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Nurse Staffing, Mortality, and Length of Stay in For-Profit and Not-for-Profit Hospitals

The issue of differential quality in for-profit (FP) and not-for-profit (NFP) hospitals remains a critical health policy question. With research demonstrating a relationship between nurse staffing and quality, the question arises whether the relationship differs in these hospital types. Using Healthcare Cost and Utilization Project data from the period 1990–1995, we found that case mix-adjusted registered nurse (RN) staffing was significantly lower in FPs than in NFPs, and we found a superior distribution of outcomes (mortality and length of stay) obtained with a lower level of RN staffing. The differences in mortality and length of stay disappeared, however, after controlling for population and market characteristics.

In the early to mid-1990s, acute care hospitals were buffeted by dramatic changes in their operating environments because of the increasing dominance of managed care, market responses to industry overcapacity, more stringent Medicare reimbursement policy, new technology development, and demands for shorter lengths of stay. Hospitals reacted by introducing a range of strategies aimed at improving the efficiency of their internal operations. In view of the fact that expenditures for nursing personnel comprise a significant portion of the hospital budget (Kovner et al. 2002), it is not surprising that in an attempt to reduce labor costs and improve efficiency hospitals also re-engineered and re-designed clinical care processes, which frequently resulted in changes in nurse staffing (ANA 1995).

Because of the different incentives in for-profit hospitals (FPs) and not-for-profit hospitals (NFPs), the transformation of

hospital care during this time period renewed policy debates regarding the social utility of for-profit hospitals. The debate continues today, with the House Ways and Means Committee recently holding hearings on the appropriateness of granting tax-exempt non-profit status to hospitals (Commonwealth Fund 2005). Proponents suggest that FPs can facilitate health coverage of the uninsured, generate more tax revenue for the government, free resources from acute care for public health services, and enhance a hospital's ability to access capital. Opponents suggest that FPs will increase prices, lower quality, be less likely to accept unprofitable patients, and fail to provide adequate community benefits because their objective is to maximize shareholder profit (Gray 1997; Schlesinger and Gray 2006).

The confluence of several policy issues raises the question whether hospitals with

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different ownership structures produce care of equal quality with the same number of, or fewer, nurses. These issues include ongoing concerns about hospitals' profit or tax-exempt nonprofit status, potential disparities in quality in the two types of hospitals, a significant nursing shortage (Buerhaus, Staiger, and Auerbach 2004), and emerging nurse staffing research about the contribution of nursing to improved quality of care (Kovner et al. 2002; Needleman et al. 2002; Mark et al. 2004).

If the profit motive spurs efficiency concerns to a greater degree in FPs than in NFPs, and these concerns play out in operational changes in the staffing and deployment of nurses providing care in the hospital setting, there may be significant consequences for how hospitals develop strategies to recruit, retain, and use nurses. In addition, if the relationship between nurse staffing and quality differs significantly in FP and NFP hospitals, then states considering legislation mandating minimum nurse staffing regulations should account for differences in ownership type in the ratios to be proposed. There also may be implications for national-level policy decisions about aggregate supply and demand for nurses, and strategies to address the shortage of nurses.

Thus, our paper examines whether FP and NFP hospitals differ in their nurse staffing, their mortality (e.g., death during hospitalization), and their length of stay (e.g., number of days hospitalized). We examine the distribution of staffing and outcomes (mortality and length of stay) in FP and NFP hospitals in 1990 and 1995. Data from these years are particularly relevant to understanding potential differences in responses by FPs and NFPs to a significant structural change in the health care environment: the rapid growth of managed care penetration (Jensen et al. 1997; Marquis and Long 1999).

Background

Staffing in For-Profit and Not-for-Profit Hospitals

The evidence concerning differential staffing in FPs and NFPs is not conclusive. Investigating the effects of ownership conver-

sion is one avenue for examining this question. Mark (1999) examined the effects of conversions on changes in hospital staffing between 1989 and 1992; she found that in NFP to FP conversions, total staff-to-patient ratios decreased significantly, but the decline in nurse staffing was not statistically significant. In contrast, she found that when FPs converted to NFP status, both registered nurse (RN)-to-patient ratios and administrator-to-patient ratios increased, and the increases were statistically significant. A Commonwealth Fund report (Hadley, Gray, and Collins 2001) found that in hospitals converting from FP to NFP status between 1985 and 1993, total full-time equivalent (FTE) staff (nurse staffing was not identified separately) grew significantly more slowly in the three years pre-conversion than in a matched set of hospitals that did not convert; the differences in staffing were not significant in either the three- or five-year post-conversion period.

Picone, Chou, and Sloan (2002) found that in conversions to FP status, real wages and salaries (of which a significant portion was nurse wages) fell substantially during the conversion year, but cuts were partially restored in subsequent years. A similar pattern was found for wages and salaries per adjusted patient day. While conversions to NFP status also resulted in a drop in wages and salaries during the conversion year, the decrease was not nearly as large as in hospitals that converted to FP status. More recently, Shen (2003) used panel data to examine ownership conversions and found that hospitals converting to FP status reduced registered nurses per hospital bed by 13.5%, and licensed practical nurses (LPNs) per hospital bed by 10.25%. In contrast, conversion to NFP status did not change the RN-to-bed ratio, although LPNs per hospital bed were reduced by 17.5%.

Finally, Spetz, Seago, and Mitchell (2003) used a fixed-effects model, controlling for wages, patient days, case mix, service mix, percentage of county discharges insured by a health maintenance organization (HMO), and year, to investigate the impact on staffing of ownership conversion in 219 California hospitals. They found that conversions from NFP to FP status were associated with

declines in RN staffing, but the changes were not statistically significant. In contrast, while conversions from FP to NFP ownership were associated with increases in RN staffing, the increases were not statistically significant.

