Variations in Physicians' Hospitalization Practices: A Population-based Study in Manitoba, Canada

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Abstract: This paper uses claims data from a universal health care system to describe physicians' hospitalization styles after adjusting for case-mix characteristics of their primary patients. Patients were uniquely assigned to that physician (general or family practitioners, internist, general surgeon, or obstetrician/gynecologist) seen most frequently over each two two-year periods (1972-74 and 1974-76). Four indices were developed including: 1) percentage of primary patients hospitalized; 2) mean number of readmissions for such patients; 3) mean length of stay; and 4) total days of hospitalization per primary care patient (a summary measure combining the first three). Rates of admission, not length of stay, were shown to be strongly related to this summary measure. Marked variations in the hospitalization indices were observed across physicians; these variations cannot be explained by the health or sociodemographic characteristics of a physician's patients. Rural physicians practicing in areas with high bed-to-population ratios and low occupancy rates were particularly high users of hospitals. The economic implications of different practice styles are shown to be large; physicians who were high users of hospitals serve 27 per cent of the patients but their patients consume 42 per cent of the hospital days. (*Am J Public Health* 1986; 76:45–51.)

Introduction

There is a growing interest in the role of physician discretion in explaining variations in hospitalization rates across small areas,[1] states,[2] and regions.[3] Since hospitals account for the largest proportion of health care expenditures and physicians act as gatekeepers to these institutions, determining the degree to which physicians differ in their propensity to hospitalize is important.

Interviews with physicians provide anecdotal examples of the influence of physician practice on hospital utilization patterns,[2] while physician discretion has been shown to provide the best explanation for how surgical workloads change when physicians enter and leave small areas.[4] On the other hand, Eisenberg[5] pointed out that few such studies have controlled for disease severity or patient case-mix.

The objective of this paper was to determine if primary care physicians differ in their propensity to hospitalize patients, after adjusting for case-mix and controlling for physician specialty. The relationship of physician practice style to the amount of hospital care used by their patients was also analyzed.

Methods

In Manitoba, Canada, all medical and hospital care with minor exceptions is covered entirely by a government health care plan and there is no limitation on use except for chiropractic care and optometrist visits. A complete history of physician visits, hospitalizations, and surgery can be reconstructed for each individual from health insurance (claims) data. Since out-of-province medical care is reimbursible by the Manitoba Health Services Commission, and since physicians operate under a fee-for-service system, both patient and physician have an incentive to document all utilization. The reliability and validity of the Manitoba claims data have been investigated extensively.[6]

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Assigning Patients to Physicians

Physician practices were identified using principles similar to those developed by Wennberg and Gittelsohn[7] for small area analysis. A probability sample of 80,000 individuals aged 25 or over (stratified by age, sex, and urban/rural residence) was drawn from the provincial health registry. The sampled individuals were assigned uniquely to that physician (general or family practitioner, internist, general surgeon, or gynecologist) seen most frequently over each of two two-year periods (1972–74 and 1974–76). An individual so assigned was referred to as one of the physician's "primary patients". Individuals were excluded if they made no visits over the four-year period to a primary physician (n = 6,978), if they were hospitalized out-of-province (382), or if they had a hospital stay of 90 days or longer (480). Individuals were also excluded if their claims identifiers were inconsistent (2,204), if they resided in a personal care home at the beginning of the observation period (2,507), or if they died during the first year of this period (2,046). A final sample of 65,549 patients (16,213 of whom were hospitalized for nonobstetrical reasons), was assigned to physicians.

Propensity to Hospitalize

Four different indices measured a physician's propensity to hospitalize: 1) percentage of primary patients hospitalized; 2) mean number of readmissions per primary patient; 3) mean length of stay per admission; and 4) total days of hospitalization per primary patient (a summary measure combining the first three). Each physician's actual ("observed") score on each of these indices was calculated by aggregating the hospitalization experience of his primary patients.

This score was adjusted for differences in primary patient case-mix as follows: The "expected" probability of hospitalization (or expected number of readmissions, length of stay, etc.) was calculated for each of the primary patients through the use of regression equations relating individual characteristics to each hospitalization outcome. The data used in the regressions were taken from patient histories constructed for each of the 65,549 individuals. All their contacts with physicians, hospitals, and nursing homes and all deaths were summarized for the period July 1972–June 1976. These expected scores were also aggregated over physician's primary patients.

