Articles

Hospital Registered Nurse Shortages: Environmental, Patient, and Institutional Predictors

Jean Ann Seago, Michael Ash, Joanne Spetz, Janet Coffman, and Kevin Grumbach

Objective. To examine the characteristics of acute-care hospitals that report registered nurse shortages when a widespread shortage exists and when a widespread shortage is no longer evident.

Data Source. Secondary data from the American Hospital Association's Nursing Personnel Survey from 1990 and 1992 were used. The study population was all acute-care hospitals in the United States.

Study Design. Outcome variables included whether a hospital experienced a shortage in 1990, when many hospitals reported a nursing shortage, or whether a hospital reported a shortage in both 1990 and 1992. Predictor variables included environmental, patient, and institutional characteristics. Associations between predictor and outcome variables were investigated using probit analyses.

Principal Findings. Location in the South, a high percentage of nonwhite county residents, a high percentage of patients with Medicaid or Medicare as payer, a higher patient acuity, and use of team or functional nursing care delivery consistently predicted hospitals reporting shortages both when there was a widespread shortage and when there was no widespread shortage.

Conclusions. Although some characteristics under the direct control of hospitals, such as nursing care delivery model, are associated with their reporting a shortage of nurses, shortage is also strongly associated with broader population characteristics such as minority communities and a public insurance payer mix. Awareness of these broader factors may help inform policies to improve the distribution of nurse supply.

Key Words. Environmental characteristics, hospital characteristics, patient characteristics, registered nurse, shortage

Periods of shortage and excess in the supply of registered nurses (RNs) have frequently occurred in the United States (Friss 1994) and are of concern to many groups, including health care consumers, payers, employers, and policymakers. Shortages raise concern for the quality of patient care; some

studies have linked the number of hours of nursing care to patient outcomes (Aiken, Smith, and Lake 1994; Kovner and Gergen 1998; Minnick et al. 1989; Sochalski, Aiken, and Fagin 1997).

A number of theories have been proposed to explain the phenomenon of nursing shortages and excesses. Economists argue that shortages are related to a lack of or lagged increase in real wages (Friss 1994), an imperfectly competitive market such as in monopsony or oligopsony (Yett 1975), or a problem with geographic distribution and specialty (Yett 1970; Friss 1994). Some economists have proposed that shortages are in part related to the delay between the point when potential workers observe an increase in wages and the time it takes them to receive the training necessary to enter the labor market (Yett 1975).

Nursing leaders speculate that the image of nursing leads to nursing shortages (Friss 1994); that shortages are a function of job satisfaction or dissatisfaction (Johnston 1997; Prescott 1989; Relf 1995), downsizing, or restructuring (Shogren, Calkins, and Wilburn 1996); or that the shortage is characterized by too few nurses in certain specialty areas (Dracup and Bryan-Brown 1998; Robertson, Herth, and Cummings 1994; Rohrlach 1997; Shoemake 1994). Several authors (Havens and Aiken 1999; Kramer 1990; Scott, Sochalski, and Aiken 1999) have studied hospitals designated by the American Nurses Association as "magnet" hospitals, that is, hospitals that were identified as having an environment that attracted and retained well-qualified nurses (Scott, Sochalski, and Aiken 1999). Although only 41 hospitals were designated as magnet hospitals, these hospitals experienced lower turnover and vacancy rates during the later part of the 1980s and the early 1990s.

Much of the literature related to solving the shortage problem advocates increasing the supply of RNs (Bernreuter and Goddard 1994; Casey 1996;

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Davis 1994; Greene and Nordhaus-Bike 1998; Roberts et al. 1989). But factors such as skill variety, autonomy, task significance, and positive feedback have been found to reduce turnover and improve nurse job satisfaction (Curran 1991).

Although the literature described above might explain the overall varying nature of nursing shortages and suggest solutions for these shortages, it does not explain why particular hospitals report shortages when others do not. This literature does not articulate which characteristics predispose a hospital to experience a nursing shortage either in periods of general shortage or when most hospitals do not report a nursing shortage.

Studies of other health care workers such as physicians have found that geographic area, regional demographics, earnings, and working conditions affect recruitment and retention. Rural areas generally have lower supplies of physicians than urban areas (Council on Graduate Medical Education 1998). Communities with both high rates of poverty and high percentages of racial/ethnic minorities in their populations are most likely to experience shortages of physicians (Ginzberg 1994; Komaromy, Grumbach, Drake, et al. 1996). Studies of physician retention in rural shortage areas indicate that earnings and working conditions also influence physicians' choice of practice location (Kindig 1990; Pathman, Konrad, and Ricketts 1994).

