health+care+at+the+crossroads.pdf. Accessed September 17, 2002.
9. Spetz J. What should we expect from California's minimum nurse staffing legislation. *J Nurs Adm*. 2001;31:132-140.
10. Seago JA. The California experiment: alternatives for minimum nurse-to-patient ratios. *J Nurs Adm*. 2002;32:48-58.
11. Friedman L. Nurse ratios are still too high. *San Francisco Chronicle*. January 30, 2002:A19.
12. Governor Gray Davis announces proposed nurse-to-patient ratios [press release]. Sacramento, Calif: Office of the Governor; January 22, 2002.
13. Lake ET. Advances in understanding and predicting nurse turnover. *Res Sociol Health Care*. 1998;15:147-171.
14. Aiken LH, Clarke SP, Sloane DM. Hospital staffing, organizational support, and quality of care: cross-national findings. *Int J Qual Health Care*. 2002;14:5-13.
15. *AHA Annual Survey Database*. 1999 ed. Chicago, Ill: American Hospital Association; 1999.
16. Commonwealth of Pennsylvania. *Hospital Questionnaire: Reporting Period July 1, 1998-June 30, 1999*. Harrisburg, Pa: Department of Health, Division of Statistics.
17. Needleman J, Buerhaus PI, Mattke S, Stewart M, Zelevinsky K. Nurse staffing and patient outcomes in hospitals. Available at: http://bhpr.hrsa.gov/nursing/staffstudy.htm. Accessed August 6, 2002.
18. Ayanian JZ, Weissman JS, Chasan-Taber S, Epstein AM. Quality of care for two common illnesses in teaching and nonteaching hospitals. *Health Aff (Millwood)*. 1998;17:194-205.
19. Hartz AJ, Krakauer H, Kuhn EM, et al. Hospital characteristics and mortality rates. *N Engl J Med*. 1989;321:1720-1725.
20. Asch DA, Jedrziewski MK, Christakis NA. Response rates to mail surveys published in medical journals. *J Clin Epidemiol*. 1997;50:1129-1136.
21. *The Registered Nurse Population*. Rockville, Md: US Dept of Health and Human Services; 1996.
22. Maslach C, Jackson SE. Burnout in health professions: a social psychological analysis. In: Sanders GS, Suls J, eds. *Social Psychology of Health and Illness*. Hillsdale, NJ: Lawrence Erlbaum Associates; 1982:227-251.
23. Maslach C, Jackson SE. *Maslach Burnout Inventory Manual*. 2nd ed. Palo Alto, Calif: Consulting Psychologists Press; 1986.
24. Silber JH, Williams SV, Krakauer H, Schwartz JS. Hospital and patient characteristics associated with death after surgery: a study of adverse occurrence and failure to rescue. *Med Care*. 1992;30:615-629.
25. Silber JH, Rosenbaum PR, Ross RN. Comparing the contributions of groups of predictors: which outcomes vary with hospital rather than patient characteristics? *J Am Stat Assoc*. 1995;90:7-18.
26. Silber JH, Rosenbaum PR, Schwartz JS, Ross RN, Williams SV. Evaluation of the complication rate as a measure of quality of care in coronary artery bypass graft surgery. *JAMA*. 1995;274:317-323.
27. Silber JH, Kennedy SK, Even-Shoshan O, et al. Anesthesiologist direction and patient outcomes. *Anesthesiology*. 2000;93:152-163.
28. Silber JH, Rosenbaum PR, Trudeau ME, et al. Multivariate matching and bias reduction in the surgical outcomes study. *Med Care*. 2001;39:1048-1064.
29. Silber JH, Kennedy SK, Even-Shoshan O, et al. Anesthesiologist board certification and patient outcomes. *Anesthesiology*. 2002;96:1044-1052.
30. Hanley JA, McNeil BJ. The meaning and use of the area under a receiver operating characteristic (ROC) curve. *Radiology*. 1982;143:29-36.
31. Huber PJ. *The Behavior of Maximum Likelihood Estimates Under Non-standard Conditions: Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability*. Berkeley: University of California Press; 1967:221-233.
32. White H. Maximum likelihood estimation of misspecified models. *Econometrica*. 1982;50:1-25.
33. Hosmer DW, Lemeshow S. *Applied Logistic Regression*. New York, NY: John Wiley & Sons Inc; 1989.
34. Bishop YM, Fienberg SE, Holland PW. *Discrete Multivariate Analysis: Theory and Practice*. Cambridge, Mass: MIT Press; 1975.
35. Agresti A. *Categorical Data Analysis*. New York, NY: John Wiley & Sons Inc; 1990.
36. Shortell SM, Hughes EFX. The effects of regulation, competition, and ownership on mortality rates among hospital inpatients. *N Engl J Med*. 1988;318:1100-1107.
37. Institute of Medicine. *Nursing Staff in Hospitals and Nursing Homes: Is It Adequate?* Washington, DC: National Academy Press; 1996.
38. Aiken LH, Sloane DM, Lake ET, Sochalski J, Weber AL. Organization and outcomes of inpatient AIDS care. *Med Care*. 1999;37:760-772.
39. Mitchell PH, Shortell SM. Adverse outcomes and variations in organization of care delivery. *Med Care*. 1997;35(suppl 11):NS19-NS32.
40. Moses LE, Mosteller F. Institutional differences in postoperative death rates. *JAMA*. 1968;203:492-494.
41. Pronovost PJ, Jenckes MW, Dorman T, et al. Organizational characteristics of intensive care units related to outcomes of abdominal aortic surgery. *JAMA*. 1999;281:1310-1317.
42. Needleman J, Buerhaus P, Mattke S, Stewart M, Zelevinsky K. Nurse-staffing levels and the quality of care in hospitals. *N Engl J Med*. 2002;346:1715-1722.
43. Audit Commission. *Acute Hospital Portfolio: Review of National Findings: Ward Staffing*. London, England: The Audit Commission; 2001:3.
44. Nursing Executive Committee. *Reversing the Flight of Talent: Nursing Retention in an Era of Gathering Shortage*. Washington, DC: Advisory Board Co; 2000.

Special Article

NURSE-STAFFING LEVELS AND THE QUALITY OF CARE IN HOSPITALS

JACK NEEDLEMAN, PH.D., PETER BUERHAUS, PH.D., R.N., SOEREN MATTKE, M.D., M.P.H., MAUREEN STEWART, B.A., AND KATYA ZELEVINSKY

ABSTRACT

Background It is uncertain whether lower levels of staffing by nurses at hospitals are associated with an increased risk that patients will have complications or die.

Methods We used administrative data from 1997 for 799 hospitals in 11 states (covering 5,075,969 discharges of medical patients and 1,104,659 discharges of surgical patients) to examine the relation between the amount of care provided by nurses at the hospital and patients' outcomes. We conducted regression analyses in which we controlled for patients' risk of adverse outcomes, differences in the nursing care needed for each hospital's patients, and other variables.

Results The mean number of hours of nursing care per patient-day was 11.4, of which 7.8 hours were provided by registered nurses, 1.2 hours by licensed practical nurses, and 2.4 hours by nurses' aides. Among medical patients, a higher proportion of hours of care per day provided by registered nurses and a greater absolute number of hours of care per day provided by registered nurses were associated with a shorter length of stay ($P=0.01$ and $P<0.001$, respectively) and lower rates of both urinary tract infections ($P<0.001$ and $P=0.003$, respectively) and upper gastrointestinal bleeding ($P=0.03$ and $P=0.007$, respectively). A higher proportion of hours of care provided by registered nurses was also associated with lower rates of pneumonia ($P=0.001$), shock or cardiac arrest ($P=0.007$), and "failure to rescue," which was defined as death from pneumonia, shock or cardiac arrest, upper gastrointestinal bleeding, sepsis, or deep venous thrombosis ($P=0.05$). Among surgical patients, a higher proportion of care provided by registered nurses was associated with lower rates of urinary tract infections ($P=0.04$), and a greater number of hours of care per day provided by registered nurses was associated with lower rates of "failure to rescue" ($P=0.008$). We found no associations between increased levels of staffing by registered nurses and the rate of in-hospital death or between increased staffing by licensed practical nurses or nurses' aides and the rate of adverse outcomes.

