MARKETWATCH

Nurse Staffing In Hospitals: Is There A Business Case For Quality?

Costs are only part of the picture; we also need to consider the payoff in cost savings and the value of better patient care.

by Jack Needleman, Peter I. Buerhaus, Maureen Stewart, Katya Zelevinsky, and Soeren Mattke

ABSTRACT: We construct national estimates of the cost of increasing hospital nurse staffing and associated reductions in days, deaths, and adverse outcomes. Raising the proportion of nursing hours provided by registered nurses (RNs) without increasing total nursing hours is associated with a net reduction in costs. Increasing nursing hours, with or without increasing the proportion of hours provided by RNs, reduces days, adverse outcomes, and patient deaths, but with a net increase in hospital costs of 1.5 percent or less at the staffing levels modeled. Whether or not staffing should be increased depends on the value patients and payers assign to avoided deaths and complications. [*Health Affairs* 25, no. 1 (2006): 204–211]

PATIENT SAFETY AND quality improvement efforts have grown impressively in recent years. Despite these gains, though, questions remain about the value of improving quality from both societal and hospital perspectives. From the societal perspective, the question is whether gains from improving quality reduce costs to patients, hospitals, and payers or, if they increase costs, whether the value of the quality improvement to patients justifies spending more on care. From the hospital perspective, the question is whether cost savings or revenue gains from improving quality offset the costs of quality initiatives—that is, whether there is a business case for quality. Sheila Leatherman and colleagues, in language relevant to both perspectives, recently wrote, "There is a compelling need to understand better the economic implications for all stakeholders of implementing quality improvement."[1]

The growing body of evidence linking hospital workforces to patient outcomes suggests that one way to improve quality is to increase nurse staffing.[2] Because nurses are a large portion of hospital labor costs, the cost of increasing staffing would not be insignificant. The additional costs of having more nurses, however, should be offset to some extent by the

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monetary and nonmonetary benefits of reducing adverse outcomes.

There are many ways to improve quality and patient safety in hospitals (for example, equipping hospitals with new technology, investing in training and education, imposing regulations, and increasing nurse staffing). Whether there is a business case for any particular option depends on many factors, and each hospital will have to make its own assessment. In instances where there is not a clear business case for increased nurse staffing, there might be a "social case"; thus, it would be socially beneficial to have policy intervention.

In this study we provide data to help hospitals and policymakers consider both the business and social cases for investing in nurse staffing by estimating the costs of increasing staffing and cost savings resulting from avoided deaths, reduced lengths-of-stay, and decreased adverse patient outcomes associated with higher nurse staffing levels.

Study Data And Methods

In an earlier study we analyzed data from 799 nonfederal acute care general hospitals in eleven states. Discharge abstracts and nurse staffing data were obtained from the states; data on hospital size, location, teaching status, from the American Hospital Association (AHA) annual survey; and cost-to-charge ratios, from Medicare cost reports.

In regression analyses we found an association of nurse staffing and (1) lengths-of-stay, urinary tract infections, upper gastrointestinal bleeding, hospital-acquired pneumonia, shock, or cardiac arrest among medical patients and (2) "failure to rescue," defined as the death of a patient with one of five life-threatening complications—pneumonia, shock or cardiac arrest, upper gastrointestinal bleeding, sepsis, or deep vein thrombosis—among surgical patients. Details of that study are described elsewhere.[3] Exhibit 1 presents rates of these outcomes and descriptive statistics for the 799-hospital sample.

In this study we simulated the effect of three options to increase nurse staffing: raise the proportion of hours provided by registered nurses (RNs) to the seventy-fifth percentile for hospitals below this level; raise the number of licensed (that is, RNs and licensed practical/vocational nurses, or LPNs) nursing hours per day to the seventy-fifth percentile; and raise staffing to each of these levels in hospitals where each is below the seventy-fifth percentile. This percentile was chosen based on our judgment that attaining this level of staffing is feasible for most hospitals (Exhibit 2).

The required number of additional nurse hours to meet the seventy-fifth-percentile levels was estimated from the original sample. Estimates of avoided adverse outcomes and days of care were simulated from the regression models from the earlier study, and estimates of avoided costs and deaths were made with additional regression modeling in the original data. Costs of avoided adverse outcomes were estimated from patient-level regressions of costs per case on patient diagnosis and other characteristics and variables for each adverse outcome. Costs of avoided days were estimated by multiplying average costs per day by regression-based estimates of reduced days net of the days associated with adverse outcomes.

Because many hospital costs are fixed in the short run, hospitals might not fully recover the average costs of avoided days or avoided complications. Based on a review of studies of hospital fixed and variable costs, we estimated variable costs of hospitals to be 40 percent of average costs, and we multiplied calculated costs by this amount to estimate the short-term cost impact of reduced hospital patient days and avoided adverse outcomes.[4] Over time, hospitals should be able to adjust their fixed costs to reflect the change in volume. We present estimates of cost savings assuming short-term savings of 40 percent of average costs and with full recovery of fixed costs.

We projected the results from the sample to all nonfederal U.S. acute care hospitals and updated the estimates of needed staffing, avoided adverse outcomes and days, and costs to reflect hospital costs, admissions, and lengths-of-stay in 2002. Specifically, our sample had 26 percent of the discharges from U.S. nonfederal acute care hospitals in 1997. We constructed

EXHIBIT 1
Mean And Standard Deviation (SD) Of Patient Outcomes And Hospital Characteristics, Hospital Sample

	Mean	SD		Mean	SD
Outcomes			Hospital characteristics		
Length-of-stay (days)	5.02	1.98	Mean number of beds	226.58	198.86
Urinary tract infection	6.30%	2.34%	Teaching status		
Hospital-acquired pneumonia	2.34%	1.15%	Major teaching hospital	10.26%	30.37%
Shock/cardiac arrest	0.57%	0.81%	Other teaching hospital	19.02	39.27
Upper GI bleeding	1.04%	0.63%	Nonteaching hospital	70.71	45.54
Failure to rescue[a]	19.69%	13.30%	Location		
			Large metro area	53.94%	49.88%
			Small metro area	25.66	43.70
			Nonmetro area	20.40	40.32

SOURCE: J. Needleman et al., "Nurse-Staffing Levels and Quality of Care in Hospitals," *New England Journal of Medicine* 346, no. 22 (2002): 1415–1422.

NOTES: All outcomes except "failure to rescue" are analyzed for medical patients; "failure to rescue" is analyzed for surgical patients. The sample had 799 hospitals, with 5,075,969 medical and 1,104,659 surgical discharges. Because they had no patients in the pool for the event, one hospital was excluded from the analysis of upper gastrointestinal (GI) bleeding, one from the analysis of shock and cardiac arrest, and fourteen from the analysis of failure to rescue. Two were excluded from the analysis of length-of-stay because of outlying predictions. Percentages may not add up to 100 percent because of rounding.

[a] "Failure to rescue" is defined as hospital mortality among patients with hospital-acquired pneumonia, shock or cardiac arrest, upper GI bleeding, sepsis, deep vein thrombosis, or pulmonary failure.

national estimates of adverse outcomes, nursing full-time equivalents (FTEs), and costs by multiplying estimates from the sample by 100 divided by 26. We used data on RN wages from the 1997 and 2002 Current Population Surveys (CPS) and the change in admissions, lengths-of-stay, spending per admission, and spending per day between 2002 and 1997 from the AHA annual survey to update the estimates of avoided adverse outcomes, avoided days, deaths, and costs. In aggregate, between 1997 and 2002, licensed hours per day and the proportion of licensed hours provided by RNs reported to the AHA, and average case-mix, measured by the Medicare case-mix index, did not change substantially; thus, no adjustments were made to the staffing variables.[5]

Because neither our prior work nor other studies capture all of the effects of nurse staffing on patient care, and because we do not have direct measures of patient-reported quality, we do not attempt a cost-effectiveness analysis of the impact of raising nurse staffing. We do present estimates of the cost per avoided death.

Study Results

■ **Cost of increasing nurse staffing.** In 2002, U.S. short-term acute general hospitals employed 942,000 FTE RNs and 120,000 FTE

EXHIBIT 2
Proportion Of Registered Nurses (RNs) And Number Of Licensed Nursing Hours At The 25th And 75th Percentiles Of Hospitals Studied

	Mean	Standard deviation	25th percentile	75th percentile	Minimum	Maximum
Proportion of RNs	0.87	0.10	0.81	0.94	0.49	1.00
Number of licensed hours	8.99	2.05	7.58	10.23	4.07	16.75

SOURCE: J. Needleman et al., "Nurse-Staffing Levels and Quality of Care in Hospitals," *New England Journal of Medicine* 346, no. 22 (2002): 1415–1422.

LPNs.[6] Increasing the proportion of RNs to the seventy-fifth percentile (option 1) would require hospitals below this level to replace more than 37,000 FTE LPNs with RNs at an estimated cost of $811 million.

Increasing nurses in hospitals with licensed hours below the seventy-fifth percentile (option 2) requires an increase in FTE RNs of 114,456, and FTE LPNs of more than 13,000, costing $7.5 billion. If hospitals below either of these staffing levels increased staffing to the seventy-fifth percentile (option 3), FTE RNs would increase by nearly 158,000 and FTE LPNs would fall, changes that would cost $8.5 billion (Exhibit 3).

■ **Reduced adverse outcomes and avoided hospital days.** Increasing nurse staffing is associated with fewer adverse outcomes under all options (Exhibit 4), with 70,000 fewer adverse outcomes if hospital nurse staffing met both seventy-fifth-percentile thresholds (option 3).

Decreases in urinary tract infections, pneumonia, and shock or cardiac arrest are associated most with increasing the proportion of RNs. Failure to rescue in surgical patients is more sensitive to the number of licensed nursing hours per day. Upper gastrointestinal bleeding appears equally sensitive to changes in both staffing measures. We believe that urinary tract infections, pneumonia, and shock or cardiac arrest are more sensitive to the RN/LPN mix than hours at the bedside because preventing these complications draws heavily on the skills and education of RNs in patient assessment and intervention, not just increased time to observe and treat patients.