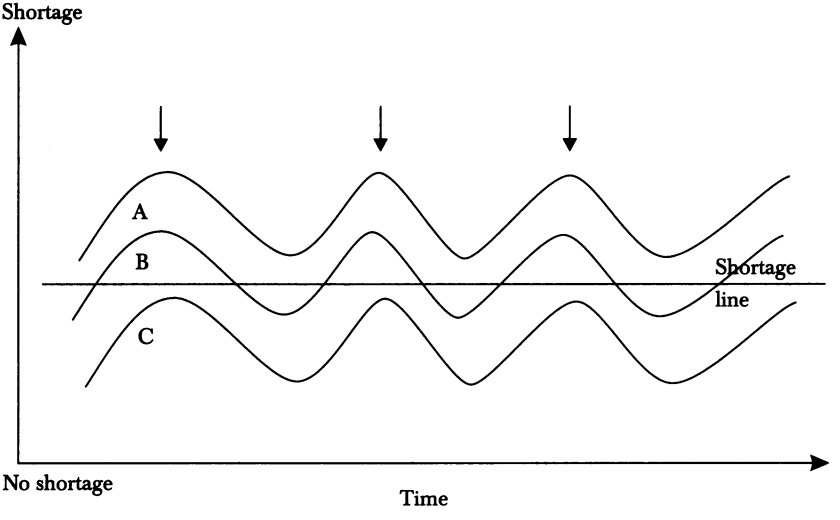
These factors may not have the same effect on nursing employment because the nursing workforce is unusual in several ways. First, 95 percent of RNs are female. Because most RNs are married and have children, they tend to commute but not move for a job. RNs also are likely to work near where they were trained. Because the nursing workforce is less mobile than many other labor groups, regional geographic markets are an important factor in the workforce (Aiken 1989). In addition, female RNs tend to modify their work schedule to meet their family's financial and personal needs. For example, during economic downturns the supply of RNs increases because nurses enter the labor market to replace their spouse's lost earnings (O'Neil and Coffman 1998).

In this article, we examine the characteristics of hospitals that report shortages when a widespread shortage exists (as in 1990, with a U. S. nurse vacancy rate of 11 percent) (Buerhaus 1994) and when a widespread shortage is no longer evident (as in 1992, with a vacancy rate of 8.7 percent) (Buerhaus 1994; Friss 1994). Vacancy rates correlate with hospital administrators' declarations of shortage (Grumbach, Ash, Seago, et al. 2001). We examine data from 1990, when 47 percent of hospitals in a national survey reported a moderate or severe shortage of RNs with a mean vacancy rate of 9.4 percent, and from 1992, when only 19 percent reported a moderate or severe shortage

of RNs with a mean vacancy rate of 7.2 percent (Grumbach, Ash, Seago, et al. 2001).

Figure 1 illustrates our conceptual model, which includes three types of hospitals. At different times, there is a greater or lesser degree of marketwide shortage. The year 1990, with almost half of all hospitals reporting a nursing shortage, would represent such a peak period of marketwide shortage; most hospitals had fallen out of shortage status by 1992. Despite these marketwide trends, some hospitals never experience RN shortage and some report shortages only during times of widespread shortage. Other hospitals tend to always report a shortage. Our study examines the characteristics of shortage hospitals during a peak phase (1990) and identifies the characteristics of hospitals in persistent shortages. Based on our previous work (Grumbach, Ash, Seago, et al. 2001) and that of nursing researchers (Aiken and Mullinix 1987; Aiken, Smith, and Lake 1994; Curran 1991; Sochalski, Aiken, and Fagin 1997) and economics researchers (Friss 1994; Yett 1975), we hypothesized that environmental, patient, and institutional characteristics predict hospitals with a nursing shortage.

Figure 1: Conceptual Model



Note: Arrows indicate periods of marketwide RN shortage. Line A represents those hospitals that are always in shortage; line B represents those hospitals that move in and out of shortage; and line C represents those hospitals that are never in shortage. The shortage line is the average point at which hospitals declare shortage.

METHODS

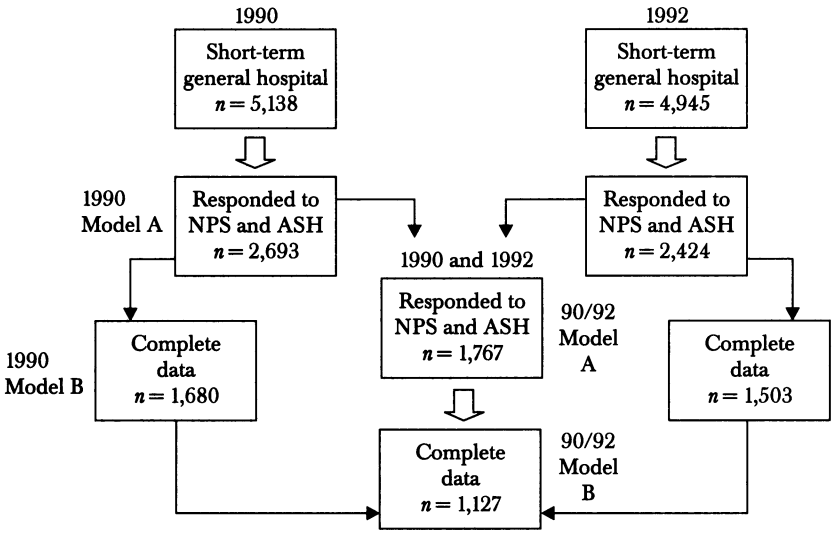
Data on nursing shortages were obtained from the American Hospital Association's (AHA) Nursing Personnel Survey (NPS) and Annual Survey of Hospitals (ASH) conducted in 1990 and 1992. The NPS provides detailed information about the characteristics of nurses and the hospitals in which they work. It provides the most recent available database with respect to hospital RNs; we were unable to find any other comparable source of data. In the NPS, hospitals report whether they are experiencing a nursing shortage and whether that shortage is mild, moderate, or severe. Hospitals also report employment levels and the number of vacancies they have. A recent analysis found that a hospital's self-report of nursing shortage in the NPS is correlated with reported vacancies and the number of RNs employed per inpatient year (Grumbach, Ash, Seago, et al. 2001). This suggests that a hospital's report of shortage is associated with more objective measures of staffing.