Conclusions A higher proportion of hours of nursing care provided by registered nurses and a greater number of hours of care by registered nurses per day are associated with better care for hospitalized patients. (N Engl J Med 2002;346:1715-22.)

HOSPITALS, wrote Lewis Thomas in *The Youngest Science*, are "held together, glued together, enabled to function . . . by the nurses."[1] More than 1.3 million registered nurses work in hospitals in the United States. As hospitals have responded to financial pressure from Medicare, managed care, and other private payers, registered nurses have become increasingly dissatisfied with the working conditions in hospitals. They report that they are spending less time taking care of increasingly ill patients and believe that the safety and quality of inpatient care are deteriorating.[2-7] Although the number of hours of care per patient-day provided by registered nurses rose through the mid-1990s,[8-12] some question whether the staffing of nurses has increased rapidly enough to keep pace with the increasing severity of illness among hospitalized patients and thus to ensure safe and high-quality care.[13]

Research on the relation between the level of staffing by nurses in hospitals and patients' outcomes has been inconclusive. Whereas some studies have reported an association between higher levels of staffing by nurses and lower mortality,[14-20] as well as lower rates of other adverse outcomes,[21-30] others have found no such relations.[30-39] Previous studies have assessed only a limited number of outcomes that are sensitive to the extent or quality of nursing care, such as falls by patients and errors in medication. Many studies have used small samples of hospitals, controlled only to a limited extent for the patient's initial risk for the outcomes under study, failed to include nurses' aides as part of the nursing staff, and used inconsistent measures of staffing levels. We examined the relation between the levels of staffing by nurses in hospitals and the rates of adverse outcomes among patients, using administrative data from a large multistate sample of hospitals.

From the Department of Health Policy and Management, Harvard School of Public Health, Boston (J.N., S.M., M.S., K.Z.); the Vanderbilt University School of Nursing, Nashville (P.B.); and Abt Associates, Cambridge, Mass. (S.M.). Address reprint requests to Dr. Needleman at the Harvard School of Public Health, Department of Health Policy and Management, Rm. 305, 677 Huntington Ave., Boston, MA 02115, or at needlema@hsph.harvard.edu.

METHODS

Measures of Adverse Outcomes

The study was approved by the Harvard School of Public Health Human Subjects Committee. On the basis of published[21,27,28,30,39-47] and unpublished materials, we identified 14 adverse outcomes during hospitalization (11 for both medical and surgical patients and 3 for surgical patients only) that could be coded on the basis of hospital-discharge abstracts and that are potentially sensitive to staffing by nurses. Building on previous studies,[30,48-50] we developed coding rules to construct risk groups of patients and to identify patients with each outcome (listed in the Appendix).

Study Population

We obtained data on hospital discharges and the staffing by nurses from 11 states that collect both types of data: Arizona, California, Maryland, Massachusetts, Missouri, Nevada, New York, South Carolina, Virginia, West Virginia, and Wisconsin. We estimated 1997 staffing as the weighted average of staffing in the hospital's fiscal years 1997 and 1998, except in Virginia, for which only fiscal 1997 data were available. We obtained data on discharges for the 1997 calendar year (for Virginia, we obtained data for the four calendar quarters matching each hospital's fiscal year). The initial sample was 1041 hospitals. We then excluded hospitals with an average daily census of less than 20, an occupancy rate below 20 percent, or missing data on staffing, as well as those reporting extremely low or high levels of staffing per patient-day (below the 7.5th percentile or above the 92.5th percentile). The final sample included 799 hospitals, which together accounted for 26 percent of the discharges from nonfederal hospitals in the United States in 1997.

Measures of Staffing

The levels of staffing by registered nurses, licensed practical nurses, and nurses' aides were estimated in hours. For states reporting staffing as full-time equivalents, we used a standard year of 2080 hours (52 weeks at 40 hours per week). In California, the levels of staffing of nurses for inpatient and outpatient care are calculated directly from financial data reported by the California Office of Statewide Health Planning and Development. Using these data, we found that the standard measure, "adjusted patient-days," that was used to adjust total hours of nursing care to reflect the number of both inpatients and outpatients treated at the hospital (hospital volume)[51] underestimated staffing for inpatient care and overestimated staffing for outpatient care. To adjust for this bias, we constructed a regression model, using data from California, that predicted staffing for inpatient care per inpatient-day on the basis of the level of staffing per adjusted patient-day and the number of outpatients treated; we used this model to estimate staffing for inpatient care from the staffing levels per adjusted patient-day reported in the other 10 states.

For easier comparison of the levels of staffing by nurses in different hospitals, we adjusted the hours of nursing care per day for differences in the nursing care needed by the patients of each hospital. We used estimates of the relative level of nursing care needed by patients in each diagnosis-related group[28,52] to construct a nursing case-mix index for each hospital. We divided hours of nursing care per inpatient-day by this index to calculate the adjusted number of hours of nursing care per day.

Risk Adjustment and Characteristics of the Hospitals

To control for differences among hospitals in the relative risk of the outcomes as a result of variations in the mix of patients, we used patient-level logistic-regression analyses to predict each patient's probability of having each adverse outcome. Patient-level variables in these analyses included the rate of the outcome in the patient's diagnosis-related group, the state of residence, age, sex, primary health insurer, whether or not the patient was admitted on an emergency basis, and the presence or absence of 13 chronic diseases.[48] The regression analyses also included interactions between the specific rate of each outcome in each diagnosis-related group and all the other variables, as well as interactions between age and the variables related to chronic disease. We added the predicted probabilities for patients in each hospital to obtain the expected number of patients in that hospital who would have each outcome. We used the same variables in an ordinary least-squares regression analysis to estimate the expected length of stay. We obtained information on the other characteristics of the hospitals (number of beds, teaching status, state, and metropolitan or nonmetropolitan location) from the American Hospital Association's Annual Survey of Hospitals for 1997[51] and 1998.[53]

Statistical Analysis

The unit of analysis was the hospital. We calculated the length of stay, the rates of adverse outcomes, the hours of nursing care per inpatient-day, and the proportion of hours of nursing care provided by each category of nursing personnel.

For each outcome, we performed regression analyses with the use of nurse-staffing and control variables. In all analyses, the control variables included the state, number of beds, teaching status, and location of the hospital. We used ordinary least-squares regression to analyze the difference between the actual and expected length of stay. We report regression coefficients for these analyses. For other outcomes, we included the number of patients with the adverse outcome as the dependent variable in a negative binomial regression model (the appropriate model for this type of data[53]) and the expected numbers for each adverse outcome as the measure of exposure required by the model. We report incidence-rate ratios from these analyses.

