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.

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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 Homes 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.
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8. Our findings were approximately equal to those found by Lichtig and Schultz. They were half those estimated by Flood and Diers and by Behner.
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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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