In 1990 and 1992 both the NPS and the ASH surveyed all hospitals that were members of the AHA. However, not all hospitals responded to the surveys. The AHA identified 5,138 nonfederal short-term general hospitals as active in 1990 and 4,945 in 1992. There was a notable decline in the number of hospitals responding to the NPS between 1990 and 1992. In 1990, 2,693 hospitals (48.2 percent) responded to both the ASH and NPS, and 2,424 hospitals (35.7 percent) responded in 1992 (Figure 2). In addition, some respondent hospitals did not answer every question in the NPS.

We define the shortage hospitals as those reporting a moderate or severe shortage of RNs. We define two outcome variables: (1) whether a hospital experienced a shortage in 1990, when many hospitals reported a nursing shortage; and (2) whether a hospital reported a shortage in both 1990 and 1992. We hypothesized that environmental, patient, and institutional characteristics predict the hospitals experiencing a shortage in a year when shortages were prevalent (1990) and when many hospitals shifted from a shortage to a nonshortage status (1990–92). We did not create a separate economic factor category, but economic variables are included in the variables. Information about environment, patient, and institutional characteristics was obtained from the AHA/ASH (1990 and 1992), the 1996 Area Resource File (ARF) produced by the Bureau of the Health Professions, and other sources. Variable definitions and data sources are summarized in Table 1.

The specific variables that were chosen in the environmental, patient, and institutional characteristics were identified through a review of previously cited literature regarding shortages of nurses and other health care workers.

Figure 2: Response Rate to 1990 and 1992 NPS and ASH



Note: Models A and B refer to the data groups included in the different probit models used for data analysis.

The environmental variables included in our model are geographic region; large, medium, or small metropolitan areas; county unemployment rate (as a proxy for spouse employment); county poverty rate; percent population minority; percent population elderly; and density of population. The patient variables include percentages of Medicare and Medicaid discharges from the hospital as well as hospital case mix [derived from the Health Care Financing Administration's (HCFA) data on Medicare discharges]. Institutional variables include ownership status, number of beds, nursing wage, nursing care delivery system (NCDS), technology sophistication, nursing autonomy (career ladders, unit self-management, collaborative committees, itemized nursing care), computerized patient records, collective bargaining, percentage of nurses with a Bachelor of Science in Nursing (BSN), and whether the hospital has an RN school. The nursing wage variable was defined as RN wage in a hospital relative to RN wages in other hospitals in the same health service area (HSA)[1] (Grumbach, Ash, Seago, et al. 2001).

Several institutional characteristics that we examined are not available in any database other than the NPS. A few studies in the literature suggest that various institutional characteristics are important for recruiting RNs (Aiken,

Table 1: Variables, Definitions, and Sources

Variable	*Definition*	*Source*
Dependent Variables		
1990 shortage	Hospitals self-report moderate or severe shortage in 1990	NPS
Persistent shortage	Hospitals self-report moderate or severe shortage in 1990 and 1992	NPS
Independent Variables		
Environmental		
U.S. geographic region	Northeast (referent), Midwest, South, West	ARF
County population	<250,000; 250,000–1,000,000 (referent); >1,000,000	ARF
County unemployment rate	Percentage of unemployed in county	ARF
County poverty rate	Percentage of population below poverty level	ARF
County percent nonwhite	Percentage nonwhite in county	ARF
County percent 65 years and over	Percentage 65 and over in county	ARF
County population density	No. of people/square mile	ARF
Patient		
Percent Medicaid	Percentage of hospital discharges with Medicaid as payer in 1990	ASH
Percent Medicare	Percentage of hospital discharges with Medicare as payer in 1990	ASH
Patient acuity	HCFA-reported Medicare case-mix adjustment in 1990	HCFA
Institutional		
Hospital ownership status	For profit, nonprofit (referent), state/local government	ASH
No. of hospital-staffed beds	Average number of beds that the hospital staffs	ASH
Hospital RN wage	RN wage relative to RN wages in other hospitals in the same HSA	ASH
NCDS	Primary/total: patient care given by an RN Team/functional: patient care supervised by RNs and given by non-RNs (referent) Modular/case management: patient care based on location in the hospital or location in a discrete patient disease population	NPS
Technical sophistication of the hospital	Saidin Service Mix Index (Spetz and Baker 1999): scoring whereby the more rare service gets a higher score	ASH
Nursing policy variables	Career ladder: system to promote RNs for increasing skills Unit self-management: RNs have voice in unit management	NPS