Another set of studies has made direct comparisons between FPs and NFPs in staffing, rather than investigating the effects of ownership conversions on staffing. Carter, Massa, and Power (1997) compared 185 Texas hospitals and found support for their hypothesis that FPs would exhibit less “expense preference behavior” by utilizing fewer full-time or FTE employees, a finding that held regardless of possible economies of scale (number of hospital beds). Shukla, Pestian, and Clement (1997) compared the economic performance of FPs and NFPs, and reported that labor cost was higher but paid hours per admission were lower in FP hospitals, which paid more in both salary and benefits than did NFPs. Seago, Spetz, and Mitchell (2004), in a study making direct comparisons among California hospitals of different ownership types, found that independent FPs had the highest RN hours per day and highest RN-to-patient ratios, and the richest skill mix of any ownership type. However, in multivariate regressions, FPs, particularly those that were part of multihospital systems, used fewer RN hours to care for medical-surgical patients. Interestingly, when Seago and colleagues included dummy variables to distinguish urban FPs from their rural FP counterparts, FPs were no longer significantly different from other hospitals. The authors’ explanation is that most independent FP hospitals in California are located in rural areas and need to maintain a minimum number of RN hours even if there are no patients in the facility.

The findings of the studies reviewed here suggest that conversion to FP status may result in reduced registered nurse staffing; similarly, the comparison studies indicate that FPs may use fewer RNs. However, definitional differences in measuring nurse staffing, as well as the inclusion of RNs within other employee and wage categories, render conclusive statements difficult. In addition, with the exception of the studies by Spetz, Seago, and Mitchell (2003; Seago, Spetz, and Mitchell 2004), none of the studies reported here

has directly examined differential nurse staffing by ownership type. Moreover, the generalizability of the discussed studies is limited because of their focus on one state, and by the likely conflation of ownership status and rural location. The lack of definitive conclusions about different staffing levels in FP and NFP hospitals highlights the need for more detailed studies of nurse staffing.

Mortality and Length of Stay in For-Profit and Not-for-Profit Hospitals

There is also a substantial, but inconclusive body of research on quality differences between FPs and NFPs. Conceptual and methodological diversity—use of disparate clinical conditions, risk models, selection of outcomes and the timing of their measurement, data sets, and analytic approaches relying on widely varying assumptions—contribute to the lack of clarity on the issue. As with the research on staffing, some studies have investigated mortality and length of stay differences between FPs and NFPs, while others have examined the effects of hospital ownership conversions on mortality and length of stay.

One reason earlier comparative studies of mortality rates in FPs and NFPs are inconclusive is that they were cross-sectional, used data collected before the time of burgeoning managed care penetration, and did not have a specific focus on ownership status.¹ More recent studies, however, using methods that account for potential sources of bias, highlight the difficulty in addressing the issue. For example, three recent studies found complex relationships between ownership and mortality after ownership conversions. Using data from the National Long-Term Care Survey, Picone, Chou and Sloan (2002) examined 30-day mortality and found that converting from government or nonprofit status to for-profit status increased mortality for one or two years following conversion, after which the increase in mortality rates was less steep. Whether the same findings would hold for inpatient mortality is a question of importance since much of the research on the relationship between nurse staffing and mortality has focused on inpatient rather than 30-day mortality. More difficult causal issues are

raised when examining an outcome (mortality) at some temporal distance from the intervention (nurse staffing). Farsi (2004), using data on Medicare patients in hospitals that changed ownership in California, found that conversion in either direction (i.e., NFP to FP, or vice versa) had adverse effects: hospitals that converted to FP status had increased inpatient myocardial infarction mortality rates, while those that converted to NFP ownership had increased mortality for patients with congestive heart failure. However, in a study on mergers and acquisitions in California, Ho and Hamilton (2000) found no difference in inpatient mortality among either heart attack or stroke patients, although the authors caution against strong conclusions because the estimates were measured imprecisely.

Research also has been inconclusive about differences in length of stay (LOS) between FPs and NFPs. For example, Burns and Wholey (1991) found that LOS was longer for patients in investor-owned hospitals across 11 medical and five surgical conditions. However, the focus of this study was not specifically on ownership; ownership was one of many hospital characteristics included in the analytic model. In addition, the data were from 1988, prior to the period of rapid managed care growth. Anders (1993), in a comparative study of administrative delays in one FP and one NFP, found no difference in length of stay. More recently, Yuan et al. (2000) found that, when compared with several other ownership types (public teaching hospitals and NFP teaching hospitals), FPs had the shortest length of stay. A strength of this study was its sample size (more than 5,100 acute care hospitals), but it was limited only to Medicare patients hospitalized for 10 common medical and 10 common surgical conditions. Thus, generalizability is a concern.

Nurse Staffing, Mortality, and Length of Stay

To further complicate the confused relationships among nurse staffing, quality of care, and ownership type, there is also ambiguity about whether higher levels of nurse staffing are associated with higher quality of care. Several early studies examining the relationships between hospital characteristics and

mortality that tangentially included nurse staffing as a hospital characteristic found that higher levels of nurse staffing were associated with reduced mortality (Scott, Forrest, and Brown 1976; Hartz et al. 1989; Kuhn et al. 1991; Manheim et al. 1992). However, another study found no significant relationship between nurse staffing and mortality (Al-Haider and Wan 1991). More recent studies have found that hospitals with high nurse-to-bed ratios had lower than expected mortality rates (Silber et al. 1995; Silber, Rosenbaum, and Ross 1995). And several studies that have had the relationship between nurse staffing and mortality as their primary focus have found “better” nurse staffing associated with lower in-hospital mortality (Aiken et al. 2002; Mark et al. 2004), although Needleman et al. (2002) found no relationship to mortality. Four studies have provided support for the relationship between higher levels of nurse staffing and shorter length of stay (ANA 1997, 2000; Lichtig, Knauf, and Milholland 1999; Mark, Harless, and McCue 2005; Needleman et al. 2002).