We tested each coefficient for statistical significance using t-tests in the ordinary least-squares regression analyses and z statistics in the negative binomial regression analyses.[54] After controlling for other variables, we estimated the differences in the outcomes between hospitals with staffing levels of registered nurses at the 75th percentile and hospitals with staffing levels of registered nurses at the 25th percentile (the "decrease" in outcomes with higher levels of staffing). The 95 percent confidence intervals for the decreases were calculated with the use of Huber–White standard errors.[55] All P values are based on two-tailed tests. Statistical analysis was performed with the use of Stata software.[55]

To examine whether the mix of skills or the number of hours of nursing care was more important in influencing patient outcomes, we analyzed 10 models involving nurse-staffing variables and compared the results. We present results from the two models that most closely match those used in previous published studies. Model 1 examines the mix of skills and includes the proportion of hours of care by licensed nurses (registered-nurse–hours plus licensed-practical-nurse–hours) that were provided by registered nurses, plus aide-hours and the total hours per day provided by licensed nurses. Model 2 measures all staffing of nurses — by registered nurses, aides, and licensed practical nurses — in hours per day. Results obtained with the other models we analyzed have been reported elsewhere.[56]

RESULTS

Rates of Adverse Patient Outcomes and Length of Stay

The patient outcomes and characteristics of the hospitals are summarized in Table 1. Complications that are common in hospitalized patients, such as urinary tract infection, pneumonia, and metabolic derangement, were the most frequent. The highest rates were for "failure to rescue," defined as the death of a patient with one of five life-threatening

TABLE 1. PATIENT OUTCOMES AND CHARACTERISTICS OF THE 799 HOSPITALS.*

VARIABLE	MEDICAL PATIENTS (N=5,075,969)†	SURGICAL PATIENTS (N=1,104,659)†
Outcome		
Length of stay (days)	5.0±2.0	4.7±1.4
Urinary tract infection (%)	6.3±2.3	3.3±2.1
Pressure ulcers (%)	7.2±4.5	5.8±6.6
Hospital-acquired pneumonia (%)	2.3±1.2	1.2±2.2
Shock or cardiac arrest (%)	0.6±0.8	0.5±0.6
Upper gastrointestinal bleeding (%)	1.0±0.6	0.5±0.5
Hospital-acquired sepsis (%)	1.3±0.9	1.0±0.8
Deep venous thrombosis (%)	0.5±0.3	0.4±0.4
Central nervous system complications (%)	0.6±0.4	0.3±0.4
In-hospital death (%)	3.2±1.2	1.6±1.6
Failure to rescue (%)	18.6±5.9	19.7±13.3
Wound infection (%)‡	—	0.8±0.6
Pulmonary failure (%)‡	—	1.2±2.0
Metabolic derangement (%)‡	—	6.8±7.2

	ALL HOSPITALS
Hospital characteristic	
No. of beds	226.6±198.9
Teaching status (%)	
Major teaching hospital	10.3±30.3
Other teaching hospital	19.0±39.3
Nonteaching hospital	70.7±45.5
Location (%)	
Large metropolitan area	53.9±49.9
Small metropolitan area	25.7±43.7
Nonmetropolitan area	20.4±40.3

*Plus–minus values are means ±SD. The number of hospitals is smaller than 799 for some outcomes because hospitals with expected counts of zero were excluded. For medical patients, one hospital was excluded from the analysis of upper gastrointestinal bleeding and one from the analysis of shock or cardiac arrest. For surgical patients, 2 hospitals were excluded from the analysis of urinary tract infection; 9 from the analyses of pressure ulcer and pneumonia; 1 each from the analyses of shock or cardiac arrest, sepsis, central nervous system complications, deep venous thrombosis, in-hospital death, pulmonary failure, and wound infection; and 14 from the analyses of failure to rescue (defined as in-hospital death of a patient with hospital-acquired pneumonia, shock or cardiac arrest, upper gastrointestinal bleeding, sepsis, deep venous thrombosis, or pulmonary failure). For both groups of patients, two hospitals were excluded from the analysis of length of stay.

†Numbers shown are the number of patients discharged.

‡This outcome was assessed in surgical patients only.

complications — pneumonia, shock or cardiac arrest, upper gastrointestinal bleeding, sepsis, or deep venous thrombosis — for which early identification by nurses and medical and nursing interventions can influence the risk of death. The mean death rates were 18.6 percent among medical patients with one of these complications and 19.7 percent among surgical patients with one of these complications. Rates for outcomes were similar in all 11 states. The low rates of deep venous thrombosis — 0.4 percent among surgical patients and 0.5 percent among medical patients — may reflect underreporting of this common complication.

TABLE 2. HOURS OF NURSING CARE.*

VARIABLE	VALUE
No. of hours of nursing care per patient-day	
Registered-nurse–hours	7.8±1.9
Licensed-practical-nurse–hours	1.2±1.0
Aide-hours	2.4±1.2
Total	11.4±2.3
Proportion of total hours of nursing care (%)	
Registered-nurse–hours	68±10
Licensed-practical-nurse–hours	11±8
No. of hours of care by licensed nurses per patient-day	9.0±2.0
Registered-nurse–hours as a proportion of licensed-nurse–hours (%)	87±10

*Plus–minus values are means ±SD. Licensed nurses are registered nurses and licensed practical nurses.

Variations in Staffing Levels and Mix of Skills

The mean (±SD) numbers of hours of nursing care are shown in Table 2. Hours per inpatient-day averaged 7.8 for registered nurses, 1.2 for licensed practical nurses, and 2.4 for aides. Hours of care by licensed nurses per day averaged 9.0. The mean proportion of total hours of nursing care provided by registered nurses was 68 percent; aides provided 21 percent of total nurse-hours.

Association between Adverse Outcomes and Staffing by Nurses

The relations between adverse outcomes and the levels of staffing by registered nurses are shown in Table 3 for medical patients and in Table 4 for surgical patients. The ordinary least-squares–regression coefficients (for length of stay) or the incidence-rate ratios (for other outcomes) are given for both registered-nurse–hours as a proportion of total hours of care by licensed nurses and the number of registered-nurse–hours per patient-day. A negative regression coefficient or an incidence-rate ratio of less than 1.00 indicates that the frequency of the outcome declines as the staffing level increases. The estimated percent decreases in the rates of the outcomes associated with increasing nurse-hours from the 25th to the 75th percentile are also listed. We report results for death and outcomes for which a greater number of registered-nurse–hours or a higher proportion of licensed-nurse care provided by registered nurses was associated with lower rates of the outcome. Additional results are reported elsewhere.[56]

Registered Nurses and Adverse Outcomes

Among medical patients, we found an association between registered-nurse staffing and six outcomes. Both a higher proportion of licensed-nurse care pro-

TABLE 3. RELATION BETWEEN ADVERSE OUTCOMES AMONG MEDICAL PATIENTS AND THE LEVELS OF STAFFING BY REGISTERED NURSES (RNs).*

OUTCOME	REGRESSION COEFFICIENT OR INCIDENCE-RATE RATIO (95% CI)†	DECREASE IN RATE OF OUTCOME ASSOCIATED WITH INCREASING STAFFING OF RNs FROM 25TH TO 75TH PERCENTILE	
		% (95% CI)	P value
Length of stay			
Proportion of RN-hours	−1.12 (−2.00 to −0.24)	3.5 (1.4 to 5.7)	0.01
No. of RN-hours per patient-day	−0.09 (−0.13 to −0.05)	5.2 (3.4 to 7.1)	<0.001
Urinary tract infection			
Proportion of RN-hours	0.48 (0.38 to 0.61)	9.0 (6.1 to 11.9)	<0.001
No. of RN-hours per patient-day	0.99 (0.98 to 1.00)	3.6 (1.2 to 6.0)	<0.003
Upper gastrointestinal bleeding			
Proportion of RN-hours	0.66 (0.45 to 0.96)	5.1 (0.5 to 9.7)	0.03
No. of RN-hours per patient-day	0.98 (0.97 to 0.99)	5.2 (1.4 to 8.9)	<0.007
Hospital-acquired pneumonia			
Proportion of RN-hours	0.59 (0.44 to 0.80)	6.4 (2.8 to 10.0)	0.001
No. of RN-hours per patient-day	0.99 (0.98 to 1.00)	2.7 (−0.4 to 5.8)	0.08
Shock or cardiac arrest			
Proportion of RN-hours	0.46 (0.27 to 0.81)	9.4 (2.6 to 16.3)	0.007
No. of RN-hours per patient-day	0.98 (0.96 to 1.01)	4.1 (−2.5 to 10.8)	0.22
Failure to rescue			
Proportion of RN-hours	0.81 (0.66 to 1.00)	2.5 (0.0 to 5.0)	0.05
No. of RN-hours per patient-day	1.00 (0.99 to 1.01)	0.1 (−2.5 to 2.4)	0.96
In-hospital death			
Proportion of RN-hours	0.90 (0.74 to 1.09)	1.4 (−1.1 to 3.8)	0.27
No. of RN-hours per patient-day	1.00 (0.99 to 1.01)	0.3 (−2.1 to 2.7)	0.83

*There were a total of 799 hospitals, but hospitals were excluded from the analysis of any outcome for which their expected count was zero. Two hospitals were excluded from the analysis of length of stay, one was excluded from the analysis of upper gastrointestinal bleeding, and one was excluded from the analysis of shock or cardiac arrest. The proportion of licensed-nurse–hours provided by registered nurses ("proportion of RN-hours") was measured by model 1; the number of RN-hours per patient-day was measured by model 2. Model 1 also included measures of aide-hours per patient-day and licensed-nurse–hours per patient-day, and model 2 also included measures of aide-hours per patient-day and licensed-practical-nurse–hours per patient-day. None of these other variables showed a consistent association with the rates of outcomes. The models are described further in the Methods section. No association was found between the measures of registered-nurse staffing and the following adverse outcomes among medical patients: sepsis, deep venous thrombosis, central nervous system complications, and pressure ulcers. CI denotes confidence interval.