Hospital days would be lower by 1.5 million under option 1, almost 2.6 million under option 2, and 4.1 million under option 3. The larger reduction in length-of-stay (and corresponding reduction in cost) associated with option 2 compared with option 1 reflects our earlier finding that length-of-stay is associated more with hours of nursing care than with the RN/LPN mix.

Short-term cost savings associated with reducing adverse outcomes and hospital days are substantial (Exhibit 4). Because the costs of changing the RN/LPN mix without changing licensed hours are relatively low (option 1), short-term cost savings exceed the cost increases by $242 million. While options 2 and 3 are associated with substantial avoided costs, these are not enough to offset the costs of increased nurse staffing. The net short-term cost increase associated with options 2 and 3 would be $5.8 and $5.7 billion, respectively. Although large, these amounts are approximately 1.5 percent of annual hospital expenditures.

Over time, hospitals can adjust fixed costs to reflect reduced volume or replace these days and services with other, higher-value services or programs to which the fixed costs would be allocated. For some hospitals, this adjustment

EXHIBIT 3
Costs Of Hiring Additional Registered Nurses (RNs) And Licensed Practical Nurses (LPNs) To Increase Nurse Staffing To The 75th Percentile Of Hospitals Studied, National Estimates Updated To 2002

	Option 1: Raise proportion of RNs to 75th percentile without changing number of licensed hours	Option 2: Raise number of licensed hours to 75th percentile without changing proportion of RNs	Option 3: Raise both proportion of RNs and number of licensed hours to 75th percentile
Change in FTE RNs	37,089	114,456	157,894
Change in FTE LPNs	−37,089	13,093	−30,345
Total cost (in millions)	$811	$7,538	$8,488

SOURCE: Authors' estimates using data from J. Needleman et al., "Nurse-Staffing Levels and Quality of Care in Hospitals," *New England Journal of Medicine* 346, no. 22 (2002): 1415–1422, updated to 2002 based on 1997 and 2002 American Hospital Association annual survey data and on wage data for nurses employed in hospitals from the Current Population Survey.
NOTE: Full-time equivalent (FTE) estimates were derived by dividing change in total hours by 2,080.

EXHIBIT 4
Avoided Adverse Outcomes, Hospital Days, Costs, And Deaths If Proportion Of Registered Nurses (RNs) Or Number Of Licensed Nursing Hours Were Increased To The 75th Percentile Of Hospitals Studied, National Estimates Updated To 2002

	Option 1: Raise proportion of RNs from 75th percentile without changing number of licensed hours	Option 2: Raise number of licensed hours to 75th percentile without changing proportion of RNs	Option 3: Raise both proportion of RNs and number of licensed hours to 75th percentile
Number of avoided adverse outcomes			
Failure to rescue (major surgery pool)	354	597	942
Urinary tract infection	40,770	4,174	44,773
Hospital-acquired pneumonia	11,761	1,372	13,093
Upper GI bleeding	4,145	4,129	8,182
Shock or cardiac arrest	2,908	540	3,426
Total avoided outcomes	59,938	10,813	70,416
Hospital days avoided	1,507,493	2,598,339	4,106,315
Cost impacts (in millions)			
Cost savings assuming that 40% of hospital costs are variable			
Cost savings of avoided outcomes	$ 73	$ 17	$ 89
Cost savings of avoided days	980	1,702	2,683
Total avoided costs	1,053	1,719	2,772
Net cost of increasing nursing	−242	5,819	5,716
Net cost as percent of hospital expenses	−0.1%	1.5%	1.4%
Cost savings assuming that fixed hospital costs are recovered (in millions)			
Cost savings of avoided outcomes	$ 183	$ 42	$ 224
Cost savings of avoided days	2,450	4,256	6,707
Total avoided costs	2,633	4,298	6,930
Net cost of increasing nursing	−1,821	3,240	1,558
Net cost as percent of hospital expenses	−0.5%	0.8%	0.4%
Avoided deaths	4,997	1,801	6,754

SOURCE: Authors' estimates using data from J. Needleman et al., "Nurse-Staffing Levels and Quality of Care in Hospitals," *New England Journal of Medicine* 346, no. 22 (2002): 1415–1422, updated to 2002 based on 1997 and 2002 American Hospital Association annual survey data and on wage data for nurses employed in hospitals from the Current Population Survey.

NOTES: Urinary tract infection, hospital-acquired pneumonia, upper gastrointestinal (GI) bleeding, and shock or cardiac arrest and change in length-of-stay were analyzed for medical patients only. Failure to rescue was analyzed for surgical patients only. Cost savings of avoided outcomes and days are initially reduced by 60 percent based on research that only 40 percent of hospital costs are variable in the short run. Over time, fixed costs should be reduced to reflect changed volume. Estimates based on recovery of 40 percent of average costs and all average costs are presented. Net cost of increasing nurse staffing was calculated by subtracting total estimated cost savings due to avoided outcomes and days from cost of increasing nurse staffing reported in Exhibit 3.

would be speedy; for others, slow. If fixed costs were fully recaptured, the net costs of increased nurse staffing would be much lower (Exhibit 4).

Decreases in length-of-stay associated with higher nurse staffing generate more than 90 percent of our projected cost savings. We examined four other studies finding an association of either hours of nurse staffing or the proportion of nursing staff that is RNs and lengths-of-stay in either medical-surgical units or hospitals in general, to determine whether using results from these studies would generate higher or lower estimates than ours.[7] Although most are not directly comparable to our study, when we reanalyzed these results, we found that our estimates of the association of staffing and lengths-of-stay are approximately equal to those that would be constructed from two of the studies, and approximately half those that would be estimated from two others.[8] Two additional studies assessing the association of nurse staffing and lengths-of-stay in intensive care units

(ICUs) found that moving nurse staffing below a one-to-two ratio was associated with 30–50 percent longer stays.[9] In light of these comparisons, our estimates of cost offsets appear conservative.

■ **Avoided in-hospital deaths.** Increased staffing under all options is associated with fewer in-hospital deaths (Exhibit 4). We examined results from two recent studies that reported an association of staffing and mortality, to determine whether applying results from these studies would generate higher or lower estimates of avoided deaths than ours. Applying the results of Barbara Mark and colleagues, we would increase our projected avoided deaths by 60–80 percent.[10] Applying the finding of Linda Aiken and colleagues for surgical patients, our projected number of postsurgical deaths would be three times larger and, if we extrapolated this result to all patients, medical and surgical—which we do not believe is justified based on our and others' research—the estimate of avoided deaths would be more than three times larger than we present.[11]

Discussion

There is an unequivocal business case for hospitals to improve nurse staffing under one option we examined: raising the proportion of RNs without changing licensed hours. This option also was the least costly—$811 million—and would achieve a net reduction in short-term costs of $242 million. We note that these are aggregate estimates, and some hospitals might not realize the expected savings, such as those where RNs' wages are relatively high compared with LPNs' wages. Although these hospitals might not experience a net cost savings, patients treated in them would likely still benefit from reduced lengths-of-stay and fewer adverse outcomes.

Although the increase in nurse staffing under option 2 yields a smaller reduction in both adverse outcomes and their associated costs compared with option 1, it results in a much larger reduction in hospital days because of unmeasured complications and delays in care, with sizable cost savings. Nevertheless, the costs of this approach are not offset by cost savings associated with the reduction in adverse outcomes and the increase in avoided hospital days.

Changing nurse staffing to meet both thresholds (option 3) results in an increase in RN employment but a decrease in LPNs. Although this option would achieve the greatest reduction in adverse outcomes and hospital days, estimated staffing costs would be highest and not totally offset by estimated savings.

Our cost estimates of short-term savings are based on an assumption that hospitals' variable costs are 40 percent of average costs. Over time, hospitals should be able to reduce fixed costs in response to changes in use, and long-term savings are likely to be much higher than in the short term, although options 2 and 3 still do not pay for themselves (Exhibit 4). The speed of this adjustment depends on whether the hospital can scale back operations or replace the lost volume with other services to which the fixed costs can be allocated.

■ **Reduction in patient deaths.** We estimated that more than 6,700 in-hospital patient deaths could be avoided by raising nurse staffing and that approximately three-quarters (4,997) of these could be achieved by increasing the proportion of RNs (option 1). To provide context for this finding, we estimated the cost per avoided death by dividing the net cost of increased nurse staffing by the number of avoided deaths associated with each staffing option. Under option 3, in which both staffing thresholds are met, estimated short-term costs per avoided death are $846,000. Under option 2, in which only licensed nursing hours are increased, short-term costs per avoided death are $3.23 million, which approximates the marginal cost per avoided death of moving from option 1 to option 3. Estimated costs of avoided deaths, assuming full recovery of fixed costs, would be $231,000 for option 3 and $1.8 million for option 2.

In estimating the benefits of increased nurse staffing, we did not consider the value to patients and their families of reduced morbidity (such as decreased pain and suffering, and days lost from work), the economic value to

hospitals of lower liability and improved reputation and image from reducing adverse nursing-related morbidity and mortality, or the positive effects of increased nurse staffing in reducing adverse outcomes not considered in this analysis but observed in other studies, including patient falls, bloodborne infections, decubitus ulcers, and medication errors.[12] Similarly, increased patient satisfaction, good discharge planning, and patients' increased ability to perform self-care were not included in this study, yet they, too, have both economic and noneconomic value.[13] Nor did we estimate potential cost savings from reducing nurse turnover through increased nurse staffing.[14] Given this undercounting of the cost offsets from increased nurse staffing, our estimates of the cost per avoided death should be viewed as upper-bound estimates. The costs per avoided death that we estimated are below the values of a statistical life used by federal agencies in their rule making on health and safety, which range from $3 million to $6 million.[15] By these standards, investing in additional licensed nursing hours is worth doing.