In summary, the research reviewed here remains ambiguous with regard to differences between FP and NFP hospitals in terms of nurse staffing, mortality, and length of stay. However, the literature does suggest a beneficial effect of nurse staffing on mortality and length of stay. To date, there has been no research that specifically examines nurse staffing, mortality, and length of stay in for-profit and not-for-profit hospitals during a period of time of major upheaval in hospital environments; that is the purpose of our study.

Approach

Theoretical approaches to understanding differences in hospital behavior suggest that such differences arise from differential claims on “wealth” as a consequence of different forms of ownership. The early theoretical work of Modigliani and Miller (1958) suggests that an investor-owned (or for-profit) firm is a wealth-maximizing entity that seeks out investment projects that increase the wealth of its stockholders. Somewhat later, the major theories of hospital behavior (New-

house 1970; Pauly and Redisch 1973) suggested that NFP hospitals were assumed to be utility maximizing (Newhouse 1970), while FP hospitals were assumed to be profit maximizing. Ever since, there has been controversy about whether NFPs and FPs behave differently, with Pauly and Redisch (1973) calling NFPs “for-profit firms in disguise” and Wheeler and Clement (1990) arguing for a “for-profit” view of NFPs.

If NFPs are “for-profit firms in disguise,” we expect that the increased competition in hospital markets due to burgeoning managed care penetration caused the differences that may have existed between FPs and NFPs in 1990 to have lessened by 1995. In particular, we expect that NFPs may have imitated FPs’ staffing strategies in order to be successful. To control for systematic differences in the location of FP hospitals compared to NFP hospitals and the potential impact of location on outcomes, we also compare the distributions of outcomes after controlling for population and market characteristics.

Kernel Density Estimates

Rather than estimate a parametric model of quality and staffing levels comparing FP and NFP hospitals, we use a nonparametric approach in which we compare the distributions of staffing and outcomes at FP and NFP hospitals. We use visual representations based on kernel density estimates—a technique not commonly applied in health services research and, to our knowledge, not yet applied in the literature on FP and NFP hospitals. The statistical tests of the distributions are the Kolmogorov-Smirnov and Epps and Singleton (1986) tests.

Like a histogram, kernel density estimates approximate the distribution or density of a variable from a sample. But kernel density estimate assumptions are less restrictive than those for a histogram (Fox 1990; DiNardo and Tobias 2001). A histogram has nonoverlapping bins, and the height of the bar for a bin estimates the probability density at the bin center, putting equal weight on each observation in the bin regardless of the distance from the bin center. Hence, the appearance of the histogram depends on the location of the bin centers, which are determined by the choice of

bin width and location of the first bin. Kernel density estimates are different because bins are allowed to “overlap” (so bin centers are not determined by bin width), and different weights are put on observations depending on the nearness to the point at which the density is being estimated (DiNardo and Tobias 2001).

The kernel density estimates are then augmented by two statistical tests for differences in distributions: the Kolmogorov-Smirnov test (Conover 1999) and the Epps-Singleton test (1986). Rather than a test for differences in means (or conditional means), these are omnibus tests for any difference in the shape of the distribution—location, dispersion, skewness, and so on (Hollander and Wolfe 1999; Sachs 1984). The two-sample Kolmogorov-Smirnov test is based on comparing the maximum vertical distance in the two empirical cumulative distribution functions. The Epps-Singleton test is based on the empirical characteristic functions for the two samples. The consequence of the generality of these tests is that they are less powerful than a test specific to one aspect of a distribution (e.g., location). Nevertheless, these are the sharpest tests for homogeneity of two distributions (Sachs 1984) and are the most appropriate for our purposes given our approach focusing on insights from nonparametric analysis.²

Methods

Sample

The Healthcare Cost and Utilization Project (HCUP) National Inpatient Sample (NIS) is an all-payer database, including a 20% probability sample of U.S. community hospitals, stratified by ownership/control, number of beds, teaching status, urban/rural location and U.S. region. Each year, approximately 900 hospitals are included; 422 hospitals were included in each of our study years (1990 through 1995). These 422 hospitals, known as the HCUP longitudinal cohort, comprise 49% of the HCUP base-year sample. Hospitals are located in 11 states (Arizona, California, Colorado, Florida, Illinois, Iowa, Massachusetts, New Jersey, Pennsylvania, Washington, and Wisconsin).

From the 422 hospitals in our initial sample, we eliminated 12 hospitals that switched ownership status in the 1990–1995 period, and eliminated another six hospitals due to the inability to match them across all data sets. Two additional hospitals were eliminated because their data were for a system rather than an individual hospital, and two others were dropped because revenue information was missing from all files from the Centers for Medicare and Medicaid Services (CMS). Hospitals with staffing outliers also were excluded. Additional exclusions were for hospitals with fewer than 15 expected mortalities (Mark et al. 2004). These exclusions resulted in a sample of 48 FP hospitals and 268 NFPs in 1990, and 44 FPs and 266 NFPs in 1995. Although this small sample is a limitation of our study, the two-sample Kolmogorov-Smirnov test and Epps-Singleton tests are often applied with sample sizes considerably smaller than ours (e.g., Arnon et al. [2006] applied the two-sample Kolmogorov-Smirnov test with sample sizes for the groups as small as 11 and 17). In addition, the limitation of the small sample is somewhat offset by the fact that we have observations on these hospitals over a six-year period of time, and while the results we report use data from 1990 and 1995, they are essentially similar in other years (results available upon request from the authors).

In 1995, our sample of 310 hospitals was 85% NFP (70% private NFP, 15% public) and 13% FP (with 2% unknown), compared to national figures of 85% NFP (58% private NFP, 27% public) and 15% for-profit (AHA 1995). Hospitals in our sample were somewhat larger (206 beds vs. 170 beds for U.S. hospitals) and treated a somewhat more complex mix of patients (case-mix index 1.36 vs. 1.23 for U.S. hospitals). Average HMO penetration (measured as HMO enrollment as a percentage of total hospital service area [HSA] population) in our sample in 1995 was 22.5%, somewhat greater than the 16% in hospitals nationwide (Baker 2001), and the range in our sample (0% to 60.4%) was nearly as large as the national range (0% to 73%). Thus, although there are some differences, our final sample reflects the overall population of U.S. hospitals.