Continued

Table 1: *Continued*

Variable	*Definition*	*Source*
Nursing policy variables	RN/MD committees: collaborative decision making between MDs and RNs Itemized RN care: specific care hours billed to patients Computerized charting: electronic documentation	NPS
Collective bargaining	Whether the hospital has an RN union	NPS
Percent BSN RNs	No. of RNs with BSN as a percent of total RNs	NPS
Diploma RN school at hospital	Yes/no	NPS

Smith, and Lake 1994; Buerhaus 1993; Shortell, Zimmerman, Rousseau, et al. 1994; Sochalski, Aiken, and Fagin 1997). For example, some hospitals have recently shifted from the primary care or total patient care model of care delivery, in which the nursing staff is almost entirely comprised of RNs, to the team or functional model, in which RNs supervise and coordinate teams of licensed vocational nurses and unlicensed assistive personnel. RNs may prefer one of these care delivery systems to another, and thus choice of NCDS may affect a hospital's likelihood of experiencing a shortage. Similarly, providing career ladders, organizing collaborative committees, and offering unit self-management may attract nurses and deter shortage.

We used *t*-tests and chi-square analyses to compare the environmental, patient, and institutional characteristics of shortage and nonshortage hospitals. We also estimated probit regressions to predict whether a hospital reported a shortage in 1990 and 1992. The analyses for the 1990 shortage status are cross-sectional, comparing hospitals reporting a shortage in that year with those that did not report a shortage (Grumbach, Ash, Seago, et al. 2001). The persistent shortage analyses examine a longitudinal sample of hospitals that reported data in both 1990 and 1992 surveys and compare hospitals reporting a shortage in both years with hospitals that reported a shortage in neither year or only one of the years. We used 1990 values for independent variables in the persistent sample analyses because there was minimal change in values (e.g., percent Medicare discharges over time) between 1990 and 1992.

Some variables in the model may be endogenous; that is, the outcome variable measuring shortage may influence the independent or explanatory variables. In particular, a hospital experiencing a shortage may alter its care delivery system, RN wage, nursing staff autonomy, or skill mix. Although it would be ideal to use instrumental variables to identify the causal relationships

between these institutional characteristics and nursing shortages, we were not able to identify suitable instruments. We did, however, look at trends in changing NCDSs that illuminate this issue.

In addition to the problem of endogeneity, another limitation to using the institutional variables was the reduction in the sample size when the institutional characteristics were included (Figure 2). Many hospitals participating in the NPS had incomplete data for the institutional variables. Thus, we estimated two equations for each model: one that excludes the institutional variables (model A), and one that includes them (model B).

RESULTS

The proportion of hospitals declaring different shortage levels for 1990 and 1992 is reported in Table 2. Of hospitals that declared moderate to severe shortage in 1990, 27.3 percent still reported moderate to severe shortage in 1992 (Table 3). Of the hospitals that had no shortage in 1990, only 10.2 percent had a moderate to severe shortage in 1992. On unadjusted analysis, many of the environmental, patient, and organizational characteristics differed significantly between shortage and nonshortage hospitals (Table 4).

We also examined a longitudinal panel of hospitals reporting data in both 1990 and 1992 to determine whether hospitals that had persistent shortages over this period might be distinguished by different characteristics from hospitals with shortages of nurses only in 1992 or those without a shortage in either year. Most of the characteristics that predicted shortage hospitals in the 1990 cross-sectional analysis (Table 4) also predicted hospitals

Table 2: Shortage Type by Year*

Shortage type	*1990 (n = 2,800)*	*1992 (n = 2,526)*
No shortage	28.6 (800)	25.7 (648)
Mild shortage	24.0 (671)	54.4 (1,373)
Moderate shortage	36.4 (1,019)	17.1 (433)
Severe shortage	11.07 (310)	2.9 (72)

*Percentage (frequency shown in parentheses).

Table 3: Classification of Hospitals, 1990 Versus 1992

	Moderate/Severe 1992		
Moderate/Severe 1990	*0 (No)*	*1 (Yes)*	*Total*
0 (No)	864	98	962
	89.8%	10.2%	100%
	58.5%	29.9%	53.3%
1 (Yes)	613	230	843
	72.7%	27.3%	100%
	41.5%	70.1%	46.7%
Total	1,477	328	1,805
	81.8%	18.2%	100%
	100%	100%	100%

Note: Row 1 is the frequency; row 2 is the row percentage; row 3 is the column percentage.

with a persistent shortage of nurses in the longitudinal 1990–92 analysis (Table 5).

We repeated the analyses of the cross-sectional 1990 data and the longitudinal 1990–92 data using probit analyses to measure the independent effects of these predictor variables. The probability derivatives from these adjusted analyses indicate the percentage point change (in absolute terms) in the probability of a hospital being in shortage status for a unit change in the explanatory variable (Table 6). Because some of our variables were not independent (i.e., hospitals within counties), we adjusted the standard errors using the Huber and White robust estimator of variance (Stata 1997). Many of the characteristics that were significant predictors of shortage hospitals in the unadjusted analyses remained significant predictors in the probit models.