■ **Implications for hospitals and policymakers.** Pressures are mounting for hospitals to control costs at the same time patient volume is increasing and the demand to improve patient safety and quality is gaining momentum. Our analysis examines the costs of responding to this demand by raising hospital nurse staffing, and it estimates the cost offsets and economic value associated with avoided hospital days, morbidity, and mortality. These estimates can inform discussions and influence judgments about nurses' contribution to improving the quality of care.

From a hospital's perspective, increasing nurse staffing is costly. Nevertheless, greater use of RNs in preference to LPNs appears to pay for itself. Improved patient outcomes and reduced days associated with more hours of nurse staffing would only partially offset the costs to achieve them, and, depending on the reimbursement systems in use, cost savings could be shared with payers instead of accruing solely to the hospital. This creates a strong disincentive to increase nurse staffing. From a patient's perspective, however, using standard measures of value, the additional costs to increase nurse staffing appear justified.

Policymakers and public and private payers should focus on finding ways to reconcile patient and hospital perspectives. For example, when Medicare was established in 1965 and hospitals faced a large shortage of nurses, Congress included extra payments to help hospitals raise wages and increase staffing. Might providing payment supplements to hospitals to increase nurse staffing bridge the gap between public and private valuation of increased staffing?

The central questions that emerge from this study for public and private payers, patient advocates, hospitals, accreditation agencies, and others involved in setting policy are as follows: How important is the goal of improving patient quality? Should increasing nurse staffing be encouraged as a means for pursuing this goal? Should funds be made available to hospitals to help realize this goal? And finally, What assurances are needed that any funds provided to hospitals are actually used to increase nurse staffing?

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NOTES

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2. See, for example, Institute of Medicine, *Keeping Patients Safe: Transforming the Work Environment of Nurses* (Washington: National Academies Press, 2003); M.W. Stanton and M.K. Rutherford, "Hospital Nurse Staffing and Quality of Care" (Rockville, Md.: Agency for Healthcare Research and Quality, 2004); and J. Needleman and P. Buerhaus, "Nurse Staffing and Patient Safety: Current Knowledge and Implications for Action," *International Journal for Quality in Health Care* 15, no. 4 (2003): 275–277. See also R.J. Blendon et al., "Views of Practicing Physicians and the Public on Medical Errors," *New England Journal of Medicine* 347, no. 24 (2002): 1933–1940; and D.E. Altman, C. Clancy, and R.J. Blendon, "Improving Patient Safety—Five Years after the IOM Report," *New England Journal of Medicine* 351, no. 20 (2004): 2041–2043.
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4. The studies reviewed include B. Friedman and M.V. Pauly, "A New Approach to Hospital Cost Functions and Some Issues in Revenue Regulation," *Health Care Financing Review* 4, no. 3 (1983): 105–114; J.R. Lave and L.B. Lave, "Hospital Cost Functions," *Annual Review of Public Health* 5 (1984): 193–213; M.V. Pauly and P. Wilson, "Hospital Output Forecasts and the Cost of Empty Hospital Beds," *Health Services Research* 21, no. 3 (1986): 403–428; and T.W. Grannemann, R.S. Brown, and M.V. Pauly, "Estimating Hospital Costs: A Multiple-Output Analysis," *Journal of Health Economics* 5, no. 2 (1986): 107–127.
5. Methods are described in greater detail in an online Technical Appendix, http://content.healthaffairs.org/cgi/content/full/25/1/ 204/DC1.
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11. L.H. Aiken et al., "Hospital Nurse Staffing and Patient Mortality, Nurse Burnout, and Job Dissatisfaction," *Journal of the American Medical Association* 288, no. 16 (2002): 1987–1993.
12. The other studies are cited in Note 2.
13. P.H. Mitchell, S. Ferketich, and B.M. Jennings, "Quality Health Outcomes Model: American Academy of Nursing Expert Panel on Quality Health Care," *Image—The Journal of Nursing Scholarship* 30, no. 1 (1998): 43–46.
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Is What's Good for the Patient Good for the Hospital? Aligning Incentives and the Business Case for Nursing

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Is What's Good for the Patient Good for the Hospital?

Aligning Incentives and the Business Case for Nursing

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This article examines the social and business case for quality related to nursing and the need to restructure incentives to align the interests of the hospital and payers with the interests of the patients. Increasing the proportion of nurses who are registered nurses is associated with net cost savings. Increasing both nursing hours and the proportion of nurses who are registered nurses would result in improved quality and fewer deaths (creating a social case for improved staffing) but would be associated with small cost increases. Cost offsets associated with reduced turnover because of higher staffing would reduce the net cost increase but not result in savings. Under current reimbursement systems, hospitals that increase nurse staffing to improve patient outcomes will likely lose money as a result. Current proposals for pay for performance would create limited incentives for improving hospital nursing care.

Keywords: *business case; nursing; quality; hospital payment*

In their 2003 *Health Affairs* article, "The Business Case for Quality: Case Studies and An Analysis," Leatherman and colleagues (2003) define the term *business case* as follows:

> A business case for a health care improvement intervention exists if the entity that invests in the intervention realizes a financial return on its investment in a reasonable time frame, using a reasonable rate of discounting. This may be realized as "bankable dollars" (profit), a reduction in losses for a given program or population, or avoided costs. In addition, a business case may exist if the investing entity believes that a positive indirect effect on organizational function and sustainability will accrue within a reasonable time frame. (p. 18)

The key point in this definition is that there is a net return to the health care institution. This can come from cost savings that are retained in the organization, through enhanced revenues that exceed the costs of improving quality, or both. The increase in revenues can be directly tied to the improved service, or it may be indirect via a halo effect if the improvement increases revenue for other services.

The authors draw a distinction among

- the *business case*, which analyzes the value of intervention from the financial perspective of the entity that will implement the quality initiative and bear its costs,
- the *economic case*, which focuses on financial costs and returns, appropriately discounted, to whomsoever they accrue, and
- the *social case,* which values the benefits to the patient and to society at large without considering costs.

The authors note that if the economic case for an initiative exists, that is, there is net economic benefit, in principle, by redistributing costs and payments across the different parties, the economic case and business case considerations can be brought into alignment. I would extend this analysis to note that if there is net social benefit beyond direct financial returns (e.g., an increase in quality adjusted life years or reduced patient anxiety), and if the value to patients exceeds the cost to achieve these benefits, patients should be willing to pay for these benefits either directly or through increased health insurance premiums.

These authors' distinctions among the business, economic, and social cases parallel debates regarding cost-benefit and cost-effectiveness analysis, in which the question of whose perspective should govern decisions has been discussed at length. The consensus that has emerged is that, in public decision making, the social perspective should be given priority (Gold, Siegel, Russell, & Weinstein, 1996). But for private decisions, we must recognize that although the social perspective might guide policy, unless there is an alignment of incentives, what is good for the patient or society might not be in the interest of the hospital providing treatment.

Indeed, Leatherman and colleagues (2003) examined four cases of what they described as innovations of proven worth. They found that although the case for the service was always favorable for individual patients and society, for three of the four the business case for the provider was unfavorable, and the business case for insurers or employers was mixed. In principle, the system should be aligned to the patients' needs and goals, but often it is not, and the institutions' interests often dominate the decisions that are made. This misalignment creates a conflict between the institutions' business interests and patients' interests.

In the balance of this article, I examine the social and business case for quality related to nursing and the need to restructure incentives to align the interests of the hospital and payers with the interests of the patients. I begin by briefly summarizing the evidence for nursing's impact on a wide range of outcomes and one study's effort to quantify the benefits and costs of increasing nursing. I then discuss the limitations of that study and project how addressing these limitations might change the estimate of the economic value of hospital nursing. I conclude that the value of expanding nurse staffing beyond current levels is merited by the value to patients but, under current reimbursement systems, is unlikely to result in cost savings or enhanced revenues that offset the increased costs. I conclude by briefly discussing the types of payment reforms that might create a better alignment of patient and hospital interests.

Nurses' Contributions to Care

One of the challenges of determining the impact of nurses on the quality of care is that, in sharp contrast to assessing a specific quality initiative focused on changing a specific process of care, nurses are everywhere in the hospital and engaged in all aspects of care. Many services that have historically been delivered on an inpatient basis—surgery, imaging, laboratory tests, physical and other therapy—are now provided for many patients on an outpatient basis, and one of the principal reasons patients are hospitalized is that they need the ongoing care, observation, and assessment of the nursing staff. Among the activities that are a routine part of nursing are delivering ordered care, assessing and monitoring patients' conditions, implementing timely and appropriate interventions both directly and by calling on other caregivers, and educating patients and their families. Nursing is one of the core services of hospitals. Because nurses are engaged in all aspects of care, often with other members of the care team, it can be difficult to disentangle their specific contributions.

A wide range of studies have tried to do so, focusing on measuring the association of nurse staffing and organization on the rates of specific outcomes or complications such as mortality or hospital acquired infections or more broadly on length of stay, hospital costs, and patient satisfaction. Table 1, abstracted from Needleman, Kurtzman, and Kizer (2007), presents a count of studies by complication or outcome and the type of nurse staffing studied and the number that have or have not found an association with nurse staffing and the outcome studied.