Data

Data sources included the Area Resource Files, the American Hospital Association (AHA) Annual Survey, the Centers for Medicare and Medicaid Services (CMS, formerly the Health Care Financing Administration) Minimum Cost and Capital File, the CMS Wage Rate File, the CMS Provider of Services File, the CMS Case Mix Index File, the CMS Online Survey Certification and Reporting system (OSCAR) files, and HCUP files.

Measures

Table 1 provides definitions and data sources of all variables; in most cases, measurement is straightforward. Complete descriptions of the variables and their measurement can be found in Mark et al. (2004) and Mark, Harless, and McCue (2005). Here we provide a brief description of selected variables.

Ownership. We classified hospitals, based on AHA data, as to whether they were for-profit or not-for-profit.

Mortality and length of stay. From HCUP data, we determined whether a patient died during the hospital stay (inpatient mortality) and then totaled the actual number of deaths for a hospital in the calendar year. Ho and Hamilton (2000) point out that using inpatient mortality is subject to possible bias by the fact that it is censored by live discharge. Mortality might be lower in FPs than in NFPs if FPs discharge patients earlier and perhaps to other institutions (e.g., long-term care facilities) where they then die. Thus, 30-day mortality rates might be a better indicator of hospital quality. Two issues argue against this approach, however. First, the HCUP data only report inpatient mortality. Second, mortality after discharge is likely to be confounded with post-discharge treatment, and perhaps be less sensitive to the delivery of hospital care. In order to partly account for possible differences in discharge practices of FP hospitals, we exclude from our analysis patients who were discharged to another facility or who had other “non-routine” discharges.³

Risk adjustment for mortality and length of stay measures was performed using Med-

Table 1. Variable definitions and sources of data

Variable	Definition	Sources
Quality measures		
Mortality ratio	Observed mortalities/expected mortalities	HCUP, Medstat
Length of stay (LOS) ratio	Mean of LOS/mean of expected LOS	HCUP, Medstat
Hospital characteristics		
Ownership	FP or NFP	AHA survey
Case-mix index (CMI)	Complexity of Medicare cases treated	CMS
Staffing measures		
RN staffing	RN FTEs/1,000 inpatient days	AHA, OSCAR
CMI-adjusted RN staffing	RN FTEs/(CMI $\times$ 1,000 inpatient days)	AHA, OSCAR, CMS
Market characteristics		
Number of HMOs	Number of HMOs in the hospital service area (HSA)	Wholey et al. (1997)/InterStudy
HMO penetration	HMO enrollment as % of total HSA population	Wholey et al. (1997)/InterStudy
Herfindahl index	Sum of squared market share in an HSA	AHA survey
Inpatient use	Inpatient days/1,000 HSA population	Area Resource Files
Population characteristics		
Metropolitan Statistical Area (MSA)	Indicator variable for hospitals located in MSA	AHA
Per capita income	Income/population (thousands of 1995 \$)	Area Resource Files
Unemployment rate	Unemployment rate in HSA (%)	Area Resource Files
Percentage elderly	HSA population $\geq$ 65 years old (%)	Area Resource Files
Insurance coverage percentages	Percent patients in HSA with primary payer private insurer (including HMO), Medicare, Medicaid, or self-pay	HCUP
Population	HSA population (in thousands)	Area Resource Files

Notes: HCUP = Healthcare Cost and Utilization Project National Inpatient Sample; AHA survey = American Hospital Association Annual Survey; CMS = Centers for Medicare and Medicaid Services; OSCAR = CMS Online Survey Certification and Reporting system.

stat's Disease Staging methodology (Gonnella, Hornbrook, and Louis 1984), which can be directly applied to HCUP data. Diseases are "staged" into four substages (no complications through death) from Uniform Billing (UB)-82/UB-92 information, which includes the patient's age, gender, admission type, admission source, and type of treatment (medical vs. surgical). This information is used to derive a predicted probability of death and expected length of stay. For our study, the disease staging methodology generated an estimated probability of death and expected length of stay for every discharge. These probabilities were summed over a hospital's discharges to yield an estimate of the number of deaths "expected" for that hospital as well as the expected length of stay. Expected length of stay for a hospital was obtained by calculating the geometric mean of expected length of stay for all patients at a hospital for a given

year (but patients with natural log of actual LOS four standard deviations above the mean were excluded). A mortality ratio greater than 1 indicates that the actual number of deaths exceeds the expected number, while a mortality ratio less than 1 indicates that the actual number of deaths was less than expected. Length of stay ratios are interpreted similarly.

Staffing measures. Registered nurse staffing was measured as the number of registered nurse full-time equivalents per 1,000 inpatient days. Licensed practical nurse and non-nurse staffing were defined similarly. We addressed the problem of the AHA data not distinguishing nurse staffing for inpatient and outpatient services by following Kovner and Gergen (1988; Kovner et al. 2002) in allocating staffing to the inpatient facility based on the ratio of inpatient to outpatient gross revenues. In addition, we used the OSCAR files to provide supplemental information on nurse staffing.