†Data for length of stay are regression coefficients; data for all other outcomes are incidence-rate ratios. A negative regression coefficient or an incidence-rate ratio of less than 1.00 indicates that the frequency of the outcome declines as staffing increases. Confidence intervals have been rounded.

vided by registered nurses (model 1) and more registered-nurse–hours per day (model 2) were associated with a shorter length of stay and lower rates of urinary tract infections and upper gastrointestinal bleeding. A higher proportion of registered-nurse–hours (model 1), but not a greater number of registered-nurse–hours per day (model 2), was associated with lower rates of three other adverse outcomes: pneumonia, shock or cardiac arrest, and failure to rescue. The association for failure to rescue was not as strong as the associations for the other five outcomes, and it was more sensitive to the specifications of the models.[56]

Among surgical patients, a higher proportion of registered-nurse–hours (model 1) was associated with a lower rate of urinary tract infection. A greater number of registered-nurse–hours per day (model 2) was associated with a lower rate of failure to rescue; a greater number of licensed-nurse–hours per day was also associated with a lower rate of failure to rescue (incidence-rate ratio, 0.98; 95 percent confidence interval, 0.97 to 1.00; P=0.02). Because most licensed-nurse–hours are provided by registered nurses, these associations are consistent. Among both medical and surgical patients, we found no evidence of an association between in-hospital mortality and the proportion of registered-nurse–hours, the number of registered-nurse–hours per day, or the number of licensed-nurse–hours per day.

Measures of Staffing by Other Nurses

In addition to the association with a lower rate of failure to rescue among surgical patients, a greater number of licensed-nurse–hours per day was associ-

TABLE 4. RELATION BETWEEN ADVERSE OUTCOMES AMONG SURGICAL PATIENTS AND THE LEVELS OF STAFFING BY REGISTERED NURSES (RNs).*

OUTCOME	INCIDENCE-RATE RATIO (95% CI)†	DECREASE IN RATE OF OUTCOME ASSOCIATED WITH INCREASING STAFFING OF RNs FROM 25TH TO 75TH PERCENTILE	
		% (95% CI)	P value
Urinary tract infection			
Proportion of RN-hours	0.67 (0.46 to 0.98)	4.9 (0.3 to 9.5)	0.04
No. of RN-hours per patient-day	1.00 (0.98 to 1.02)	0.0 (−4.2 to 4.2)	1.00
Failure to rescue			
Proportion of RN-hours	0.73 (0.49 to 1.09)	3.9 (−1.1 to 8.8)	0.12
No. of RN-hours per patient-day	0.98 (0.96 to 0.99)	5.9 (1.5 to 10.2)	0.008
In-hospital death			
Proportion of RN-hours	0.99 (0.67 to 1.47)	0.1 (−4.7 to 4.9)	0.97
No. of RN-hours per patient-day	1.00 (0.99 to 1.01)	0.0 (−3.9 to 3.8)	0.98

*There were a total of 799 hospitals, but hospitals were excluded from the analysis of any outcome for which their expected outcome was zero. Two hospitals were excluded from the analysis of urinary tract infection, 14 from the analysis of failure to rescue, and 1 from the analysis of in-hospital death. The proportion of licensed-nurse–hours provided by registered nurses ("proportion of RN-hours") was measured by model 1; the number of RN-hours per patient-day was measured by model 2. Model 1 also included measures of aide-hours per patient-day and licensed-nurse–hours per patient-day, and model 2 also included measures of aide-hours per patient-day and licensed-practical-nurse–hours per patient-day. None of these other variables showed a consistent association with the rates of outcomes. The models are described further in the Methods section. Only results showing a consistent association with the rates of outcomes are presented. No association was found between the measures of registered-nurse staffing and the following outcomes among surgical patients: length of stay, pneumonia, sepsis, deep venous thrombosis, shock or cardiac arrest, gastrointestinal bleeding, pressure ulcers, metabolic derangement, central nervous system complications, pulmonary failure, and wound infection. CI denotes confidence interval.

†An incidence-rate ratio of less than 1.00 indicates that the frequency of the outcome declines as staffing increases.

ated with a shorter length of stay among medical patients (regression coefficient, −0.08; 95 percent confidence interval, −0.12 to −0.05; P<0.001). Measures of staffing by aides and licensed practical nurses had either nonsignificant associations with lower rates of the adverse outcomes we studied or significant associations with higher rates of the adverse outcomes (data not shown). Thus, whereas there was evidence that greater numbers of registered-nurse–hours or licensed-nurse–hours were associated with a shorter length of stay among medical patients and lower rates of failure to rescue among surgical patients, there was no evidence of an association between lower rates of the outcomes we studied and a greater number of licensed-practical-nurse–hours or aide-hours per day or a higher proportion of aide-hours.

DISCUSSION

In a large sample of hospitals from a diverse group of states, after controlling for differences in the nursing case mix and the patients' levels of risk, we found an association between the proportion of total hours of nursing care provided by registered nurses or the number of registered-nurse–hours per day and six outcomes among medical patients. These were the length of stay and the rates of urinary tract infections, upper gastrointestinal bleeding, hospital-acquired pneumonia, shock or cardiac arrest, and failure to rescue (the death of a patient with one of five life-threatening complications — pneumonia, shock or cardiac arrest, upper gastrointestinal bleeding, sepsis, or deep venous thrombosis). The evidence was weaker for failure to rescue than for the other five measures. As in other studies,[32,57] higher levels of staffing by registered nurses were associated with lower rates of failure to rescue among surgical patients, among whom we also found an association between a higher proportion of registered-nurse–hours and lower rates of urinary tract infections.

The fact that fewer outcomes among surgical patients than among medical patients were found to be associated with the level of staffing by registered nurses may have several explanations. Surgical patients may be healthier than medical patients and therefore have a lower risk of adverse outcomes. The smaller size of the samples of surgical patients may also have made it more difficult to detect associations.

Our findings clarify the relation between the lev-

els of staffing by nurses and the quality of care. We found consistent evidence of an association between higher levels of staffing by registered nurses and lower rates of adverse outcomes, but no similar evidence related to staffing by licensed practical nurses or aides. Our findings may reflect the actual contribution of these different members of the nursing staff to patients' outcomes in general, or they may be specific to the outcomes we examined. It is possible that the outcomes for which we found significant associations may be more sensitive to the contribution that the skills and education of registered nurses, in particular, make to patient care.

A higher proportion of total hours of nursing care provided by registered nurses was more frequently associated with lower rates of adverse outcomes than was a greater number of registered-nurse–hours per day. This difference may reflect a real effect, or it may simply indicate that we could measure differences in the mix of staff among hospitals with greater precision than we could nurse-hours adjusted for case mix.