The table includes studies examining 27 separate outcomes. Three types of nurse staffing have been regularly studied: the proportion of the nursing staff who are registered nurses (RNs), the number of hours per day of nursing care from RNs or licensed nursing staff (RNs plus LPNs) per patient per day, or an equivalent measure of volume of care such as patients per nurse and a wide range of nursing variables. There are a substantial number of studies reporting no association, but often these examine care for a specific subset of patients or a specific way of organizing or delivering nursing services. (For example, one study of failure to rescue, that is, potentially avoidable deaths among patients with complications, separately examined the association of nurse staffing and this outcome in medical and surgical patients, finding an association for surgical patients but not medical patients [Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2002]. Both results are reported in the table.) The ability to study the association of nurse staffing and outcomes has also been hindered by the cost of unit based data collection or the imprecision inherent in using annual hospital level data on staffing and outcomes. Notwithstanding these issues, the overwhelming impression that emerges from reviewing the literature is that nurse staffing has been found to be associated with a wide range of outcomes. Some of these outcomes have serious implications for patients' long-term health (e.g., failure to rescue, shock, cardiac arrest, or falls) or the costs of their hospital stay (e.g., pneumonia). Others, such as the impact of nurse staffing on length of stay, can

Table 1
Number of Studies on Nurse Staffing and Patient and Hospital Outcomes, Count of Studies by Outcome, Staffing Variable, and Result

	Measure of Nurse Staffing					
	RN Proportion of Nursing		RN Hours per Patient Day		Other Nursing Variables	
Outcome or Complication Studied	Association	No Association	Association	No Association	Association	No Association
Mortality	1	1	9	6		
Failure to rescue	1	1	2	1		
Pneumonia	4	1	7	1	1	2
Urinary tract infection	4	1	4	2	2	2
Post-op infection	2		2			1
Wound infection		2		2		1
Sepsis		2	4	3	1	1
Nosocomial infection			3			
Deep vein thrombosis		1	1	1		
Shock or cardiac arrest	1	1		1		
Upper gastrointestinal bleeding	1	1	1	1		
Pressure ulcers	4	2	3	3		
Metabolic derangement		1		1		
Pulmonary failure		1	2	1		
Central nervous system complications		1		1		
Atelectasis					1	
Pain management	1		1		1	
Medication errors	2	2	2	1	1	3
Reintubation			2			
Falls	3	1	2	1	2	2
Restraint use			3			
Length of stay	2	1	8	1	1	1
Hospital costs			1			1
Readmission			1			
Functional independence	1					
Patient satisfaction	3	1	1		1	1
Patient complaints	1		1			

Source: Adapted from Needleman, Kurtzman and Kizer (2007).
Note: RN = registered nurse.

reflect the impact of studied and unstudied complications and delays in care because of short staffing. Still others may reflect indirect costs to the hospital, such as patient dissatisfaction that translates to lower future volume.

The Costs and Cost Offsets of Increasing Hospital Nurse Staffing

U.S. hospitals display wide variations in nurse staffing, in both the hours of nurse staffing per patient and the mix of RNs and other staff. Some of these differences reflect differences in models of unit staffing based on nursing philosophy, availability of complementary staff such as phlebotomists, and physical layouts of the nursing unit. Some reflect differences in the nursing acuity of patients, that is, the patients' need for nursing care because of their physical and mental condition. (Research has shown that patient nursing acuity is poorly correlated with standard measures of overall resource use, such as diagnostic related groups [DRGs], and is best captured by nursing-specific systems [Ballard, Gray, Knauf, & Uppal, 1993; Hernandez & O'Brien-Pallas, 1996a, 1996b; O'Brien-Pallas, Irvine, Peereboom, & Murray, 1997; O'Brien-Pallas, Tritchler, & Till, 1989].) Some differences, however, are not associated with these factors and appear to be hospital-to-hospital variations in funding nursing services.

Research suggests that having an adequate nurse workforce can reduce length of stay, complications, and costs. From the business case perspective, hospital managers at low-staffed hospitals would ask five finance related questions about increasing staffing:

Table 2
Avoided Days, Complications, Deaths, and Costs and Cost Offsets Associated With Increasing Nurse Staffing to Upper Quartile, U.S. Nonfederal General Hospitals, 2002

	Option		
	Increase RNs, Decrease LPNs, Keeping Nursing Hours per Day Constant	Increase Nursing Hours per Patient Day, Keeping RN Proportion Constant	Increase Both Proportion of RNs and Nursing Hours per Patient Day
Net change in full-time equivalent RNs	37,089	114,456	157,894
Net change in full-time equivalent LPNs	–37,089	13,093	–30,345
Cost of change in nurse staffing ($)	811 million	7,538 million	8,488 million
Avoided days	1,507,483	2,598,339	4,106,315
Avoided complications	59,938	10,813	70,416
Avoided deaths	4,997	1,801	6,754
Total avoided costs (assuming full cost recovery) ($)	2,633 million	4,298 million	6,930 million
Cost of avoided days (assuming full cost recovery) ($)	2,450 million	4,256 million	6,707 million
Cost of avoided complications (assuming full cost recovery) ($)	183 million	42 million	224 million
Avoided costs (assuming recovery of variable costs only) ($)	1,053 million	1,179 million	2,772 million
Net cost (savings) assuming full cost recovery ($)	(1,821 million)	3,240 million	1,558 million
Net costs as percentage of total hospital costs (%)	(–0.5)	0.8	0.4
Net cost (savings) assuming recovery of variable costs only ($)	(242 million)	5,819 million	5,716 million
Net costs as percentage of total hospital costs (%)	(–0.1)	1.5	1.4

Source: Needleman, Buerhaus, Stewart, Zelevinsky, and Mattke (2006).
Note: RN = registered nurse; LPN = licensed practical nurse. Variable costs estimated at 40% of average costs.

- How much would it cost to increase nurse staffing?
- Would these costs be offset by cost savings from reduced length of stay and complications?
- Would the hospital realize these cost savings, or, because of how the hospital is paid, would these savings be captured by payers?
- Can the hospital attract additional profitable patients on the basis of its nurse staffing?
- Are there cost savings other than those achieved via better patient care that might also be realized if nurse staffing is increased?

No answers to these questions have been published using an integrated model that includes information on all or most of the outcomes associated with nurse staffing. My colleagues and I developed a partial model, published in *Health Affairs*, that can provide insight into what a more comprehensive model might tell us about the answer to the first two questions posed above (Needleman, Buerhaus, Stewart, Zelevinsky, & Mattke, 2006). That model is based on the findings of Needleman et al. (2002). That study examined two dimensions of nurse staffing: the proportion of the licensed nursing staff who were RNs and the number of licensed nursing hours per patient day. It found substantial variation across hospitals in these measures, with the interquartile range of the RN proportion of 81% to 94% and the interquartile range of licensed hours per day of 7.6 to 10.2. This research also found statistically significant and robust associations between one or both of these measures and the following outcomes: (among medical patients) length of stay, urinary tract infections, hospital acquired pneumonia, shock or cardiac arrest, and upper gastrointestinal bleeding; (among surgical patients) urinary tract infections and failure to rescue (defined in this study as deaths among patients experiencing one of five complications: shock or cardiac arrest, pneumonia, sepsis, upper gastrointestinal bleeding, and deep vein thrombosis).

In the *Health Affairs* analysis, we estimated the number of nurses needed to increase any hospital below the 75th percentile on each nurse staffing measure to that level and the costs associated with those increases. We also estimated the cost offsets associated with reducing length of stay and the rates of urinary tract infections, pneumonia, cardiac arrest, and upper gastrointestinal bleeding among medical patients and failure to rescue among surgical patients. The cost offsets were estimated assuming that, in the short run, hospitals would recover only the variable costs of avoided care (approximately 40% of average costs) but would recover full costs over

the long term, as hospitals rescaled their operations to reflect reduced volume or reprogrammed the freed-up capacity to new services. Avoided deaths were calculated, directly for surgical patients based on changes in the failure to rescue rate and indirectly for medical patients based on changes in the rates for shock and cardiac arrest, pneumonia, deep vein thrombosis, and upper gastrointestinal bleeding. All estimates were projected to those for U.S. nonfederal short-term general hospitals in 2002. Table 2 summarizes the avoided days, complications, deaths, costs, and cost offsets estimated.

Several conclusions emerge from these data. First, the principal source of avoided costs is avoided days of care. The costs associated with avoided days vary from 13 to 100 times those of the avoided complications modeled. This is not surprising given that the length of stay reductions are averaged over all patients, whereas the reduction in complications affects relatively few patients.

Given the substantial savings associated with reduced length of stay and avoided days, it is useful to reflect on how this is achieved. The length of stay reductions are approximately one fourth of a day of a 5-day length of stay. Some of these savings are likely associated with reductions in complications not directly measured or with early identification and intervention to prevent costly and timely problems from emerging. But the savings are also likely associated with the improved ability of nurses to efficiently deliver care—to complete the admissions and discharge processes without distraction, including such tasks as medication reconciliation and patient education and reducing delays in care while patients are in the hospital.

Second, following from the first observation, although the complications modeled are only a portion of those listed in Table 1, it is unlikely that adding additional complications to the model would substantially add to the cost savings associated with improved patient care associated with increasing nurse staffing.

Third, the results of the analysis are sensitive to judgments about how to deal with fixed costs. Assuming in the short run 40% of hospital cost are variable, the net cost of the option for increasing both the proportion of licensed staff who are RNs and increasing the hours per patient day is 1.5% of current hospital costs. If hospitals can recover their fixed costs, either by rescaling their operations to eliminate these as volume decreases or by developing replacement services to which the fixed costs will be allocated, then the net cost is only 0.4% of hospital costs. Any discussion of the business case must address the question of the extent to which fixed costs are recoverable through quality improvement.

Fourth, increasing the proportion of hours provided by RNs without increasing hours is an option that recovers its costs, even if only variable costs are taken into account. This meets the criterion for demonstrating the economic case. Whether it constitutes a business case depends on whether the hospital retains the savings, given how it is paid. This is further discussed in the next section.

For the other two options, the additional costs of nursing are not fully recovered by direct cost savings in patient care. However, the net costs are relatively small (approximately 1.5% if fixed costs are not recovered, 0.8% or 0.4% if they are). To put these increases into context, the Medical Payment Advisory Commission has suggested that 1% to 2% of payments be initially set aside for pay-for-performance incentives.

From a social value perspective, increased costs at these levels might justified. In the *Health Affairs* article, we noted that if one simply divided the unrecovered costs by the number of avoided deaths, the cost per avoided death (assuming only variable costs are recovered) would be $846,000 if both staffing changes were implemented and $3.23 million if only the option of increasing hours were implemented. (If fixed costs could be recovered, the costs per avoided death would be substantially lower, $231,000 and $1.8 million, respectively.) These estimates are well within the parameters federal agencies have used in their rule making on occupational and environmental regulations (U.S. Environmental Protection Agency, Office of the Administrator, 2000; Viscusi, 1993). Furthermore, loading all these costs on avoided deaths overstates the cost per avoided death because it ignores the value patients would assign to getting out of the hospital earlier and avoiding complications.