In both of the 1990 shortage models, hospitals located in the Midwest and South were at least 10 percentage points more likely than those in the Northeast to report a shortage ($p < .01$), and hospitals located in counties with a higher percentage of nonwhite residents had a higher probability of shortage ($p < .01$). We also interacted the South and nonwhite resident variables and found that the relationship between race and shortage was stronger outside the South for 1990. The only patient characteristic that significantly predicted a self-report of shortage was hospitals with a higher acuity index ($p < .01$). None of the institutional variables had a significant effect on the likelihood of reporting shortage in model A.

Several additional institutional characteristics were added to the equation in model B. Hospitals that had a primary/total NCDS were 7 to 10 percentage points less likely to report a shortage than hospitals that used

Table 4: Characteristics of Shortage and Nonshortage Hospitals in 1990

	All Hospitals	*Nonshortage Hospitals*	*Shortage Hospitals*
Environment			
Region ($n = 2,693$)*, %			
Northeast	18	20	15
Midwest	33	35	30
South	34	29	41
West	15	16	15
Population of metropolitan area ($n = 2,693$)*, %			
1,000,000 or more	24	20	29
250,000–1,000,000	55	61	49
Less than 250,000	20	18	23
County poverty rate in 1990 ($n = 2,693$)*	14.3 (6.5)	13.7 (6.1)	15.0 (6.8)
County % nonwhite ($n = 2,693$)*	15.6 (15.2)	12.1 (12.9)	19.6 (16.6)
County % 65 years and over ($n = 2,693$)*	13.9 (4.1)	14.3 (4.1)	13.5 (4.1)
County population density ($n = 2,693$)*	12.0 (45.7)	8.5 (37.2)	15.8 (53.3)
Patient			
Medicaid % of discharges ($n = 2,693$)*	12.8 (9.6)	12.1 (8.5)	13.6 (10.7)
Medicare % of discharges ($n = 2,693$)*	39.7 (11.8)	40.6 (11.4)	38.8 (12.1)
Log patient acuity ($n = 2,693$)*	.184 (.155)	.165 (.153)	.206 (.154)
Institutional			
Ownership ($n = 2,693$), %			
State/local	27	27	27
Not-for-profit	65	66	63
For profit	8	7	10
No. of beds ($n = 2,693$)*, %			
Under 100	38	43	33
100–300	39	38	40
300 or more	23	19	27
Hospital wage premium ($n = 1,680$)	−.005 (.093)	−.008 (.093)	−.002 (.093)
NCDS ($n = 1,680$)*, %			
Team/functional	46	43	50
Primary/total patient care	32	34	29
Other	22	23	21
Log technical index 90 ($n = 1,680$)*	1.03 (1.0)	.919 (1.01)	1.16 (.94)
Career ladder 90 ($n = 1,680$)	24%	23%	26%
Unit self-management ($n = 1,680$)	21%	23%	20%
Collaborative committees ($n = 1,680$)	30%	31%	29%
Nursing care itemized ($n = 1,680$)	3.4%	3.9%	2.9%
Computerized patient documentation ($n = 1,680$)	9.6%	8.3%	10.9%
Collective bargaining ($n = 1,680$)	13.5%	13.9%	13.8%
% BSN ($n = 1,680$)*	22.8 (17.6)	21.6 (17.3)	24.0 (17.8)
RN school ($n = 1,680$)	3.8%	3.7%	4.0%

*$p < .01$ for differences between nonshortage and shortage hospitals.

Note: Numbers in parentheses are standard deviations.

Table 5: Characteristics of Hospitals With and Without Persistent Shortage in 1990–92

	All Hospitals	*Nonshortage Hospitals*	*Shortage Hospitals*
Environment			
Region ($n = 1{,}767$)*, %			
Northeast	21	22	12
Midwest	36	38	21
South	31	28	55
West	12	12	12
Population of metropolitan area ($n = 1{,}767$), %			
1,000,000 or more	26	26	27
250,000–1,000,000	21	20	26
Less than 250,000	53	54	47
County poverty rate in 1990 ($n = 1{,}767$)*	13.6 (6.1)	13.2 (5.8)	16.4 (7.2)
County % nonwhite ($n = 1{,}767$)*, mean	15.1 (14.9)	13.8 (14.1)	23.4 (17.3)
County % 65 years and over ($n = 1{,}767$)	13.9 (3.9)	14.0 (3.9)	13.6 (4.2)
County population density ($n = 1{,}767$)	12.7 (45.3)	12.1 (42.3)	17.1 (61.7)
Patient			
Medicaid % of discharges ($n = 1{,}767$)*	12.7 (9.4)	12.4 (9.1)	14.6 (11.0)
Medicare % of discharges ($n = 1{,}767$)	36.2 (11.4)	39.1 (11.2)	40.0 (13.0)
Log patient acuity ($n = 1{,}767$)*	.195 (.15)	.191 (.15)	.221 (.15)
Institutional			
Ownership ($n = 1{,}767$), %			
State/local	26	26	29
Not-for-profit	68	69	64
For profit	5	5	7
No. of beds ($n = 1{,}767$)*, %			
Under 100	33	34	27
100–300	40	40	40
300 or more	47	25	34
Hospital wage premium ($n = 1{,}127$)	−.005 (.09)	−.004 (.09)	−.004 (.10)
NCDS ($n = 1{,}127$)*, %			
Team/functional	45	42	60
Primary/total patient care	32	34	20
Other	23	24	20
Log technical index ($n = 1{,}127$)	1.12 (.97)	1.10 (.97)	1.25 (.98)
Career ladder ($n = 1{,}127$)	25%	25.3%	26%
Unit self-management ($n = 1{,}127$)	22%	22%	21%
Collaborative committees ($n = 1{,}127$)	31%	31%	29%
Nursing care itemized ($n = 1{,}127$)	3.3%	3.6%	1.3%
Computerized patient documentation ($n = 1{,}127$)	10.8%	10.8%	10.7%
Collective bargaining ($n = 1{,}127$)	15.3%	15.8%	12.7%
Percent BSN ($n = 1{,}127$)	22.8 (17.4)	22.5 (16.9)	25.2 (20.1)
RN school ($n = 1{,}127$)	5.0%	4.5%	8.0%