Table 2. Percentile values in 1990 and 1995, by ownership status

	Percentile values 1990			Percentile values 1995		
	25 th	50 th	75 th	25 th	50 th	75 th
Outcome measures						
Mortality ratio						
NFP	1.53	1.73	1.97	1.27	1.49	1.72
FP	1.31	1.58	1.76	1.10	1.33	1.55
LOS ratio						
NFP	.89	.97	1.05	.67	.72	.78
FP	.87	.93	.98	.64	.69	.74
Hospital characteristic						
CMI						
NFP	1.13	1.24	1.36	1.19	1.30	1.50
FP	1.25	1.30	1.37	1.30	1.39	1.48
Staffing measures						
RN staffing						
NFP	2.53	3.00	3.64	2.94	3.57	4.33
FP	1.99	2.82	3.82	2.71	3.34	4.00
CMI-adjusted RN staffing						
NFP	2.01	2.36	2.86	2.19	2.65	3.14
FP	1.63	2.14	2.94	2.01	2.30	2.75
Market characteristics						
HMO penetration						
NFP	5.04	13.39	21.54	11.59	21.80	33.51
FP	3.40	16.79	16.84	12.41	22.72	33.51
Number of HMOs						
NFP	2.00	5.47	9.75	3.44	7.58	12.15
FP	2.35	9.56	15.47	4.61	8.45	14.00
Herfindahl index						
NFP	4.88	16.66	26.07	5.00	17.04	27.37
FP	3.51	5.35	16.56	3.33	6.24	18.26
Inpatient days per 1,000 population						
NFP	738	930	1,073	581	756	948
FP	743	845	1,050	581	725	841
Population characteristics						
Per capita income						
NFP	14.86	17.25	19.47	16.32	19.34	20.89
FP	16.56	19.47	20.84	18.14	19.94	20.89
Unemployment rate						
NFP	4.63	5.36	6.39	3.90	5.19	6.70
FP	5.12	6.13	6.33	4.36	6.56	7.23
Percent elderly						
NFP	11.77	13.91	16.51	12.11	13.90	16.23
FP	11.58	16.51	21.48	12.46	16.11	21.22
Percent private insurance						
NFP	38.04	43.87	50.63	36.01	41.65	46.35
FP	35.02	38.04	42.71	35.76	38.56	39.77
Percent Medicare						
NFP	22.55	27.15	31.91	23.46	30.06	36.31
FP	20.48	29.84	32.40	22.57	27.64	37.01
Percent Medicaid						
NFP	11.26	14.80	18.60	12.67	17.60	23.12
FP	11.85	14.57	18.57	15.97	19.60	21.79
Percent self-pay						
NFP	0.00	3.43	6.47	3.11	4.74	7.32
FP	0.00	0.00	1.86	4.22	5.92	7.89

Table 2. (continued)

	Percentile values 1990			Percentile values 1995		
	25 th	50 th	75 th	25 th	50 th	75 th
Population (000s)						
NFP	256	548	2,068	278	597	2,180
FP	521	1,870	3,271	593	1,819	3,525
Number of hospitals in sample						
NFP		268			266	
FP		48			44	

Market measures. We used the hospital service areas (HSAs) that were developed by Makuc et al. (1991) and which group counties into geographic regions based on flows of inpatient hospital admissions. By definition, each HSA includes at least one hospital. Wholey et al. (1997) suggest that since over- or under-allocation pro-rating errors tend to be offset within a limited geographical area (over-allocation/under-allocation patterns occur in adjacent counties), aggregating to HSA or metropolitan statistical area (MSA) levels will produce more reliable measures of HMO penetration. We therefore measured market characteristics (number of HMOs, Herfindahl index, inpatient days per 1,000 population) at the HSA level.

Population characteristics. Given the findings that some of the significant differences in FPs and NFPs disappeared when controlling for geographic location (Seago, Spetz, and Mitchell 2004), and the propensity of FP hospitals' to locate in geographically favorable areas (Norton and Staiger 1994; Sloan et al. 2003), we included several population characteristics that might affect health and health needs in the HSA. These include: per capita income, unemployment rate, percentage elderly, insurance status (percentage of patients with primary payer private insurance, including HMO, Medicare, Medicaid, and self-pay), and total HSA population (McCue 1997; Mark 1999; Rosko 2001; Thorpe, Florence, and Seiber 2000).

Results

Table 2 presents descriptive statistics for the hospitals by ownership status in our sample

in 1990 and 1995. Note that the 25th, 50th, and 75th percentile values for mortality ratio and LOS ratio at FP hospitals are uniformly lower (indicating higher quality of care) than at NFP hospitals. In addition, FP staffing is always lower except for the 75th percentile in 1990.

The nub of the puzzle that we explore is described in Figures 1 to 3. The top half of Figure 1 contains kernel density estimates of RN staffing levels at FP and NFP hospitals in our sample for the year 1995. (Each of the other years in our sample, 1990–1994, generates similar pictures.) Except for hospitals at the very lowest level of staffing (fewer than 1.5 RN FTEs per 1,000 inpatient days), the distribution of staffing levels for FP hospitals is located left (indicating lower staffing levels) of the distribution for NFP hospitals. However, this difference is not statistically significant using either the Kolmogorov-Smirnov or Epps-Singleton tests (Table 3). The bottom half of Figure 1 shows that the difference in RN staffing distributions between FP and NFP hospitals is more pronounced when we compare staffing levels after adjusting for differences in case-mix index. With the case-mix adjustment, as indicated in Table 3, the difference is statistically significant using either the Kolmogorov-Smirnov ($p=.031$) or the Epps-Singleton test ($p=.037$).

The top half of Figure 2, which provides the kernel density estimates of the mortality ratio (actual in-hospital mortalities divided by expected mortalities), shows that the distribution of mortality ratios at FP hospitals lies to the left (lower mortality ratio) of that for NFP hospitals. Put another way, FP mortality ratios nearly “dominate” those at NFP hospitals in that, with the exception of

Figure 1. Kernel density estimates of RN staffing levels in 1995, by ownership status

the five smallest NFP mortality ratio observations, the cumulative distribution of outcomes for FP hospitals lies to the left of the cumulative distribution for NFP hospitals. As indicated in Table 3, this difference is statistically significant using either the Kolmogorov-Smirnov ($p=.012$) or the Epps-Singleton test ($p=.022$).

The top half of Figure 3 provides the kernel density estimates for the LOS ratio (the geometric mean of actual length of stay divided by the geometric mean of expected

length of stay). Here, the distribution of outcomes for FP hospitals dominates that for NFP hospitals in that the cumulative distribution of LOS ratios for FPs lies to the left of the cumulative distribution for NFP hospitals, and again the difference is statistically significant.