Finally, although this model estimates the costs and cost offsets associated with direct patient care costs, and, as discussed above, the estimates would not change substantially with the addition of other complications to the model, it ignores other potential cost offsets. The most significant offset discussed has been reduced turnover of nurses. Estimates of the impact of improved staffing on turnover have not been made, but an estimate can be constructed.

Aiken, Clarke, Sloane, Sochalski, and Silber (2002) found that, in Pennsylvania hospitals, an increase in one patient per nurse increased burnout and job dissatisfaction by 23% and 15%, respectively, and that the intent to leave among nurses with high burnout and job dissatisfaction was 43%, compared to 11% among nurses who were not burned out or dissatisfied. They also reported that 43.2% of nurses reported high emotional exhaustion and that 41.5% were dissatisfied with their current job. Based on these figures, the intent to leave among Pennsylvania nurses in the Aiken sample was approximately 25%. Interpolating from the data presented in the article, the interquartile range for patients per nurse was

approximately 1.25 patients. If hospitals were moved to the high end of this range, job dissatisfaction and burnout would decrease and intent to leave would decline. I estimate a 13% decline in intent to leave.

Annual turnover among nurses in 2005 was estimated by the Bernard Hodes Group, based on a national poll of health care recruiters, to be 13.9% (American Association of Colleges of Nursing, 2007). A 13% reduction in this rate would imply reduced turnover of 1.8 percentage points. According to the 2002 Advancing Health in America Annual Survey, there were approximately 760,000 full-time RNs and 423,000 part-time nurses working in U.S. nonfederal short-term general hospitals, or 972,000 full-time equivalents. A reduction in turnover of 1.8 percentage points would imply reduced turnover of approximately 17,500 full-time equivalent nurses. Recent estimates of the cost of replacing a nurse are varied, with many estimates in the range of 50% to 100% of annual salary (Contino, 2002; Hayes et al., 2006; Jones, 1990; O'Brien-Pallas et al., 2006; VHA's Center for Research and Innovation, 2002; Waldman, Kelly, Arora, & Smith, 2004). If the cost of turnover averages $60,000 per nurse, approximately 1 year's salary, the estimated cost saving would be approximately $1 billion. This is a substantial additional cost saving that would accrue directly to hospitals and would offset a substantial portion of the net costs of increasing hours of licensed staff (estimated at $3.2 billion for full cost recovery, $5.8 billion if there is recovery of only variable costs). Although these cost savings do not fully offset the direct costs of enhancing nursing and thus do not support a business case for nursing, by lowering the net cost of the benefits realized by patients, they enhance the economic and social cases for increased nursing.

Hospital Payment Systems and the Business Case

How much of the cost offsets associated with improved patient care hospitals actually realize depends on the systems under which they are paid. There are three broad systems for paying hospitals in the United States:

- *Charges or a percentage of charges:* Charges are established by the hospital. Charges are established for routine services, such as general care on a nursing unit, and specific services, such as surgical time, tests, and medicines. For large payers with which the hospital has a contractual relationship, the percentage of charges paid is subject to negotiation. The markup of hospital charges over costs widely varies from hospital to hospital. One variation of this, in wide use by Blue Cross plans and Medicare prior to the adoption of DRGs as the principal form of payment, was to set the percentage of charges to be paid based on the ratio of costs to charges, effectively making the payment equal to costs (or, in some cases, costs with a fixed margin).
- *Per diem:* An average payment per day of hospital stay, sometimes specific to the type of unit (medical–surgical, intensive care, pediatric, obstetric, etc.) the patient was on.
- *Per discharge:* Some discharge-based systems, such as the Medicare DRG-based prospective payment system, vary the per admission payment based on the patient's diagnosis, providing for some risk adjustment of the payment.

Cost savings associated with reduced length of stay would be retained by the hospital under a per discharge payment system but would revert to the payer under systems in which the hospital is paid a percentage of charges or per diem. Indeed, under per diem, the amount the payer recovered would approximate average costs or charges per day, even if the hospital realized only savings of the variable costs associated with caring for the patient. Under a charge-based system, the amount the payer recovered would approximate the average costs of the nursing-unit associated care.

The mix of payment methods among hospitals is unknown. In 2006, according to the actuaries of the Centers for Medicare & Medicaid Services (CMS), the proportion of hospital payments received from Medicare was 28.9%, 17.2% from Medicaid, 36.2% from private insurance, 9.9% from other public payers, and 7.8% from other private sources (Catlin, Cowan, Hartman, & Heffler, 2008). Medicare paid on a per admission basis, as did many Medicaid programs and some private insurers. It is likely, however, that at least one fourth of hospital payments are based on charges or per diem, and this proportion could be substantially higher. To the extent these payment systems capture cost savings for payers, but not hospitals, from reduced length of stay, any business case rationale for investing in additional or more highly trained nursing staff is substantially weakened. A one third reduction in savings under the option of expanding both nursing hours and the proportion of licensed hours from RNs increases the net cost of enhanced staffing under full cost recovery from $1.6 billion to $3.9 billion.

As noted earlier, if cost savings from quality initiatives cannot be retained in the institution, a business case for those initiatives would be weak even if the economic or social case were strong. This reflects a misalignment

of the incentives for hospitals within the payment system. This would appear to be the case with respect to nursing. Hospitals that increase nurse staffing in light of research demonstrating an association of improved outcomes with such increases will likely lose money as a result.

Current hospital payment systems also have other weaknesses vis-à-vis nursing. Most serious is that even those systems that are resource based, such as charges or DRGs, because they estimate nursing resources based on averages within broad bed types, do not automatically adjust for changes in patient *nursing* acuity within units. Many hospitals have implemented nursing-specific acuity systems and adjust their shift-to-shift and day-to-day staffing to reflect the nursing needs of patients. Payment systems in place today do not make similar adjustments. This means not only that day-to-day variations in nursing acuity are not taken into account in payment but also that long-term trends of increasing costs of "routine nursing" within unit types because of increasing acuity as less acutely ill patients are discharged earlier or shifted to outpatient treatment may not be reflected in payment policies or adjustments may significantly lag increased acuity.

One of the proposed reforms in payment for encouraging high quality is "pay for performance." The precise form for such reform is still evolving, with continued debate about whether the performance should be measured based on process measures or outcome measures. CMS currently has a pay-for-reporting demonstration based on process measures (Department of Health & Human Services, CMS, 2007), but payment for the current measures will create weak incentives at best for improving hospital nursing care. Although the measures adopted include the three process measures endorsed by the National Quality Forum (2004) as part of its hospital nursing-sensitive measure set—smoking cessation counseling for patients with pneumonia, chronic heart failure, and heart attacks (and a fourth measure, discharge plans for patients with chronic heart failure, is arguably nursing related)—the other measures adopted do not reflect key elements of the core work of nursing: assessment, monitoring, pain management, and patient education.

The level of incentives contemplated in pay for performance match the estimated costs of increasing nurse staffing presented above, but if pay-for-performance systems do not focus on the processes or outcomes central to nursing, the incentive will encourage change in other areas of hospital care. A proposed rule will expand the measures to be reported to include four additional measures endorsed by the National Quality Forum as nursing sensitive (failure to rescue, pressure ulcers, patient falls, and falls with harm) and others, such as venous thromboembolism, that have been shown in some studies to be nursing sensitive (Department of Health & Human Services, CMS, 2008). These changes will strengthen the association of pay for reporting and nursing care.

Also being integrated into Medicare payment are policies to eliminate payment for hospital-acquired complications. In 2008, eight complications are subject to these restrictions, and the list is expanded for 2009 (Department of Health & Human Services, CMS, 2008). Many of these complications, including pressure ulcers, catheter-associated urinary tract infections, falls, and deep vein thrombosis, have been associated with nurse staffing. Although the number of dollars at risk to an individual hospital is likely to be small, programs such as these change the business case calculations a hospital might make regarding the organization of its nursing services.

Aligning Patient and Payer Incentives

This article began by asking whether patient and hospital incentives were aligned, whether what was good for the patient was good for the hospital. The analysis suggests a misalignment that can be corrected only by changing payment. The discussion of the social and economic case at the beginning of the article noted that, in principle, such an alignment should be feasible because patients should be willing to change their payment or accept increases in their premiums to realize the gains in value additional payments to hospitals could achieve.

The nature of hospital payment in the United States complicates this calculation. A substantial portion of hospital care—that for Medicare or Medicaid—is not directly or indirectly paid for by the current beneficiaries. Those making decisions on payment levels and modes, although they take their responsibility to their beneficiaries seriously, also have a responsibility to and take guidance from others, especially when additional funds might be required.

In the private insurance market, most insurance is bought by employers for their employees, and individuals purchasing insurance have limited information on quality and little incentive to expand their knowledge or act on it, because they are unlikely to be hospitalized or use many services in general. As a result, there will be limited pressure from insureds to pay more for hospitals to improve the quality of their nursing care. Strategies for realizing the social value of increased nurse staffing in hospitals will need to take these realities into account.

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The Economic Value of Professional Nursing

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Background: Improved understanding of the economic value of registered nurse services can help inform staffing decisions and policies.
Objectives: To quantify the economic value of professional nursing.
Methods: We synthesize findings from the literature on the relationship between registered nurse staffing levels and nursing-sensitive patient outcomes in acute care hospitals. Using hospital discharge data to estimate incidence and cost of these patient outcomes together with productivity measures, we estimate the economic implications of changes in registered nurse staffing levels.
Subjects: Medical and surgical patients in nonfederal acute care hospitals. Data come from a literature review, and hospital discharge data from the 2005 Nationwide Inpatient Sample.
Measures: Patient nosocomial complications, healthcare expenditures, and national productivity.
Results: As nurse staffing levels increase, patient risk of nosocomial complications and hospital length of stay decrease, resulting in medical cost savings, improved national productivity, and lives saved.
Conclusions: Only a portion of the services that professional nurses provide can be quantified in pecuniary terms, but the partial estimates of economic value presented illustrate the economic value to society of improved quality of care achieved through higher staffing levels.