*$p < .05$ for comparisons between nonshortage and shortage hospitals.

Note: Numbers in parentheses are standard deviations.

Table 6: Probit Analysis of Shortage Correlates*

	1990 Shortage		*Persistent Shortage 1990 and 1992*	
	Model A	*Model B*	*Model A*	*Model B*
No. of respondents	2,693	1,680	1,767	1,127
Environment				
Region (compared to Northeast)				
Midwest	.099	.163	.023	.052
	(.002)	(< .001)	(.360)	(.140)
South	.201	.229	.119	.162
	(< .001)	(< .001)	(.001)	(.001)
West	−.002	.054	.060	.110
	(.975)	(.316)	(.106)	(.037)
Population of metropolitan area (compared to 250,000–1,000,000)				
Less than 250,000	−.048	−.017	−.042	−.017
	(.111)	(.662)	(.066)	(.55)
1,000,000 or more	−.028	−.029	−.036	−.051
	(.382)	(.497)	(.092)	(.055)
County unemployment rate in 1990	−.000	−.001	−.000	−.000
	(.522)	(.232)	(.842)	(.961)
County poverty rate in 1990	.000	.002	.002	.001
	(.768)	(.497)	(.175)	(.615)
County % nonwhite	.009	.009	.002	.004
	(< .001)	(< .001)	(.012)	(.005)
South × county % nonwhite	−.005	−.004	.000	−.001
	(.002)	(.062)	(.806)	(.618)
County % 65 years and over	−.003	−.005	.001	.003
	(.344)	(.200)	(.763)	(.220)
County population density	−.000	−.000	.000	.000
	(.582)	(.840)	(.742)	(.520)
Patient				
Medicaid % of discharges 1990	.002	.002	.002	.002
	(.074)	(.353)	(.009)	(.092)
Medicare % of discharges 1990	.001	.001	.003	.003
	(.279)	(.475)	(< .001)	(.003)
Log patient acuity 1990	.299	.337	.100	.163
	(.001)	(.015)	(.161)	(.110)
Institutional				
Ownership (compared to nonprofit)				
State/local	.011	−.025	−.006	−.028
	(.434)	(.452)	(.752)	(.228)
For profit	.005	−.030	−.018	−.034
	(.935)	(.551)	(.551)	(.310)
No. of beds (compared to 100–300)				
Under 100	.000	−.020	−.014	−.029
	(.977)	(.594)	(.522)	(.296)

Continued

Table 6: *Continued*

	1990 Shortage		*Persistent Shortage 1990 and 1992*	
	Model A	*Model B*	*Model A*	*Model B*
No. of beds (compared to 100–300)				
300 or more	−.017	−.042	.015	−.002
	(.577)	(.312)	(.483)	(.934)
Hospital wage premium	—	−.246	—	−.122
		(.099)		(.251)
NCDS (compared to team/functional)				
Primary/total patient care	—	−.106	—	−.065
		(.001)		(.002)
Other	—	−.075	—	−.037
		(.028)		(.095)
Log technical index	—	.038	—	.004
		(.095)		(.789)
Career ladder	—	.005	—	−.004
		(.879)		(.851)
Unit self-management	—	−.061	—	.000
		(.054)		(.987)
Collaborative committees	—	−.057	—	−.016
		(.057)		(.455)
Nursing care itemized	—	−.040	—	−.049
		(.574)		(.347)
Computerized patient documentation	—	.049	—	−.018
		(.282)		(.528)
Collective bargaining	—	.060	—	.030
		(.134)		(.354)
% BSN	—	−.000	—	.000
		(.844)		(.400)
RN school	—	.009	—	.086
		(.903)		(.090)
Pseudo R^2	.06	.08	.10	.14

*Figures shown are probability derivatives (p-values are in parentheses).

Note: Model B includes smaller sample sizes than model A because of nonresponse to institutional variables included in model B.

team/functional NCDSs. The presence of unit self-management was associated with a 6 percentage point lower likelihood of shortage in 1990, and the presence of RN-physician collaborative committees was associated with a 5.6 percentage point lower likelihood of shortage in 1990. However, we cannot reject the null hypothesis of no association in either of the latter cases at the .05 level. It is also important to note that wage in 1990 was not a significant predictor of nursing shortage.