Consistent with research cited earlier demonstrating the importance of population and market characteristics in the location of FP hospitals, differences in the distribution of quality of care between FP and NFP hospitals

Figure 2. Kernel density estimates of the mortality ratio and adjusted mortality ratio in 1995, by ownership status

are not as simple as the top halves of Figures 2 and 3 would suggest. It is straightforward to show that these differences in the distributions of outcomes are in part attributable to population and market characteristics—that is, differences in where FP hospitals are located, rather than any variable specifically under the control of the hospitals. To demonstrate, we estimated a model for mortality ratio and LOS ratio with regressors reflecting population and market characteristics. For example, for the mortality ratio we have:

$$\begin{aligned}
 \text{Mortality Ratio}_i = & \beta_0 + \beta_1 \text{MSA}_i \\
 & + \beta_2 \ln(\text{Population}_i) + \beta_3 \text{Older}_i \\
 & + \beta_4 \text{Unemployment Rate}_i + \beta_5 \ln(\text{HSA Hospital Use}_i) \\
 & + \beta_6 \ln(\text{Per Capita Income}_i) + \beta_7 \ln(\text{HSA Hospital Use}_i) \\
 & \times \ln(\text{Per Capita Income}_i) + \beta_8 \text{Herfindahl Index}_i \\
 & + \beta_9 \text{Percent Private} + \beta_{10} \text{Percent Medicare} \\
 & + \beta_{11} \text{Percent Medicaid} + \beta_{12} \text{Percent Self-Pay} \\
 & + \beta_{13} \text{HMO Penetration}_i + \beta_{14} \text{Number of HMOs}_i \\
 & + \beta_{15} \text{HMO Penetration}_i \times \text{Number of HMOs}_i + u_i
 \end{aligned} \tag{1}$$

Figure 3. Kernel density estimates of the LOS ratio and adjusted LOS ratio in 1995, by ownership status

where the variables are defined as in Table 1, $\ln$ indicates natural log, and u_i is the random error term for hospital i .⁴ To obtain a measure of quality of care *adjusted* for differences in population and market characteristics, we calculated the predicted value at the mean value of each of the variables and added back in $\hat{u}_i$, the residual for hospital i .

$$Adj. Mortality Ratio_i = \hat{\beta}_0 + \hat{\beta}_1 MSA$$

$$\begin{aligned} &+ \hat{\beta}_2 \overline{\ln(Population)} + \hat{\beta}_3 \overline{Older} \\ &+ \hat{\beta}_4 \overline{Unemployment Rate} + \hat{\beta}_5 \overline{\ln(HSA Hospital Use)} \\ &+ \hat{\beta}_6 \overline{\ln(Per Capita Income)} + \hat{\beta}_7 \overline{\ln(HSA Hospital Use)} \\ &\times \overline{\ln(Per Capita Income)} + \hat{\beta}_8 \overline{Herfindahl Index} \\ &+ \hat{\beta}_9 \overline{Percent Private} + \hat{\beta}_{10} \overline{Percent Medicare} \\ &+ \hat{\beta}_{11} \overline{Percent Medicaid} + \hat{\beta}_{12} \overline{Percent Self-Pay} \\ &+ \hat{\beta}_{13} \overline{HMO Penetration} + \hat{\beta}_{14} \overline{Number of HMOs} \\ &+ \hat{\beta}_{15} \overline{HMO Penetration} \times \overline{Number of HMOs} + \hat{u}_i \end{aligned} \tag{2}$$

Table 3. Tests of significance for differences in 1995 and 1990 distributions, by ownership status

	Kolmogorov-Smirnov statistic	<i>p</i> -value	Epps-Singleton chi-squared statistic	<i>p</i> -value
1995				
RN staffing	.184	.155	6.11	.191
CMI-adjusted RN staffing	.235	.031	10.19	.037
Mortality ratio	.261	.012	11.43	.022
Adjusted for population and market characteristics	.142	.435	3.29	.510
LOS ratio	.216	.059	10.29	.036
Adjusted for population and market characteristics	.188	.139	3.86	.425
1990				
RN staffing	.240	.018	12.86	.012
CMI-adjusted RN staffing	.284	.003	16.90	.002
Mortality ratio	.252	.011	13.68	.008
Adjusted for population and market characteristics	.176	.160	7.92	.094
LOS ratio	.254	.010	14.85	.005
Adjusted for population and market characteristics	.239	.019	8.57	.073

Thus, we control for immediately observable differences in population and market characteristics. But by no means do we claim to adjust for all differences potentially affecting quality of care (e.g., potential differences in patient populations remaining even after Medstat risk adjustment). (Results of these regressions are in Table 4.) We specifically do not include any hospital-level variables in equation 1; our intent is not to estimate a fully formed parametric model of quality of care, but rather to show that simply controlling for where FP hospitals are located largely resolves the puzzle/anomaly represented by Figure 1 and the top halves of Figures 2 and 3.

The graph in the bottom half of Figure 2 shows the kernel density estimates for the adjusted mortality rates for FP and NFP hospitals. Although the distribution for FP hospitals is still left of the distribution for NFP hospitals, a good deal of the disparity in the distributions evident in the top half of Figure 2 is eliminated by controlling for population and market characteristics; there is no statistically significant difference in the distributions (Table 3). As shown in the bottom half of Figure 3, the distributions of adjusted LOS ratio for FP and NFP hospitals are also more similar compared to the distributions of the LOS ratio. Again, the two tests for distributions (Table 3) confirm the conclusion con-

veyed by the bottom half of Figure 2 that these differences are not statistically significant.