We tested the association between staffing levels and 25 outcomes in medical and surgical patients and found an association for 8 of these outcomes. With the exception of failure to rescue among medical patients, these results were consistent across alternative regression models. Because of the large number of comparisons, however, it is possible that some of the associations we found may be false positive findings. In addition, differences among hospitals may be caused not by the staffing level of nurses per se but by other unmeasured factors associated with higher levels of staffing by registered nurses or other unmeasured characteristics of the hospitals' nursing work force. The level of staffing by nurses is an incomplete measure of the quality of nursing care in hospitals. Other factors, such as effective communication between nurses and physicians and a positive work environment, have been found to influence patients' outcomes.[58,59]

Other limitations of our study arise from weaknesses of currently available data. Constructing a data base on the staffing levels of nurses for inpatient care from the diverse data sets of multiple states required substantial efforts to standardize the data and to determine what proportion of a hospital's nursing staff was allocated to inpatient care. Because of the absence of reliable coding indicating whether secondary problems were present when the patient was admitted or developed later, constructing measures of quality from discharge abstracts involved defining appropriate coding and exclusion rules for each adverse outcome. These outcomes are likely to be underreported, and the degree of underreporting may be higher where staffing levels are low. Each of these limitations weakened our ability to observe associations between outcomes and staffing levels. We studied only adverse outcomes. Furthermore, not all outcomes among patients that are important to examine (for example, falls or medication errors) can be studied on the basis of discharge data. The outcomes for which we found associations with the levels of staffing by nurses should be viewed as indicators of quality rather than as measures of the full effect of nurses in hospitals.

Further research is needed to refine the measurement of the nursing case mix on the basis of discharge data and to elucidate the factors influencing the staffing levels of nurses and the mix of nursing personnel in hospitals. Given the evidence that such staffing levels are associated with adverse outcomes, as well as the current and projected shortages of hospital-based registered nurses,[60,61] systems should be developed for the routine monitoring, in large numbers of hospitals, of hospital outcomes that are sensitive to levels of staffing by nurses. Beyond monitoring, hospital administrators, accrediting agencies, insurers, and regulators should take action to ensure that an adequate nursing staff is available to protect patients and to improve the quality of care.

Supported by a contract (230-99-0021) with the Health Resources and Services Administration, Department of Health and Human Services, with funding from the Health Resources and Services Administration, the Agency for Healthcare Research and Quality, the Centers for Medicare and Medicaid Services, and the National Institute of Nursing Research; by a grant (R01 HS09958) from the Agency for Healthcare Research and Quality; and by a Dissemination and Development Grant from Abt Associations (to Dr. Mattke). The views expressed in this article are those of the authors and not necessarily those of the funding agencies or the organizations that provided data.

Presented in part at the annual meeting of the Academy for Health Services Research and Health Policy, Atlanta, June 10–12, 2001.

We are indebted to Carole Gassert, Evelyn Moses, Judy Goldfarb, Tim Cuerdon, Cheryl Jones, Peter Gergen, Carole Hudgings, Pamella Mitchell, Donna Diers, Chris Kovner, Mary Blegen, Margaret Sovie, Nancy Donaldson, Ann Minnick, Lisa Iezzoni, Leo Lichtig, Robert Knauf, Alan Zaslavsky, Lucian Leape, Sheila Burke, Barbara Berney, Gabrielle Hermann-Camara, and the Harvard Nursing Research Institute for advice and recommendations; to the California Office of Statewide Health Planning and Development and the State of Maryland for providing data at no cost; and to the staffs of the agencies in each state from which we obtained data for their assistance.

APPENDIX. CODING RULES FOR ADVERSE OUTCOMES.*

OUTCOME	DEFINITION	
	INCLUDED	EXCLUDED
Length of stay	Length of stay as reported on discharge abstract	None
Urinary tract infection	ICD-9-CM: 599.0, 996.64	Primary diagnosis, MDC 11–15; ICD-9-CM: 646.60–646.64, 639.8
Pressure ulcers	ICD-9-CM: 682, 707.0	Primary diagnosis, hemiplegia,† quadriplegia,† paraplegia,† IV drug abuse†
Hospital-acquired pneumonia	ICD-9-CM: 507.0, 997.3, 514, 482.0–482.2, 482.4–482.9, 485, 486	Primary diagnosis — ICD-9-CM: 480–487, 507.0, 514, 997.3; secondary diagnosis — ICD-9-CM: 480, 481, 483, 484, 487; MDC 4, AIDS,† immunocompromised states†
Shock or cardiac arrest	ICD-9-CM: diagnoses — 427.5, 785.5, 785.50, 785.51, 785.59, 799.1; procedures — 93.93, 99.6, 99.63	Primary diagnosis, MDC 4, MDC 5, hemorrhage,† trauma†
Upper gastrointestinal bleeding	ICD-9-CM: 531.00–531.31, 531.9, 532.00–532.31, 532.9, 533.00–533.31, 533.9, 534.00–534.31, 534.9, 535.01, 535.4, 578.9, 530.82	Primary diagnosis, MDC 6–7, trauma,† burn,† alcoholism,† ICD-9-CM: 280.0, 285.1
Hospital-acquired sepsis	ICD-9-CM: 038, 790.7	Primary diagnosis, immunocompromised states,† AIDS,† length of stay <3 days, DRG: 20, 68–70, 79–81, 89–91, 126, 238, 242, 277–279, 320–322, 415–417, 423
Deep venous thrombosis	ICD-9-CM: 415.1, 415.11, 451.11, 451.19, 451.2, 451.81, 453.8	Primary diagnosis, ICD-9-CM: 673.2
Central nervous system complications	ICD-9-CM: 780.0, 293.0, 298.2, 309.1–309.9	Primary diagnosis, MDC 1, MDC 19, MDC 20
Death	Discharge status — death	None
Failure to rescue	Discharge status — death, with sepsis, pneumonia, upper gastrointestinal bleeding, shock or cardiac arrest, or deep venous thrombosis	Absence of sepsis, pneumonia, upper gastrointestinal bleeding, shock or cardiac arrest, or deep venous thrombosis
Wound infection	ICD-9-CM: 958.3, 998.5	Primary diagnosis
Pulmonary failure	ICD-9-CM: 514, 518.4, 518.5, 518.81, 518.82	Primary diagnosis, MDC 4, MDC 5, trauma†
Metabolic derangement	ICD-9-CM: 250.10, 250.11 (excluding diabetes as primary diagnosis), 998.0 (excluding those without operation or procedure during hospital stay), 788.5 (excluding acute myocardial infarction,† cardiac arrhythmia,† cardiac arrest,† or gastrointestinal hemorrhage† as primary diagnosis), 276 (excluding MDC 5, MDC 7, MDC 10, MDC 11), 251.0	Primary diagnosis, trauma

*ICD-9-CM denotes *International Classification of Diseases, 9th Revision, Clinical Modification;* MDC major diagnostic category; AIDS acquired immunodeficiency syndrome; and DRG diagnosis-related group.

†The condition was as defined in Iezzoni,[49] updated to match the 1997 codes.