Only one variable was a significant predictor of shortage in model A but not in model B. In model A for every 10 percent increase in Medicaid discharges, there was a 3 percentage point increase in the probability of shortage ($p < .05$); in model B, however, the percentage of hospital discharges with Medicaid as payer was not significant. To test whether this change in the probability derivative for the Medicaid variable between models A and B was primarily because of confounding from the added institutional variables or from the different composition of the study sample in the two models, we repeated the probit analysis using the smaller sample in model B but excluding the additional institutional variables used in model B. The Medicaid variable was not significant in this analysis, suggesting that the difference in the probability derivative for this variable in models A and B was primarily because of the different set of hospitals included in model B.

The third and fourth columns of Table 6 present the probability derivatives predicting the likelihood of a hospital reporting a shortage in both 1990 and 1992, as opposed to reporting a shortage in neither of the years or in only one year. Again, there was a high degree of consistency between models A and B. Environmental variables associated with a hospital persistently reporting a nursing shortage were location in the South ($p < .001$) and a higher percentage of nonwhite residents in the county ($p < .001$). As found in the cross-sectional 1990 analysis, the percentage of hospital discharges with Medicaid as payer increased the likelihood of persistent shortage in model A ($p = .01$) but not in model B ($p = .07$). In Model A for each 10 percent increase in Medicaid discharges there was a 2 percentage point absolute increase in the probability of observing a shortage in both 1990 and 1992. The percentage of hospital discharges reimbursed by Medicare increased the likelihood of persistent shortage by about 1 percentage point for each 10 percentage point increase in Medicare share ($p < .001$; $p = .003$). None of the institutional variables was significant in model A.

In model B, the presence of a primary/total NCDS reduced the likelihood of a hospital experiencing persistent shortage by about 6 percentage points. Because of the issue of endogeneity we further examined the data related to NCDS for hospitals reporting in both 1990 and 1992. There was an overall trend away from functional/team NCDS and toward primary/total NCDS between 1990 and 1992. For hospitals that used a functional/team NCDS in 1990, 2 percent of the no-shortage group ended the functional/team NCDS by 1992, but 8 percent of the severe-shortage group ended that NCDS by 1992. For hospitals that did not use a primary/total NCDS in 1990, 15 percent of the no-shortage group adopted a primary/total NCDS by 1992,

but 8 percent of the severe-shortage group adopted a primary/total NCDS by 1992.

DISCUSSION

Regardless of whether we included the potentially endogenous variables or had a large or small sample size, the findings from the regression models were generally consistent. The most significant finding is that geographic area of the United States, demographics of the county population, and type of NCDS consistently predict hospitals with shortages both when there is a widespread shortage and when there is no widespread shortage. However, there are some differences between the hospitals that are more likely to experience persistent shortages and those that face shortages only when shortages are widespread.

Geographic region is an important predictor of the likelihood of a hospital experiencing a shortage of RNs. Hospitals located in southern states were more likely than hospitals in any other region of the United States to report shortages when shortage is common and also to report persistent shortages. Midwestern hospitals also were more likely to report shortages when shortage is common, but they were not more likely to experience persistent shortages. This contrasts with Yett's (1970) findings for nonfederal hospitals in the 1950s and 1960s. Yett (1970) found lower vacancy rates in the mountain and Pacific regions; however, he found that the Southeast reported low vacancy rates and the Northeast reported high vacancy rates, which is opposite to what our data show. This does make a strong case for including geographic region as an important factor when determining policy related to nursing workforce.

Being located in a county with a higher percentage of nonwhite residents increased the likelihood of a hospital experiencing both persistent and transient shortages. These findings parallel the predictors of shortage of other health care workers such as physicians. For example, Komaromy, Grumbach, Drake, et al. (1996) found that communities in California with large proportions of African American and Hispanic residents were most likely to have shortages of primary care physicians.

Insurance coverage of patients also may affect a hospital's likelihood of reporting nursing shortages. Increases in the share of patients insured by Medicaid increased the likelihood of a hospital reporting an RN shortage. In addition, hospitals with a large share of patients insured by Medicare were more likely to have persistent RN shortages. Variation in the insurance coverage of patients might reflect differences in the financial stability of hospitals or

special challenges in caring for patients with Medicare or Medicaid and thus affect the ability of a hospital to recruit RNs. Hospitals with more severely ill patients were more likely to report transient shortages but were not more likely to experience persistent shortages.

A few institutional characteristics appear to be closely associated with a hospital's likelihood of reporting both transient and persistent shortages. In particular, hospitals that use primary/total NCDSs were less likely to report shortage; conversely, hospitals that use team/functional NCDSs were more likely to report shortage. The causality of this relationship is not clear. It is possible that hospitals that use a team/functional NCDS are more likely to experience shortage because RNs prefer to not work in hospitals with this type of NCDS. On the other hand, hospitals might adopt a team/functional nursing structure in response to shortage because this staffing system relies less heavily on RNs than primary/total care. Evidence from hospitals reporting in both 1990 and 1992 suggests that hospitals do not adopt the functional/team NCDS in response to shortage. Primary nursing care delivery started in the late 1960s, principally as a way of increasing RN autonomy (Felton 1975; Zander 1985), and variations on the model have been advocated intermittently by nurse leaders since its inception (Felton 1975; Zander 1985; Montague 1995; Hoffart and Woods 1996).