We next present information showing how FP and NFP distributions of staffing and outcomes changed between 1990 and 1995. To present this information in a compact way and to emphasize differences between FP and NFP distributions, we present figures showing the *differences* in the FP and NFP kernel density estimates in 1990 and in 1995. The top half of Figure 4 shows the difference in kernel density estimates for RN staffing in 1990 (solid line) and 1995 (dashed line). The line for 1995 can be compared to the top half of Figure 1: at a given value of RN staffing, the dashed line in the top half of Figure 4 shows the *distance* between the FP and NFP density estimates that we displayed in the top half of Figure 1.⁵ When the FP density estimate in Figure 1 lies above the NFP density estimate, then the dashed line in Figure 4 lies above zero. Note that the more similar the FP and NFP density estimates are in Figure 1, the closer the difference in density lines are to zero. Hence, one can see that the 1995 FP and NFP densities are much more similar at RN staffing levels above the medians (3.57 at NFP hospitals, 3.34 at FP hospitals) than below the medians.

The difference in density figures allows us to compare both how FP and NFP hospitals differed from each other and any change in

Table 4. Regression results for equation 1 for mortality ratio and LOS ratio, 1995

Variable	Mortality ratio	LOS ratio
MSA	−.018 (.059)	−.007 (.017)
ln(Population)	−.110** (.040)	−.015 (.010)
Percent elderly	−.007 (.006)	−.005** (.002)
Unemployment rate	.008 (.011)	.004 (.003)
ln(IPDs per 1,000 population)	−1.116 (.898)	−1.038*** (.249)
ln(Per capita income)	−2.446 (2.033)	−2.367*** (.564)
ln(IPDs per 1,000 population)× ln(Per capita income)	.400 (.303)	.380*** (.084)
Herfindahl index	.001 (.003)	.000 (.001)
HMO penetration	.003 (.003)	−.000 (.001)
Number of HMOs	.006 (.008)	−.000 (.002)
HMO penetration × Number of HMOs	.000 (.000)	.000 (.000)
Percent Medicare	−.012 (.010)	.005 (.003)
Percent Medicaid	−.013 (.011)	.005 (.003)
Percent private insurance	−.010 (.010)	.006* (.003)
Percent self-pay	−.015 (.010)	.009*** (.003)
Constant	10.669 (6.250)	6.918*** (1.729)
R-squared	.142	.325
Number of observations	310	310

Note: IPD=inpatient days. Standard errors are in parentheses.

* $p<.05$.

** $p<.01$.

*** $p<.001$.

those differences from 1990 to 1995. First, FP and NFP distributions of both RN staffing and case mix-adjusted RN staffing shifted to the right (higher staffing levels) in 1995 compared to 1990; note, for example, how the difference in density “hump” for case mix-adjusted RN staffing lies at 2 in 1995, but at approximately 1.5 in 1990. (This shift right in the distribution is also indicated in the percentile values shown in Table 2.) Note that Figure 4 also suggests that the distributions of staffing become somewhat more similar in 1995 compared to 1990—the relatively large downward hump that occurs at staffing levels slightly below 2 to slightly above 3 in 1990 ameliorates considerably in 1995. This visual impression is confirmed by comparing the Kolmogorov-Smirnov and Epps-Singleton test statistics for 1990 and 1995 (Table 3). The test statistics for case-mix index (CMI)-adjusted RN staffing are much larger for 1990, and the test statistics indicate a statistically significant difference in RN staffing in 1990, unlike in 1995.

Figure 5 provides more stark visual evidence of differences in densities. We draw the figure keeping the scale the same for the difference in mortality ratio density estimates (top half) and the difference in LOS ratio

density estimates (bottom half). With the same scale, it is easy to see that differences in density estimates between FP and NFP hospitals are much larger for the LOS ratio than for the mortality ratio in both 1990 and 1995. Further, changes in the difference in density estimates between 1990 and 1995 are immediately apparent for the LOS ratio. While there is little difference in the magnitude of the differences in densities for the mortality ratio in 1990 versus 1995, the magnitude of the difference in densities for the LOS ratio in 1990 and 1995 is quite large. Thus, the difference in LOS ratio was much larger in 1990 than in 1995. Hence, while there is evidence of differences in the distribution of LOS ratios between FP and NFP hospitals in 1995, Figure 5 shows that the differences in 1990 were much larger. This is confirmed in the significance tests for the difference in distributions reported in Table 3. Both test statistics for the LOS ratio are considerably larger in 1990 than in 1995; the Kolmogorov-Smirnov test indicates a statistically significant difference in the FP and NFP distributions in 1990 even after adjusting for population and market characteristics, but the Epps-Singleton test does not provide strong evidence of such a difference.

Figure 4. Difference in kernel density estimates of RN staffing levels for for-profit and not-for-profit hospitals in 1990 and 1995

In summary, we investigated whether nurse staffing, mortality, and length of stay would differ in FP and NFP hospitals. We found that FP hospitals used significantly fewer RN FTEs/1,000 case mix-adjusted days. We also found that both mortality ratios and length of stay ratios were significantly lower in FP hospitals; however, the mortality ratio and length of stay differences were no longer statistically significant when population and market characteristics were controlled. Finally, we found that from 1990 to 1995, FP and

NFP RN staffing distributions became somewhat more similar, while the FP and NFP LOS ratios became much more similar. However, we did not observe distinct changes in the difference between FP and NFP mortality ratio densities.

Discussion

We hypothesized that FP hospitals would have lower levels of nurse staffing than NFPs. Our results suggest that case mix-adjusted

Figure 5. Difference in kernel density estimates of mortality and LOS ratios for for-profit and not-for-profit hospitals in 1990 and 1995

RN staffing levels are lower in FPs than in NFPs. We also found a superior distribution of outcomes (mortality and length of stay) obtained with a lower level of RN staffing—but we also showed that controlling for population characteristics largely eliminates these differences. Interestingly, as Table 2 indicates, FPs’ case-mix index was higher than NFPs. Perhaps this demonstrates their greater success in coding optimization and/or an income-seeking marketing strategy target-

ing patients with selected diagnostic entities such as heart surgery that, while complex, also maximize reimbursement behaviors that have been called “cream skimming” (Sloan et al. 2001).