REFERENCES

1. Thomas L. The youngest science: notes of a medicine-watcher. New York: Viking Press, 1983.
2. Wunderlich GS, Sloan FA, Davis CK, eds. Nursing staff in hospitals and nursing homes: is it adequate? Washington, D.C.: National Academy Press, 1996.
3. President's Advisory Commission on Consumer Protection and Quality in the Health Care Industry. Quality first: better care for all Americans. Washington, D.C.: Government Printing Office, 1997. (Accessed May 6, 2002, at http://www.hcqualitycommission.gov/final.)
4. Lake E. The organization of hospital nursing. Philadelphia: University of Pennsylvania, 1999. (Dissertation.)
5. Schultz MA, van Servellen GA. A critical review of research on hospital mortality among medical-surgical and acute myocardial infarction patients. Nurs Health Sci 2000;2:103-12.
6. Aiken LH, Clarke SP, Sloane DM, et al. Nurses' reports on hospital care in five countries. Health Aff (Millwood) 2001;20(3):43-53.
7. Buerhaus PI, Donelan K, DesRoches C, Lamkin L, Mallory G. State of the oncology nursing workforce: problems and implications for strengthening the future. Nurs Econ 2001;19:198-208.
8. Buerhaus PI, Staiger DO. Managed care and the nurse workforce. JAMA 1996;276:1487-93.
9. Buerhaus PI, Auerbach D. Slow growth in the United States of the number of minorities in the RN workforce. Image J Nurs Sch 1999;31:179-83.
10. Kovner CT, Jones CB, Gergen PJ. Nurse staffing in acute care hospitals, 1990-1996. Policy Politics Nurs Pract 2000;1:194-204.
11. Spetz J. Hospital employment of nursing personnel: has there really been a decline? J Nurs Adm 1998;28:20-7.
12. Anderson GF, Kohn LT. Hospital employment trends in California, 1982–1994. Health Aff (Millwood) 1996;15(1):152-8.
13. Aiken LH, Sochalski J, Anderson GF. Downsizing the hospital nursing workforce. Health Aff (Millwood) 1996;15(4):88-92.
14. Hartz AJ, Krakauer H, Kuhn EM, et al. Hospital characteristics and mortality rates. N Engl J Med 1989;321:1720-5.
15. Manheim LM, Feinglass J, Shortell SM, Hughes EFX. Regional variation in Medicare hospital mortality. Inquiry 1992;29:55-66.

16. Krakauer H, Bailey RC, Skellan KJ, et al. Evaluation of the HCFA model for the analysis of mortality following hospitalization. Health Serv Res 1992;27:317-35.
17. Scott W, Forrest W, Brown B. Hospital structure and postoperative mortality and morbidity. In: Shortell SM, Brown M, eds. Organizational research in hospitals. Chicago: Blue Cross, 1976:72-89.
18. Flood AB, Scott WR, Ewy W. Does practice make perfect? II. The relation between volume and outcomes and other hospital characteristics. Med Care 1984;22:115-25.
19. Flood AB, Scott WR. Hospital structure and performance. Baltimore: Johns Hopkins University Press, 1987.
20. Silber J, Rosenbaum PR, Ross RN. Comparing the contributions of groups of predictors: which outcomes vary with hospital rather than patient characteristics? J Am Stat Assoc 1995;90:7-18.
21. Kovner C, Gergen PJ. Nurse staffing levels and adverse events following surgery in U.S. hospitals. Image J Nurs Sch 1998;30:315-21.
22. Flood SD, Diers D. Nurse staffing, patient outcome and cost. Nurs Manage 1988;19:34-5, 38-9, 42-3.
23. Neidlinger SH, Bostrom J, Stricker A, Hild J, Zhang JQ. Incorporating nursing assistive personnel into a nursing professional proactive model. J Nurs Adm 1993;23:29-37.
24. Fridkin SK, Pear SM, Williamson TH, Galgiani JN, Jarvis WR. The role of understaffing in central venous catheter-associated bloodstream infections. Infect Control Hosp Epidemiol 1996;17:150-8.
25. Archibald LK, Manning ML, Bell LM, Banerjee S, Jarvis WR. Patient density, nurse-to-patient ratio and nosocomial infection risk in a pediatric cardiac intensive care unit. Pediatr Infect Dis J 1997;16:1045-8.
26. Pronovost PJ, Jenckes MW, Dorman T, et al. Organizational characteristics of intensive care units related to outcomes of abdominal aortic surgery. JAMA 1999;281:1310-7.
27. Blegen MA, Goode CJ, Reed L. Nurse staffing and patient outcomes. Nurs Res 1998;47:43-50.
28. Lichtig LK, Knauf RA, Milholland KD. Some impacts of nursing on acute care hospital outcomes. J Nurs Adm 1999;29:25-33.
29. Robert J, Fridkin SK, Blumberg HM, et al. The influence of the composition of the nursing staff on primary bloodstream infection rates in a surgical intensive care unit. Infect Control Hosp Epidemiol 2000;21:12-7.
30. Iezzoni LI, Daley J, Heeren T, et al. Using administrative data to screen hospitals for high complication rates. Inquiry 1994;31:40-55.
31. al-Haider AS, Wan TTH. Modeling organizational determinants of hospital mortality. Health Serv Res 1991;26:303-23.
32. Silber JH, Rosenbaum PR, Schwartz JS, Ross RN, Williams SV. Evaluation of the complication rate as a measure of quality of care in coronary artery bypass graft surgery. JAMA 1995;274:317-23.
33. Taunton RL, Kleinbeck SVM, Stafford R, Woods CQ, Bott MJ. Patient outcomes: are they linked to registered nurse absenteeism, separation, or work load? J Nurs Adm 1994;24:Suppl:48-55. [Erratum, J Nurs Adm 1994;24:72.]
34. Iezzoni LI, Ash AS, Schwartz M, Daley J, Hughes JS, Mackiernan YD. Judging hospitals by severity-adjusted mortality rates: the influence of the severity-adjustment method. Am J Public Health 1996;86:1379-87.
35. Iezzoni LI, Ash AS, Schwartz M, Mackiernan YD. Differences in procedure use, in-hospital mortality, and illness severity by gender for acute myocardial infarction patients: are answers affected by data source and severity measure. Med Care 1997;35:58-71.
36. Silber JH, Rosenbaum PR. A spurious correlation between hospital mortality and complication rates: the importance of severity adjustment. Med Care 1997;35:Suppl:OS77-OS92.
37. Bradbury RC, Stearns FE Jr, Steen PM. Interhospital variations in admission severity-adjusted hospital mortality and morbidity. Health Serv Res 1991;26:407-24.
38. Zimmerman JE, Shortell SM, Rousseau DM, et al. Improving intensive care: observations based on organizational case studies in nine intensive care units: a prospective, multicenter study. Crit Care Med 1993;21:1443-51.
39. Wan TTH, Shukla RK. Contextual and organizational correlates of the quality of hospital nursing care. QRB Qual Rev Bull 1987;13:61-4.
40. Bryan YE, Hitchings KS, Fuss MA, Fox MA, Kinneman MT, Young MJ. Measuring and evaluating hospital restructuring efforts: eighteen-month follow-up and extension to critical care. J Nurs Adm 1998;28:21-7.
41. Czaplinski C, Diers D. The effect of staff nursing on length of stay and mortality. Med Care 1998;36:1626-38.
42. CONQUEST: overview. Rockville, Md.: Agency for Health Care Policy and Research, 2001. (Accessed May 6, 2002, at http://www.ahrq.gov/qual/conquest/conqovr1.htm.)
43. Iezzoni LI, Mackiernan YD, Cahalane MJ, Phillips RS, Davis RB, Miller K. Screening quality of care using administrative data. Boston: Beth Israel Deaconess Hospital, 1999.
44. Karon SL, Sainfort F, Zimmerman DR. Stability of nursing home quality indicators over time. Med Care 1999;37:570-9.
45. Keyes MA. CONQUEST 2.0: an emerging clinical performance measurement tool. J Healthc Qual 2000;22:29-36.
46. Palmer RH, Lawthers AG, Banks NJ, et al. CONQUEST 1.0: overview of final report and user's guide. Rockville, Md.: The Agency, 1996.
47. Silber JH, Williams SV, Krakauer H, Schwartz JS. Hospital and patient characteristics associated with death after surgery: a study of adverse occurrence and failure to rescue. Med Care 1992;30:615-29.
48. Iezzoni LI, Foley SM, Heeren T, et al. A method for screening the quality of hospital care using administrative data: preliminary validation results. QRB Qual Rev Bull 1992;18:361-71.
49. Iezzoni LI. Complications screening program for the Health Care Financing Administration (CSP-HCFA): CSP updated to FY 1993 coding guidelines. Boston: Beth Israel Hospital, 1994.
50. Healthcare cost and utilization project quality indicators (HCUPQIs). Rockville, Md.: Agency for Healthcare Research and Quality, 2000. (Accessed May 6, 2002, at http://www.ahrq.gov/data/hcup/qifact.htm.)
51. The AHA annual survey database: fiscal year 1997 documentation. Chicago: American Hospital Association, 1998.
52. Ballard KA, Gray RF, Knauf RA, Uppal P. Measuring variations in nursing care per DRG. Nurs Manage 1993;24:33-6, 40-1.
53. The AHA annual survey database: fiscal year 1998 documentation. Chicago: American Hospital Association, 1999.
54. Greene WH. Econometric analysis. 4th ed. Upper Saddle River, N.J.: Prentice-Hall, 2000.
55. Stata reference manual: release 6. College Station, Tex.: Stata, 1999.
56. Needleman J, Buerhaus P, Mattke S, Stewart M, Zelevinsky K. Nurse staffing and patient outcomes in hospitals. Boston: Harvard School of Public Health, 2001. (Accessed May 6, 2002, at http://bhpr.hrsa.gov/dn/staffstudy.htm.)
57. Silber JH, Kennedy SK, Even-Shoshan O, et al. Anesthesiologist direction and patient outcomes. Anesthesiology 2000;93:152-63.
58. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. An evaluation of outcome from intensive care in major medical centers. Ann Intern Med 1986;104:410-8.
59. Aiken LH, Smith HL, Lake ET. Lower Medicare mortality among a set of hospitals known for good nursing care. Med Care 1994;32:771-87.
60. The hospital workforce shortage: immediate and future. TrendWatch. Vol. 3. No. 2. Washington, D.C.: American Hospital Association, June 2001: 1-8.
61. Buerhaus PI, Staiger DO, Auerbach DI. Implications of an aging registered nurse workforce. JAMA 2000;283:2948-54.