Key Words: nurses, quality of care, workforce issues, health economics

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Professional nursing care is a vital component of the healthcare system. More than 2.4 million registered nurses (RNs) are employed in nursing (56% in hospitals), making registered nursing the largest healthcare profession.[1] As healthcare costs increase, efforts to improve the efficiency and effectiveness of the healthcare system must take into account nurses' contribution to ensuring cost-effective, high-quality care.[2]

The term economic value of professional nursing refers to a monetary assessment of the value of services provided by nurses. In this study, we focus on the economic value of incremental changes in nurse staffing that result in improved quality of patient care. This definition emphasizes the changes in nurse staffing that affect medical costs via the impact on patient outcomes. Improved patient care that prevents nosocomial complications, mitigates complications by more rapid identification and intervention, and leads to more rapid patient recovery, creates medical savings. Reduced length of recovery and mortality have national productivity implications. From an economic perspective, healthcare facilities and other employers of RNs want to achieve a staffing level and mix such that the marginal value of employing one additional RN will equal or exceed the marginal cost.

There have been many studies on the impact of nurse staffing on patient outcomes. A recent meta-analysis found 2858 potentially relevant studies of which 28 studies met inclusion criteria and reported adjusted odds ratios of the association between RN staffing and patient outcomes.[3] The meta-analysis shows an association between higher staffing level and reduced hospital-related mortality, hospital-acquired pneumonia, unplanned extubation, failure to rescue, nosocomial bloodstream infections, and length of stay (LOS). There seems to be little association between RN staffing level and urinary tract infection (UTI) and surgical bleeding.

In our current study, completed before the meta-analysis was published, we identified studies that estimated the impact of nurse staffing and were methodologically sound, recent, and reported findings primarily using multivariate regression analysis. These studies examined the relationship between changes in RN hours per patient day (HPPD) and changes in nurse sensitive patient outcomes (NSOs). We analyzed hospital discharge data from the 2005 Nationwide Inpatient Sample (NIS) to estimate incidence and costs of these patient outcomes. We then applied the RN HPPD findings to the cost data in a model to estimate the economic implications of changes in RN staffing.

METHODS

Nurse Staffing Literature Review

We reviewed the research literature on the relationship between RN staffing level in hospitals and patient risk for UTI, hospital-acquired pneumonia, pressure ulcer, upper

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gastrointestinal bleeding, sepsis, shock/cardiac failure, pulmonary failure, central nervous system complications, deep vein thrombosis, postoperative infection, adverse drug events, and patient falls.[4–16] We also reviewed the impact of nurse staffing levels for in-hospital patient mortality (failure to rescue)[4–6,10,12,14,17,18] and LOS.[6,11,12,14,15,18,19]

Most studies identified an inverse relationship between nurse staffing levels and adverse patient outcomes, but the statistical significance of the findings varies by study and by surgical versus medical patients. Although the studies try to infer causality by controlling for case mix and other confounding factors, the reported relationships are associations. The use of existing data (rather than prospective data collection), the cross-sectional nature of the data, and variation across studies in the strength of the study design also limits the ability to generalize findings to the larger population.

Despite these limitations with the published literature, we combine findings across studies to quantify the size of the relationship for each NSO as an "elasticity." In the context of nurse staffing and patient outcomes, elasticity ($\epsilon_{HPPD,complication}$) estimates refer to the percent change in patient risk for complication for each 1% increase in HPPD. For example, an elasticity of −0.5 suggests that a 10% rise in HPPD is associated with a 5% decline in patient risk of complication.

The economic value of adding one more RN to a nursing unit depends on current staffing levels. At low staffing levels, the services of each additional RN make a large contribution to patient care and thus have high economic value. As staffing levels improve, the value of services provided by each additional RN is positive, but declining. Because the marginal value of services approach attempts to estimate the value of the services provided by the last RN hired, this approach will underestimate the average economic value of RNs for a given staff level.

To quantify the relationship between patient risk of a particular NSO and HPPD, we projected patient risk for different staffing levels with findings from several studies. From the Needleman et al study, we use the regression equations 1, 2, 9, and 10 because the specification for these equations is most similar to the control variables used in other studies.[10–12] These studies used regression analysis to isolate change in patient risk due to HPPD, controlling for patient acuity and inputs to care. Findings for patients admitted primarily for major surgery (surgery patients) were reviewed separately from patients admitted for all other reasons (medical patients). We averaged the projected risk estimates for a particular NSO for each staffing level to obtain the average risk of that NSO associated with that staffing level. Three staffing levels are of special interest for this analysis: a low staffing level (6.4 HPPD), a median staffing level (7.8 HPPD), and a high staffing level (9.1 HPPD), which are the 25th, 50th, and 75th percentile, respectively, of RN HPPD in a national sample of hospitals as reported by Needleman et al.[10–12] When using findings from studies that controlled for nursing mix, we used LPN HPPD and nurse aid HPPD of 1.2 and 2.4, respectively, reported by Needleman et al as the hospital median.

Hospital Data Analysis

The NIS hospital discharge data for 2005 were analyzed to estimate patients' underlying risk for nosocomial complications. The NIS was linked to the American Hospital Association's Annual Survey of Hospitals to identify nonfederal acute care hospitals, yielding an analysis file with 5.4 million discharges from 610 hospitals. Nosocomial complications among patients were identified by secondary diagnosis codes.[10,20]

We estimate multivariate regressions with NIS data to quantify the change in mortality risk, LOS, and cost per discharge associated with the presence of each NSO. For each analysis (mortality, LOS, cost), we estimated separate regressions for medical and surgical patients. Explanatory variables include patient age (in years), gender, admission type (elective, newborn, trauma center, urgent, emergency, other), expected payer (Medicaid, Medicare, private insurer, self pay, no charge, other), hospital characteristics (ownership/control, bed size, urban/rural, teaching status, region), a risk adjustment using diagnosis-related group (DRG), and a set of indicator variables indicating the presence of each nosocomial complication (1 = present, 0 = not present).

For the mortality analysis, we used logistic regression with in-hospital mortality as the dependent variable. The risk adjustment variable was the average in-hospital mortality rate associated with the DRG. Using the regression findings, for each discharge with a complication we projected mortality risk both in the presence and absence of the complication, with the average difference in mortality risk assumed to be attributed to the complication.

For the LOS analysis, we used Poisson regression with LOS as the dependent variable. The risk adjustment variable was average LOS associated with the DRG. Similar to the mortality analysis, we predicted LOS both in the presence and absence of each complication and attribute the average difference in LOS to the complication.

To estimate the reduction in hospital-related medical costs via prevention of nosocomial complications, we estimated the impact of each complication on hospital cost using ordinary least squares regression. Charges were converted to cost with hospital-specific cost-to-charge ratios. The risk adjustment variable was average cost associated with the DRG. The coefficient for each complication is the increase in hospital costs associated with the complication.

The hospital discharge data used are hierarchical, with patient outcomes influenced by both patient level characteristics and hospital level characteristics. The actual models used in our analysis (Poisson, logistic and ordinary least squares) do not explicitly consider the data hierarchy. Hierarchical models allow one to better understand the impact of explanatory variables at different levels in the hierarchy and to study variation at different levels of the hierarchy. The primary focus of our regression analysis is to estimate the association between presence of nosocomial complications and patient outcomes (mortality, LOS, and cost), with patient and hospital characteristics used as control variables. When we compared the results reported in this article to results using a random-intercepts model, we found differences in the esti-

mates of control variables but minimal differences in the estimates of nosocomial complications predicting mortality, LOS, and cost. Also, analysis with a random-intercepts model suggests that the proportion of total variance that is accounted for at the hospital level is small.

The NIS only contains hospital costs. Costs for professional services provided in the hospital and postdischarge costs for each NSO are based on expert medical opinion regarding patterns of physicians' hospital rounds and the following assumptions: (1) the average hospital visit by a physician or other clinician costs approximately $100; (2) patients who experience a fall receive 1 examination by a clinician; (3) for each additional day in the hospital attributed to the complication, patients are visited by their attending physician and for some complications are also visited by a specialist; and (4) after discharge, some nosocomial complications require one or more follow-up ambulatory visits, medications, and tests.

Economic Benefits per Additional RN

An economic value of nursing model was developed that combines the HPPD elasticity estimates and the NIS regression results. We calculate patient risk of complications at 3 staffing levels: 6.4, 7.8, and 9.1 HPPD. We assume the national average NSO risk is associated with HPPD of 7.8, and then use the findings from each applicable study in the literature to predict NSO risk at 6.4 and 9.1 HPPD. For most NSOs, multiple studies reported findings so we calculate multiple values for NSO risk at each staffing level and take the average. To obtain point estimates of the economic value of an additional RN at each staffing level, we compute the change in NSO risk associated with a 0.01 change in HPPD.

Multiplying NSO risk by patient volume produces an estimate of total adverse patient events during the year for a given staffing level. Comparing the projected number of adverse outcomes for any 2 nurse staffing levels suggests how quality of care changes when nurse staffing changes. Multiplying the number of adverse patient outcomes by cost per case provides an economic estimate of the benefit of reduced incidence of complications, mortality, and LOS.

Productivity Loss

Using Bureau of Labor Statistics data on average earnings and labor force participation rates by age and gender, we estimate the lost productive value to society from premature mortality and increased LOS using the following assumptions: (1) annual earnings is used as a proxy for the value of productivity for people in the labor force; (2) for people not in the labor force the value of their productivity is assumed to be 75% of the annual earnings of their peers in the labor force (to account for the value of services in the home and volunteer work); (3) for a person age "A" in year "Y," their productive value in year "Y+1" is calculated $V_{A,Y+1} = 1.01 \times V_{A+1,Y}$, where the 1.01 accounts for the annual increase in productivity; and (4) a 3% discount rate is used to calculate the net present value of future productivity.