Given the presence of a “residual claimant” at FP hospitals, one might expect that managerial structures and characteristics, safety climate, and investment in information systems to support the provision of clinical care might lead to more efficient deployment

and utilization of nurses in FP hospitals, contributing to a better distribution of outcomes produced with fewer nurses. Future studies that include primary data on these organizational variables, the qualifications (education, experience) of the nursing staff, and other key variables (such as work complexity, patient census volatility, and nursing staff turnover) might provide additional insight about how the production technology of caring for patients differs by ownership type.

The reduction of differences that we found from 1990 to 1995 in the density distributions of staffing and the LOS ratio may reflect the dramatic changes in the operating environment for acute care hospitals—both FP and NFP—due to the increasing dominance of managed care in the early to mid-1990s. NFPs may have responded to increased competitive pressures by behaving more like their FP counterparts, implementing strategic initiatives aimed at improving the efficiency of their internal operations. Such initiatives have included reductions in volume and mix of services, in bed capacity, and in length of stay, and changes in the intensity of services provided. Staffing also was affected by implementing re-engineering and re-design strategies that frequently involved reductions in nursing staff (ANA 1995). Thus, our findings provide some support for Pauly and Redisch's (1973) argument that NFPs indeed may be "for-profits in disguise," at least in the challenging times that existed during the period of our study.

We began by asking whether FPs and NFPs differed in their RN staffing, mortality, and length of stay. We found that case mix-adjusted RN staffing was significantly lower in FPs than in NFPs, and that, after controlling for population and market characteristics, there were no statistically significant differences in mortality or length of stay based on ownership type. We also found, however, that FPs and NFPs became more similar over time in terms of the distribution of RN staffing and the distribution of the LOS ratio. One limitation of our study is that the data and model are not sufficiently rich to determine whether different production functions exist across ownership types for trans-

forming inputs (i.e., staffing) into quality outputs (mortality, length of stay). Future research examining these transformation processes—specifically how the nursing care process differs at FPs from NFPs—may reveal important dissimilarities in fundamental organizational processes, such as decision making and collaborative inter-professional relationships that may favor the production of quality at lower staffing levels. In addition, quality of care encompasses a larger set of outcomes than we were able to observe. Future research should consider other outcomes measures such as the development of in-hospital complications and the occurrence of selected adverse events. More positive outcomes, such as patients' readiness for discharge and understanding of their illness and coordination of care across settings, while rarely studied, are also important.

While our study examined differences in staffing and quality of care in FP and NFP hospitals using data from 1990 and 1995, the issues continue to be relevant today. In the early to mid-1990s, hospitals faced a major upheaval in the health care market due to the rapid expansion of managed care penetration. Today, although the pace of managed care penetration has slowed, hospitals now are faced with a new upheaval: the "quality revolution." The CMS Hospital Quality Initiative is using multiple strategies to impel hospitals to provide superior quality of care (CMS 2006). These strategies include: regulation and enforcement activities to assure that Medicare hospitals comply with federal standards for patient health and safety; providing readily available and easily interpretable information for patients on the CMS Hospital Compare Web site; and rewarding superior performance through pay-for-performance, in which hospitals in the top 20% of quality performance earn a financial bonus.

Quality of hospital care increasingly is being recognized as dependent upon the adequacy of nurse staffing, a factor reflected in the bellwether enactment in 2004 of minimum nurse staffing legislation in California, and the introduction of nurse staffing legislation in more than 18 other states. Thus, hospitals' nurse staffing contributes directly

to their ability to compete successfully in the new quality race. Given these external pressures on both FP and NFP hospitals, we are likely to observe further convergence in nurse staffing and quality in FP and NFP hospitals, a question to be addressed empirically in the future. Comparative research in FP and NFP hospitals focusing on the impact of ownership on clinical micro-systems, staffing decisions,

and the organization and delivery of nursing care would enhance understanding of the mechanisms underlying the nurse staffing-quality relationship. Knowledge from this research can contribute to the development of health care policy and organizational strategies that will constructively support the deployment of an increasingly scarce registered nurse workforce.

Notes

- 1 See particularly Hartz et al. 1989; Al-Haider and Wan 1991; Keeler et al. 1992; Shortell and Hughes 1988; Sloan et al. 2001. One systematic review of the literature focused specifically on studies of hospital mortality published through 2001. Based on 14 studies, the meta-analysis found that private FPs were associated with an increased risk of in-hospital mortality (Devereaux et al. 2002)
- 2 Given the omnibus nature of these tests, results concerning the power of the tests vary with the nature of the distributions compared. An example is the Monte Carlo simulations by Epps and Singleton (1986). Given a Type I error fixed at .05 and sample sizes of 50 drawn from two distributions, power varies from: a) 100% for both the Epps-Singleton and Kolmogorov-Smirnov tests of two uniform distributions, with the same expected value, but one with variance = 2 and the other with variance = 4; b) 53% for the Epps-Singleton test and 6% for the Kolmogorov-Smirnov test comparing a uniform distribution with expected value = 0, and variance = 4 with the standard Cauchy distribution; and c) 4% for the Epps-Singleton test and 3% for the Kolmogorov-Smirnov test comparing two normal distributions with variance = 2.2, but with one having expected value = 0 and the other having expected value = 1.
- 3 We also excluded patients who were admitted from another hospital or another health facility including a long-term care facility.
- 4 Given that standard error for the standardized mortality ratio equals (observed deaths)⁵/expected deaths (Breslow and Day 1987), in estimating the model with the mortality ratio as the dependent variable, we weighted the data by the inverse of this standard error. Given that the LOS ratio was obtained as the ratio of geometric means from hospitals with quite different numbers of patients, we weighted by the square root of the number of patients at the hospital.
- 5 To make the difference in density estimates easier to read, we smoothed them slightly using a simple moving average.

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