Session 6: Health Care Workforce Shortages

Bibliography

Prepared by Edward Salsberg, M.P.A. State University of New York at Albany

Health Care at the Crossoroads: Strategies for Addressing the Evolving Nursing Crisis. Joint Commission on Accreditation of Healthcare Organizations. August, 2002.

Salsberg S. Making Sense of the System: How States Can Use Health Workforce Policies to Increase Access and Improve Quality of Care. Preliminary Report. The Reforming States Group and Milbank Memorial Fund. October 31, 2002. (Forthcoming)

Needleman J, Buerhaus PI, Mattke S, Stewart M, Zelevinsky K. Nurse Staffing and Patient Outcomes in Hospitals. Health Resources and Services Administration. February, 2001.

Wakina S. Nurse Workforce: Condition Critical. National Health Policy Forum. Washington DC: June 1, 2001.

Dummit L. Nursing Homes: Quality of Care More Related to Staffing than Spending. General Accounting Office. Washington DC: June 13, 2002.

Nursing Workforce: Emerging Nurse Shortages Due to Multiple Factors. General Accounting Office. Washington DC: July, 2001.

Projected Supply, Demand, and Shortages of Registered Nurses: 2000-2020. Bureau of Health Professions. National Center for Health Workforce Analysis. July, 2002.

Fagin CM. When Care Becomes a Burden: Diminishing Access to Adequate Nursing. Milbank Memorial Fund. New York NY: 2001.

OVERHEADS

OVERHEADS

OVERHEADS

OVERHEADS

OVERHEADS

John O. Agwunobi, M.D., M.B.A.

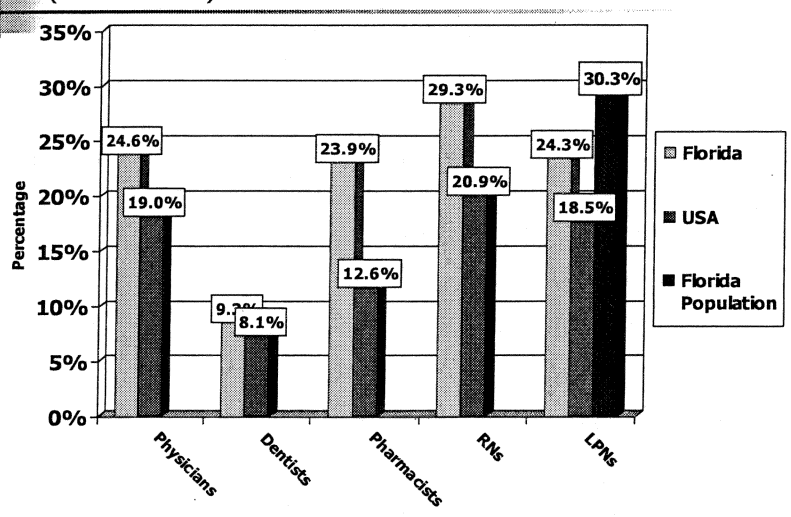
Assuring a Well-Prepared Health Workforce for the 21st Century: Florida Health Care Shortages

John O. Agwunobi, MD, MBA
Secretary
Florida Department of Health

1

Florida's Perspective

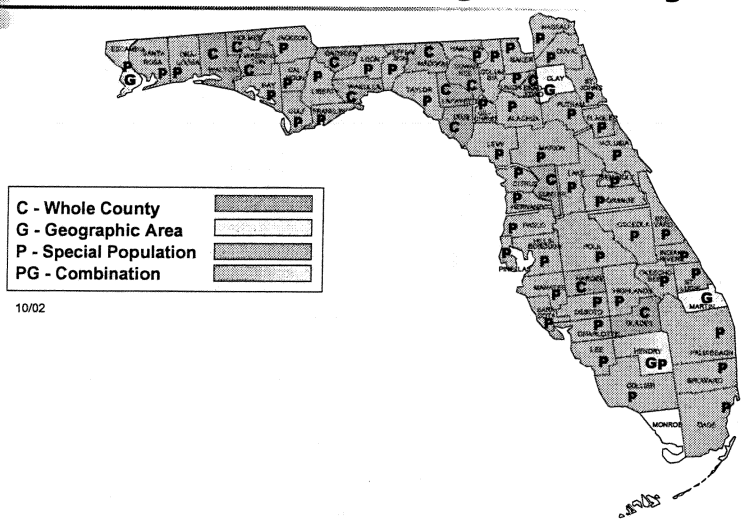
Projections for percentages of increase in health workforce from 1996 – 2006 (Bureau of Labor)



2

Primary Care

Health Professional Shortage Area Designations



3

Florida's Physicians

- Active Patient Care Physician to Population Ratio - 10th *(1998)*
- Primary Care – 59 per 100,000-national average
- Number of Physicians grew 39% while population grew 18% *('89-'98)*
- Percent of Physicians over 55 – 1st in nation with 39%
- Florida ranks 1st in population over 65

4

Existing Physician Strategies

- Medical Quality Assurance
  - Accepting credentials through the Federation of State Medical Boards
  - Reducing the number of applicants required to make personal appearances before the Board prior to approval
  - Increasing board meetings from 6 to 24 per year through teleconferencing
- Florida Health Service Corps *(F.S. 381.0302)*
- Medical Education Reimbursement and Loan Repayment Program *(F.S. 1009.65)*

5

Minority Recruitment

- 14% of Florida population is African American-3% of active physicians
- Consistent with national trend; Florida's graduating medical students illustrate a decreasing % of primary care-oriented post-graduate training. *(2002 – 64.5% vs. 2001 – 65.2%)*
- The Area Health Education Center (AHEC) Program - recruiting minority and disadvantaged students who live in medically underserved communities
- FSU College of Medicine mission is to train medical students who will specialize in primary care, geriatric training and service to rural and underserved areas

6

Florida Medical Education

- 5 Medical Schools *(NSU, UM, UF, USF, and FSU)*
- 2,055 Medical Students *('98-'99)*
- 12.8 Medical Students per 100,000 Population *('98-'99)*
- 97.7% Newly Entering Students who are State Residents *('99-'00)*
- 3.05 Medical School Graduates per 100,000 Population *(1999)*
- Rank 41st among the 46 states with Medical schools in medical school graduates per capita

7

Florida's Nurses

- Number of Nurses grew 43% while population grew 17% *('88-'96)*
- Ratio of RNs Employed in Nursing – ranked 4th *(1996)*
- Nurse Practitioners – national average *(1998)*
- Ratio of LPNs employed in Nursing – 4th *(1998)*
- Status of CNAs