TABLE 1. Estimates of Adverse Outcome Elasticities With Respect to RN Hours Per Patient Day Based on Literature Review

Adverse Events	Medical Patients	Sources	Surgical Patients	Sources
Nosocomial complications				
Urinary tract infection	−0.08	6, 10	−0.12	6, 7, 10
Pneumonia	−0.28	6, 10	−0.26	6, 7, 10
Pressure ulcer	−0.06	6, 10	−0.11	6, 10
Upper gastrointestinal bleeding	−0.15	10	−0.15	10
Sepsis	−0.04	10	0.00	10
Pulmonary failure	NA		−0.06	7, 10
Shock/cardiac failure	−0.15	10	−0.11	10
CNS complications	0.00	10	0.00	10
Deep vein thrombosis	0.00	10	−0.06	7, 10
Postoperative infection	NA		−0.09	6, 10
Accidents				
Adverse drug event	−0.06	6	−0.06	6
Fall	−0.71	15, 16	−0.71	14, 16
Other				
Length of stay	−0.18	12, 15	−0.05	10
Failure to rescue	−0.00	12	−0.19	5, 10

The elasticities presented here are point elasticities evaluated at 7.8 RN HPPD. NA indicates not applicable.

RESULTS

Nurse Staffing Elasticity Estimates

The elasticity point estimates in Table 1 show the percent change in patient risk for each NSO associated with a 1% rise in HPPD evaluated at 7.8 HPPD (median staffing level). The strength of the relationships is:

- Strong (elasticity of −0.1 or below) for patient falls, hospital-acquired pneumonia, upper gastrointestinal bleeding, shock/cardiac failure, pressure ulcer (for surgical patients), and UTI (for surgical patients).
- Modest (elasticity between −0.1 and −0.05) for UTI (for medical patients), pressure ulcer (for medical patients), pulmonary failure, adverse drug events, postoperative infection, and deep vein thromboses (for surgical patients).
- Weak (elasticity between −0.05 and 0) for central nervous system complications, sepsis, and deep vein thromboses (for medical patients).

Nurse Staffing and Mortality Risk

Logistic regression results suggest that presence of nosocomial complications is associated with a rise in risk of in-hospital mortality (Table 2). The regression coefficients for all complications are statistically different from 0 at $P < 0.05$, with the exception of pressure ulcer for medical patients. Unexpectedly, UTI is associated with lower mortality risk so for modeling we assume no mortality associated with UTI.

We compare 2 approaches to estimate the relationship between HPPD and mortality ($\epsilon_{HPPD,mortality}$). One, we combine elasticity estimates from our synthesis of the literature on the relationship between HPPD and nosocomial compli-

TABLE 2. Increased Mortality Risks Attributed to Presence of Nosocomial Complications

	Medical Patients			Surgical Patients		
Effect	Predicted Mortality Risk for Patient Without Complication (%)	Predicted Mortality Risk for Patient With Complication (%)	Attributed Mortality Risk (%)	Predicted Mortality Risk for Patient Without Complication (%)	Predicted Mortality Risk for Patient With Complication (%)	Attributed Mortality Risk (%)
Has urinary tract infection	6.43	5.63	0.00	5.33	4.92	0.00
Has pressure ulcer	7.07	7.09	0.02	5.62	6.32	0.69
Has pneumonia	8.29	14.24	5.95	9.97	11.17	1.20
Has DVT/PE	6.23	9.93	3.70	6.34	10.69	4.35
Has ulcer/gastritis/UGI bleeding	6.11	7.24	1.13	5.84	7.77	1.93
Has central nervous system complications	5.12	7.22	2.09	3.87	5.87	2.00
Has sepsis	10.23	16.98	6.75	12.17	20.71	8.53
Has shock/cardiac arrest	17.97	49.36	31.39	10.61	33.64	23.03
Has surgical wound infection		NA		6.07	6.42	0.35
Has pulmonary failure		NA		6.89	22.01	15.13

Source: Analysis of the 2005 NIS.

TABLE 3. Increased Length of Stay (in Days) Attributed to Presence of Nosocomial Complications

	Medical Patients			Surgical Patients		
Effect	Predicted LOS for Patient Without Complication	Predicted LOS for Patient With Complication	Attributed LOS	Predicted LOS for Patient Without Complication	Predicted LOS for Patient With Complication	Attributed LOS
Has urinary tract infection	5.88	7.56	1.68	9.03	13.60	4.58
Has pressure ulcer	6.54	10.73	4.19	10.51	17.10	6.59
Has pneumonia	6.32	9.10	2.79	12.78	17.26	4.48
Has DVT/PE	6.38	9.48	3.09	11.52	17.17	5.65
Has ulcer/gastritis/UGI bleeding	5.69	7.06	1.37	9.62	12.26	2.64
Has central nervous system complications	5.26	6.06	0.80	7.85	10.84	2.99
Has sepsis	6.89	12.40	5.51	15.93	25.22	9.30
Has shock/cardiac arrest	8.40	8.96	0.56	17.26	18.62	1.36
Has surgical wound infection		NA		11.68	19.82	8.14
Has pulmonary failure		NA		16.13	20.64	4.51

Source: Analysis of the 2005 NIS.
NA indicates not applicable.

cation risk ($\epsilon_{\text{HPPD,NSO}}$) with estimates from our regression analysis of the NIS on the increase in mortality risk associated with having each complication ($\epsilon_{\text{NSO,mortality}}$).

$$\varepsilon_{HPPD,\text{mortality}} = \sum_{\text{NSO}=i} \varepsilon_{\text{HPPD},i} \times \varepsilon_{i,\text{mortality}}$$

Second, we directly calculate ϵ_{HPPD} mortality based on a synthesis of the literature—for mortality, findings from Needleman et al and Aiken et al.[5,10] Compared with the first approach, the second approach produces a weaker relationship between HPPD and mortality risk for medical patients and a stronger relationship for surgical patients. Combining both medical and surgical patients, the 2 approaches produce similar estimates of change in mortality risk associated with increased RN staffing levels. The first approach (which measures lives saved by preventing NSOs) produced estimates that are approximately 87% the size of the estimates produced by the second approach. Although both approaches produce estimates with some level of imprecision, one possible interpretation is that approximately 87% of lives saved by improved RN staffing levels is achieved by preventing nosocomial complications while approximately 13% of lives saved is achieved by early detection and mitigation of complications that still occur. The second approach provides a more complete picture of the impact of RN staffing levels on

patient mortality risk, and we use findings from the second approach to compute the economic estimates presented.

Nurse Staffing and Length of Stay

The Poisson regression results estimate the average increase in LOS when each of the nosocomial complications was present (Table 3). As with the mortality analysis, we compare 2 approaches to estimate the relationship between HPPD and LOS. The approaches are identical to those used for the mortality analysis but using the elasticity estimates for LOS ($\epsilon_{NSO,LOS}$) instead of mortality. The second approach produced a more complete (and larger) estimate of nursing's impact on LOS. Although the first approach only models prevention of NSOs, the second approach also includes the impact via mitigation of nosocomial complications that do occur and faster patient discharge unassociated with nosocomial complications. Results from the second approach are used to calculate the total economic value estimates presented.

Patient Medical Costs

The results of the ordinary least squares regression analyses estimating the impact of each nosocomial complication on hospital cost is shown in Table 4. For hospital days that are prevented unassociated with prevention of NSOs, each inpatient day avoided is assumed to generate cost savings of approximately $1522 (the 2005 national average cost per inpatient day in community hospitals).[21]

Estimates of increased mortality risk, LOS and medical cost associated with each NSO are summarized in Table 5. Combining this information with estimates of the number of adverse events in 2005 suggests that these adverse events were associated with 251,000 in-hospital deaths, 22.6 million hospital inpatient days, and $41.8 billion in medical costs.

Productivity Loss

Based on the age distribution of the patients with complications and who died in the hospital, we calculate that the net present value of future productivity would average $222,400 per life saved. The estimate for individual demographic groups ranges from $1,194,000 for men age 15–44, to $13,819 for women age 65 and older. Approximately 63% of the projected deaths averted would occur among the population age 65 and older, 24% would occur among the population age 46–64, 10% would occur among the population age 18–44, and 3% would occur among the population under age 18.

Economic Benefits per Additional RN

Although we quantify the economic value of only a subset of the services that RNs provide, these partial estimates of economic value per additional full time equivalent (FTE) RN range from $58,100 (to add an RN when already at 9.1 HPPD) to $62,500 (to add an RN when already at 6.4 HPPD). That the benefits per additional RN changes relatively little between low HPPD and high HPPD is surprising and likely reflects the many data challenges faced by researchers whose work we synthesized (eg, few hospitals staff at extremely low or high levels so there is only modest variation in staffing levels across hospitals after one controls for patient mix).

At 7.8 HPPD the quantified benefits per FTE RN is $60,000. Annual medical savings per RN include $7400 from preventing nursing sensitive adverse events (91% of which are reduced hospital costs and 9% are reduced costs for professional services and other postdischarge costs); and $38,100 for hospital-related savings and $2500 for professional services savings related to reduced LOS unassociated with preventing adverse events. Productivity benefits to society per additional FTE RN include $10,300 for reduced patient mortality, and $1800 from faster recovery.

The approach used provides an estimate of the value of the next RN hired, for a given staffing level. The value of each additional nurse declines at higher staffing levels, so this marginal value approach underestimates the average value per nurse. Reflecting the nurse staffing measures in studies synthesized, this definition of FTE does not distinguish between additional staff and working longer hours.