Among hospitals reporting a transient shortage, nursing unit self-management and collaborative committees decreased the likelihood of shortage. Both of these characteristics often accompany a more progressive hospital management style and are associated with primary nursing care delivery. It is noteworthy that in our study, wage (RN wage in the hospital relative to RN wage in other hospitals in the same HSA) was not a significant predictor of shortage hospitals, which is contrary to other literature in the field. Additionally, our proxy variable for spouse unemployment (county unemployment) was not significant in any of the models.

Our analysis has several notable limitations. First, as discussed above, we cannot attribute the causality of the relationship between shortage and some of the institutional characteristics of hospitals, such as NCDS. However, in hospitals reporting in both 1990 and 1992, no evidence suggested that the hospitals adopted functional/team NCDS in response to the shortage. Combined with the finding that functional/team NCDS is correlated with higher shortage, we believe that this lends credibility to the notion that the functional/team NCDS came before the shortage. Second, our data are nearly a decade old. Unfortunately the AHA discontinued the NPS in 1993, and no more recent data are available. However, we strongly believe that using

this unique data set is preferable to ignoring it. Additionally, we believe that our findings are relevant in today's hospital environment, particularly in regard to NCDS. In the 1990s many acute-care hospitals restructured the way they deliver nursing care; this restructuring, often called patient-focused care, typically resembles the functional/team NCDS that we have linked to declared RN shortage. In addition, our findings are consistent with those of studies of physician shortages. Physician shortages are more likely to exist in the South, in rural areas, and in areas of high minority populations (Council on Graduate Medical Education 1998; Komaromy, Grumbach, Drake, et al. 1996). RN shortages are more likely in southern states, in counties with a large nonwhite population, and in hospitals with a high share of Medicaid patients. There is the possibility that the markets are monopsonistic and may be unaffected by the variables included in this model. However, even if monopsony is the cause of vacancy rates in some nursing labor markets, it cannot explain changes in vacancy rates or reports of shortages. Moreover, monopsony should exist only in less competitive labor markets; in contrast we found that factors unrelated to competitiveness of the labor market predict reports of shortages.

Our findings have important implications for federal and state policies aimed at reducing nursing shortages. The federal government and some states provide financial aid to nursing students in exchange for practice in shortage areas after graduation. The most notable example at the federal level is the Nursing Loan Repayment Program. This program repays the student loans of RNs who agree to practice for at least two years in health care organizations that primarily serve vulnerable populations and are located in counties designated by the federal government as having shortages of RNs. These designations are based on the ratio of full-time-equivalent RNs to average daily patient census (ADC). Counties with an aggregate RN-to-ADC ratio in the lowest quartile of U. S. hospitals are designated as nurse shortage counties.

This methodology relies exclusively on data regarding hospital staffing and does not take into account the characteristics of the patient population served by the hospital. Our findings indicate that population characteristics, particularly county racial/ethnic composition and health insurance status, are strong predictors of hospitals with chronic shortages of RNs. Thus, although our analyses do not use county as the unit of analysis, the current policy could be improved by considering these population characteristics, not just the RN-to-ADC ratio, when designating nurse shortage counties. Federal officials responsible for designating nursing shortage areas might look to the

proposed rules for revising the methodology for designating primary care health professions shortage areas (HPSAs) (HRSA and DHHS 1998). The proposed new methodology for designating HPSAs, which are used for several purposes including identifying communities eligible for National Health Service Corps placements, would use an index that combines information about primary care provider supply and population characteristics. Both medical and nursing care providers have special challenges when treating these vulnerable populations, and these challenges may create barriers to recruiting health care providers.

More generally our findings call into question the assumption that hospitals' difficulties in recruiting and retaining RNs can be fully resolved by policies that seek to increase RN supply. This assumption is reflected in calls to increase funding for nursing education at public colleges and universities (Keating 1998) and relax immigration restrictions for RNs. As noted previously, communities with high proportions of racial/ethnic minorities and vulnerable populations generally have the lowest supplies of physicians (Council on Graduate Education 1998; Komaromy, Grumbach, Drake, et al. 1996). Our findings suggest that a similar pattern is evident in RNs' employment choices, indicating that RN workforce policy needs to place greater emphasis on distribution relative to overall supply. Distribution policies include not only financial assistance programs but also programs that provide RNs with educational experiences with medically underserved communities and policies that seek to recruit into the profession individuals predisposed to practice in such communities. Policies to address the problem of persistent nursing shortages will need to focus more attention on these distribution issues. For those hospitals that experience only a temporary shortage, the best recommendation may be to let the market correct itself.

NOTE

1. The federal government designates HSAs for planning and resource analysis of hospitals and other health services. The 205 HSAs in the United States are constructed of either entire states or aggregates of counties.

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