8

Florida's Nurses

- Active Nurse Licenses = 180,491
- Inactive Nurse Licenses = 3,895
- 34,000 Nurses needed by 2006 *(Florida Hospital Association, Hospital Vacancies)*
- Average age RNs = 45
- Average age Nurse Faculty = 5l

9

Florida Nursing Education

- 43 Practical Nursing programs
- 24 Associate Nursing programs
- 15 Baccalaureate Nursing Programs
- 3,564 Total Graduating RNs *(includes Associate and Baccalaureate)*
- 1500 potential Baccalaureate students turned away statewide in 2001-02

10

Medical Quality Assurance Streamline Efforts

- Evening work hours for inquiries
- Merged RN/ARNP application
- Verify license in only up to two states
- Offer out of state license after background check

11

Florida Nursing Strategies

- Nursing Shortage Solutions Act (HB 519)
- Nursing Scholarships/Loan Forgiveness
- Center for Nursing (SB 1806/1808)
- EdSouth 1.06% interest school loans
- Fannie Mae 100% financed mortgage
- FIU MD to Nurse program
- Foreign Nurse recruitment

12

Florida's Pharmacists

- Pharmacists to population - 33rd *(1998)*
- Ratio of Pharmacy Techs to Pharmacists – 5th *(1998)*

13

Florida Pharmacist Education

- 4 Pharmacy Schools *(FAMU, NSU, PBAC, and UF)*
- Florida A & M University - *anticipate graduating 150 students in 2004*
- Nova Southeastern University - *anticipate graduating 160 students in 2004*
- *New* Palm Beach Atlantic Dental School - *anticipate 50 students in 2005*
- University of Florida – *anticipate graduating 120 students in 2004; anticipate graduating 240 by 2006*

14

Pharmacist Strategies

The Pharmacy Education Aid Act of 2001, H.R. 2173

- Creates a Funding Source for Pharmacy School Renovation or Expansion
- Expands Existing Federal Programs for Pharmacy Student Education
- Assures Adequate Supply of Pharmacy Faculty

Medical Quality Assurance Strategies

- Endorsement of out-of–state licenses since 2001
- Weekly review license applications

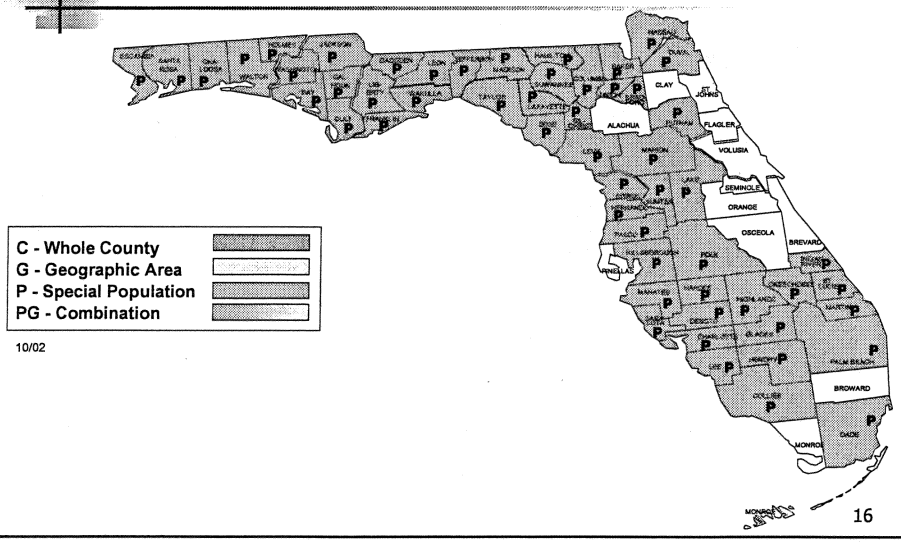
Additional Strategies

- NSU plans to open a new campus in Tampa

15

Dental Care

Health Professional Shortage Area Designations



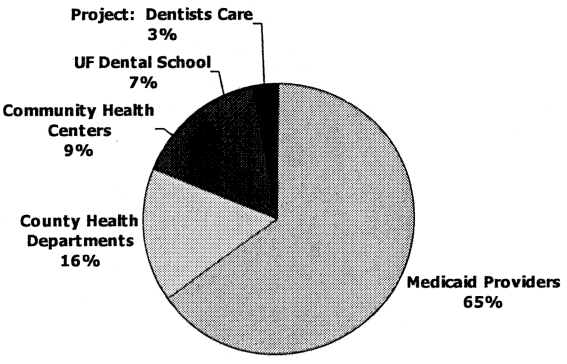
16

Florida's Dentists

- Number of Dentists to Population Ratio of 42.2 per 100,000-below national average of 48.4
- Projected growth of Dentists 1.2% while population 30% *('96-'06)*
- US Dental school graduates declined by 23% *('85-95)*

17

Access to Dental Care by Indigents



Only 9.4% of Indigents received dental visit

18

Dental Education

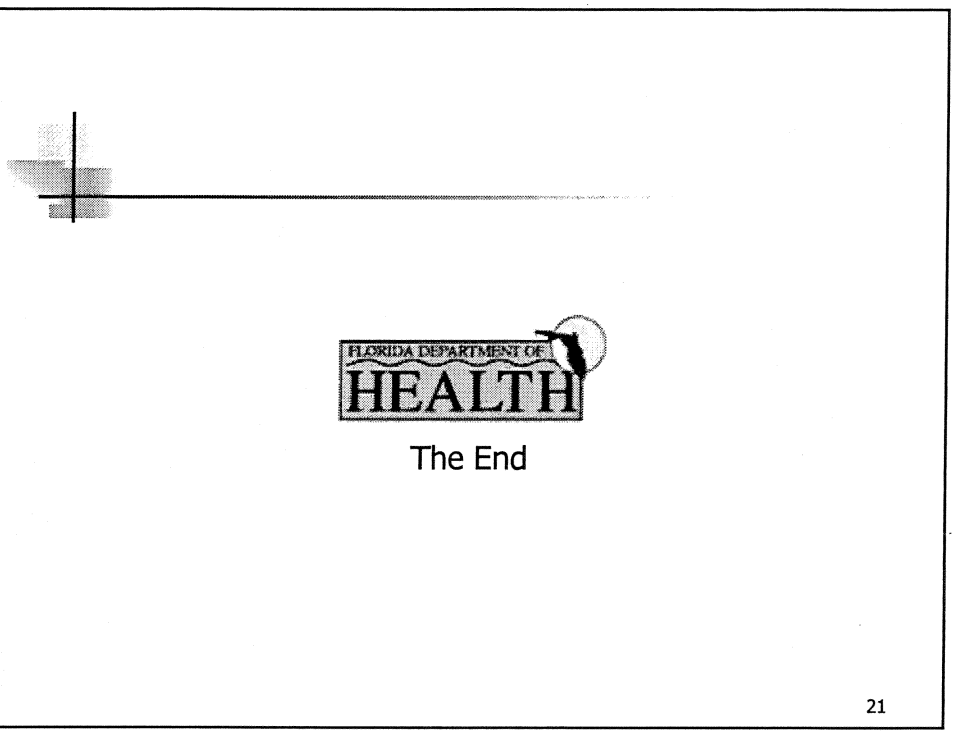
- 2 Dental Schools *(UF and NSU)*
- Nova Southeastern University - *annually graduates 100 students*
- University of Florida – *annually graduates 78-80 students*

19

Dental Strategies

- Medical Quality Assurance recent streamlining licensure efforts:
  - Committees of one to review applications for anesthesia permits, non-profit, and teaching licenses...frees board and staff time to process regular applications
  - Use of automated agendas to speed up board meeting process
- Florida Health Service Corps

20


FLORIDA DEPARTMENT OF
HEALTH
The End
21