Economic Value of Increased Hospital Nurse Staffing at the National Level

Estimates from this study suggest that adding 133,000 FTE RNs to the acute care hospital workforce [the estimated number of RNs needed to increase those hospitals below 9.1 HPPD (75th percentile) up to 9.1 HPPD] would save 5900 lives per year. The productivity value of total deaths averted is equivalent to more than $1.3 billion per year, or about $9900 per additional RN per year.

Adding 133,000 RNs nationally would decrease hospital days by 3.6 million. The value of national productivity when nurses help patients recover more rapidly is conservatively estimated at $231 million (or $1700 per additional RN per year).

Medical savings (before increased nursing labor costs) is estimated at $6.1 billion (or $46,000 per additional RN per year). Combining medical savings with increased productivity, these partial estimates of economic value average $57,700 for each of the additional 133,000 RNs. Although this national scenario highlights the potential impact of improved staffing in acute care hospitals, we acknowledge the challenges faced by the nation to meet the current and growing demand for RNs just to maintain current staffing levels. Also, improved nurse staffing is one of several factors needed to improve quality of care—including the contribution of other clinician specialties, and advances in training, processes, and technology.

DISCUSSION

This study draws heavily on the growing body of literature to quantify the economic value of professional nursing. Our findings are generally consistent with findings published by Kane et al on the relationship between staffing and complication risk, by Needleman et al on the business case for nursing and by Aiken et al on the relationship between nurse staffing level and patient mortality, despite using a different approach and combining findings across multiple studies.[3,5,12] Our findings help to confirm the basic overall findings reported in the literature.

TABLE 4. Increased Hospital Costs Attributed to Presence of Nosocomial Complications (in dollars; 2005)

	Medical Patients			Surgical Patients		
Effect	**Point Estimate**	**Standard Error**	***P***	**Point Estimate**	**Standard Error**	***P***
Intercept	$448	$20	<0.0001	$2583	$59	<0.0001
Age at admission	($1)	$0	0.0523	$6	$1	<0.0001
Female	($42)	$9	<0.0001	($448)	$24	<0.0001
Has urinary tract infection	$1389	$18	<0.0001	$4243	$60	<0.0001
Has pressure ulcer	$4457	$30	<0.0001	$4525	$75	<0.0001
Has pneumonia	$4953	$27	<0.0001	$7289	$69	<0.0001
Has DVT/PE	$4648	$62	<0.0001	$9460	$129	<0.0001
Has ulcer/gastritis/UGI bleeding	$2315	$42	<0.0001	$5114	$138	<0.0001
Has central nervous system complications	$842	$45	<0.0001	$2886	$152	<0.0001
Has sepsis	$9897	$37	<0.0001	$18,278	$90	<0.0001
Has shock/cardiac arrest	$5225	$46	<.0001	$8729	$102	<0.0001
Has surgical wound infection		NA		$12,643	$133	<0.0001
Has pulmonary failure		NA		$14,136	$72	<0.0001
Admission type (emergency omitted)						
Elective	($256)	$14	<0.0001	($1166)	$29	<0.0001
New born	($10)	$18	0.5944	$34,298	$921	<0.0001
Other	$1747	$18	<0.0001	$3739	$49	<0.0001
Trauma center	$1863	$161	<0.0001	$3017	$292	<0.0001
Urgent	($302)	$12	<0.0001	($987)	$36	<0.0001
Expected payer (private omitted)						
Medicaid	$539	$12	<0.0001	$620	$39	<0.0001
Medicare	$60	$14	<0.0001	($52)	$33	0.1223
No charge	($534)	$58	<0.0001	($632)	$185	0.0006
Other	$149	$27	<0.0001	$334	$61	<0.0001
Self	$348	$20	<0.0001	$59	$62	0.3424
Control/ownership of hospital (government/private, collapsed category omitted)						
Government, nonfederal, public	$666	$23	<0.0001	$1525	$66	<0.0001
Private, non-profit, voluntary	$755	$18	<0.0001	$1151	$49	<0.0001
Private, invest-own	$686	$21	<0.0001	$1301	$56	<0.0001
Private,collapsed category	$681	$29	<0.0001	$1378	$89	<0.0001
Bed size of hospital (large omitted)						
Small	($762)	$13	<0.0001	($1242)	$39	<0.0001
Medium	($308)	$10	<0.0001	($853)	$28	<0.0001
Region of hospital (Midwest omitted)						
Northeast	$1659	$13	<0.0001	$919	$34	<0.0001
South	($757)	$16	<0.0001	($1564)	$41	<0.0001
West	($156)	$18	<0.0001	($700)	$48	<0.0001
Location/teaching status of hospital (urban teaching omitted)						
Rural	($1934)	$19	<0.0001	($1886)	$57	<0.0001
Urban nonteaching	($1413)	$13	<0.0001	($1957)	$34	<0.0001
Average cost for DRG	$0.89	$0	<0.0001	$0.80	$0	<0.0001
Sample size (discharges)	3,834,251			1,446,624		
R^2	0.26			0.52		

Source: Analysis of the 2005 NIS.

Not all services that nurses provide can be quantified in pecuniary terms. Although there is a growing body of literature on the impact of nursing care on preventing nosocomial complications, we identified very little research on the impact of nursing on mitigating the severity of complications that still occur.

The average annual cost for hospitals to employ an RN in 2005 was approximately $83,000 (salary of $57,820 and a fringe benefit rate of 30.4%).[22] An expansion in RN supply of RNs to improve staffing levels could cause the cost per RN to rise. The benefits of increased RN staffing included in our analysis find that each additional patient care RN employed

TABLE 5. Average Attributed Increase in Mortality Risk, Length of Stay, and Medical Cost per Case

	Mortality Risk (Percentage Point Increase)		Inpatient Days		Total Medical Cost (in 2005 Dollars)	
Nosocomial Complication	**Medical**	**Surgical**	**Medical**	**Surgical**	**Medical**	**Surgical**
Urinary tract infection	0.00%	0.00%	1.68	4.58	$1628	$4770
Pressure ulcer	0.02%	0.69%	4.19	6.59	$5177	$5484
Pneumonia	5.95%	1.20%	2.79	4.48	$5837	$8511
Deep vein thrombosis	3.71%	4.35%	3.09	5.65	$5281	$10,349
Upper gastrointestinal bleeding	1.13%	1.93%	1.37	2.64	$2809	$5862
CNS complications	2.12%	2.00%	0.80	2.99	$1102	$3584
Sepsis	6.75%	8.53%	5.51	9.30	$11,259	$20,398
Shock/cardiac failure	31.39%	23.03%	0.56	1.36	$5584	$9247
Postoperative infection	NA	0.03%	NA	8.14	NA	$14,571
Pulmonary failure	NA	15.25%	NA	4.51	NA	$15,138
Adverse drug event	1.74%*		3.80†		$7789†	
Fall	Unknown		2.39‡		$7118‡	

*Based on Lazarou et al (2000).[25]
†Based on Suh et al (2000).[26]
‡Extrapolated based on estimated average cost per case reported by Hendrich et al (2003).[27]
Sources: Analysis of the 2005 NIS.

(at 7.8 HPPD) will generate over $60,000 annually in reduced medical costs and improved national productivity (accounting for 72% of labor costs). This is only a partial estimate of the economic value of nursing, omitting the intangible benefits of reduced pain and suffering by patients and family members; the risk for patient rehospitalization; benefits to the hospital such as improved reputation, reduced malpractice claims and payouts, and reduced compliance-related costs; the benefits of increased staffing related to improved work environment (eg, reduced turnover and risk of injury); and the value of administrative activities that patient care nurses perform (eg, functions related to billing and ordering). Omitted areas of economic value reflect gaps in the literature and warrant future research. The approach we used to quantify the economic value of increased staffing levels has several limitations:

One, the estimates omit the value of some services that RNs provide and consequently underestimate their economic value.

Two, a major component of estimated medical savings is reduced patient LOS. Prevention of nosocomial complications explains only a small portion of the total decrease in inpatient days. Additional research is needed to better understand the pathways that lead to reduced LOS.

Three, the approach used may encounter effect modification. If overall healthcare quality improves causing patient risk of nosocomial complications to decline with existing staffing levels, effect modification causes the estimates of economic value per RN to decline (there is less potential for quality improvements).

Four, estimates from the literature on the relationship between RN staffing level and quality of care are based on cross-sectional studies. These studies rely on associations that imply but do not establish causality. Work by Mark et al suggests that failure to adequately control for hospital characteristics can bias the estimated relationship between nurse staffing and quality of care.[23] When we compared the results reported in our paper to results using hierarchical linear models, we found differences in the estimates of control variables but minimal differences in the estimates used in our analysis (ie, the impact of nosocomial complications on predicting mortality, LOS, and cost).

The findings from this study point to 2 related issues with policy implications. First, because healthcare facilities realize only a portion of the economic value of professional nursing, under current reimbursement systems the incentive (and financial reality) is for facilities to staff at levels below where the benefit to society equals the cost to employ an additional nurse. Perception of a market failure or the increased potential for social good often results in calls for political action—as is the case with calls for mandated minimum nurse staffing ratios. A study by Evans and Kim (2006) studied the relationship between hospital staffing levels and adverse patient events in California hospitals to investigate the merit of California's mandated minimum nurse-to-patient ratios.[24]

Second, the economic value of nursing is greater for payers than for individual healthcare facilities. By reducing patient recovery periods and preventing nosocomial complications, nurses reduce the demand for selected physician services. Furthermore, depending on reimbursement method, the healthcare facility might fail to realize estimated financial benefits that accrue from prevention of nosocomial complications and reduced LOS. Regardless, insurers and other payers have a financial incentive to ensure that healthcare facilities have appropriate nurse staffing mix and levels. One potential solution that is gaining acceptance is to pay more for quality, with payers raising reimbursement rates for facilities that provide higher levels of care. More closely linking

reimbursement to patient outcomes could help facilities capture more of the benefits from improved staffing, thus strengthening the financial incentive and providing the financial means to improve quality of care.

Our findings reinforce the findings of others, strengthening the economic case for hospital investment in nursing, particularly in low staffed hospitals.

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