Each physician could then be characterized by case-mix adjusted measures, calculated by dividing a physician's

TABLE 1—Characteristics of Manitoba's Primary Physicians*

Characteristics	Per Cent			
Place of Training				
Manitoba	49.9			
Rest of Canada	8.3			
Britain	23.2			
Elsewhere	18.5			
Specialty				
General Practitioner	75.4			
Internist with 100+ consults/year	4.9			
Other Internist	5.9			
General Surgeon with 100+ consults/year	5.2			
Other General Surgeon	5.2			
Obstetrician/Gynecologist	3.5			
Appointment at Teaching Hospital	20.2			
In Rural Practice	33.6			
In Solo Practice	56.3			
	Mean	SD	Median	Range
Age	47.2	11.8	47.0	(24–80)
Number of Different Patients Seen Over 1-Year Period	1771	981	1689	(84–5816)
Number of Primary Patients in Practice	750	402	705	(96–3511)
Per cent Primary Patients Hospitalized Over Two-Year Period**	24.4	8.7	23.2	(7.1–64.4)
Number of Readmissions per Primary Patient Hospitalized**	.6	.4	.6	(0–3.3)
Average Length of Stay (Days) of Patients Hospitalized**	11.0	2.8	10.7	(4.7–22.0)
Total Days of Hospitalization per Primary Patient**	4.9	2.8	4.3	(.5–34.6)
Number of Physicians	578			

*Only physicians expected to have 15 or more primary patients hospitalized in each of the two two-year periods 1972–1974 and 1974–1976 are included in this and all subsequent tables.
**These are physicians' observed scores, unadjusted for case-mix differences.

actual score (total days of hospitalization per primary patient) by his expected score and multiplying this ratio by the provincial average. (Each of the four indices was adjusted separately by this method.) The appendix gives details on the methods used for case-mix adjustment.

The adjusted summary measure (total days of hospitalization per primary patient) was used to rank physicians according to practice style from lowest to highest in quartiles. The expected total days of hospitalization per primary patient provides an indicator—a measure of risk or case-mix severity for each physician's practice.

The extent to which primary patients of physicians with differing practice styles were similar after case-mix adjustment was tested, using two independent samples of primary patients: a new probability sample of approximately 6,000 individuals drawn from the provincial health registry; and a representative province-wide sample of 2,770 elderly individuals interviewed in 1971.[8,9] For each sample, each individual's primary physician was ascertained and this physician's quartile rank on the practice style measure (as calculated from the 65,549 sample) determined.

Robustness of the Measures

Statistical concerns about the degree to which observed variation may be attributable to random factors (including the stability of small numbers) are relevant to analyzing variations in physician practice patterns.[10] McPherson, *et al's*,[11] systematic component of variation measure, when applied to the adjusted percentage of primary patients hospitalized, judged well over half (70 per cent), of the total variance to be systematic (that remaining after the random component is subtracted). Correlations between physicians' adjusted hospitalization measures across two adjacent time periods (1972–74, 1974–76) were high for most of the measures tested (Pearson's r ranged from .59 to .70); physicians who were high users of hospital in one period tended to be high hospital users in the other. The correlation for the length of stay measure was somewhat lower (r = .26). To increase stability in these measures, scores were averaged over the two adjacent time periods and analyses using the adjusted measures were weighted by practice size.

Results

Characteristics of Manitoba's primary physicians are described in Table 1. Physicians were included only if their patient load was such that 15 or more primary patients would be "expected" to be hospitalized in both adjacent two-year periods (median number "expected" = 155). Seventy-five per cent of the primary physicians were general or family practitioners. Internists and general surgeons were classified according to how specialized their practices were (i.e., whether or not they received 100 or more referrals over a one-year period). The 578 physicians varied markedly in the per cent of their patients hospitalized over a two-year period (7.1 to 64.4), in the number of readmissions per patient hospitalized (0–3.3), in the average length of stay (4.7 to 22.0 days), and in the summary measure, days of hospitalization per primary patient (.5 to 34.6 days).

Table 2 lists the variables selected for case-mix adjustment of the hospitalization measures (see Appendix). The proportion of variance explained by the regressions (R^2) compared favorably with other analyses, including those predicting the number of hospital days used based on face-to-face interviews.[12,13]

A physician's hospital admission rate (summarized by the per cent of his patients admitted and his readmission rate) was negatively associated with the average length of stay for his hospitalized patients (r = −.38 and −.31, respectively). Although the admission rate measures correlated strongly (r = .86 and .78, respectively) with the total number of hospital

TABLE 2—Variables Used in Regression Models to Predict Hospital Usage of Primary Patients

Independent Variables	Dependent Variables in Regression: Whether Hospitalized (Yes/No)	Number of Readmissions (Of Those Hospitalized)	Average Length of Stay (Of Those Hospitalized)	Total Days Hospitalization In Two-Year Period
Age	X	X	X	X
Sex	X	X	X	X
Age × Sex (Interaction Term)	X	X	X	X
Entered a Personal Care Home within 1 yr/2 yr/3 yr	X	X	X	X
Died within 1 yr/2 yr/3 yr	X	X	X	X
Specialty and Consulting Practice of Primary Physician	X	X	X	X
Characteristics of Ambulatory Visits				
Number of Different Physicians Seen	X	X	X	X
Number of Different Specialists Seen	X	X	X	X
Number of Different Diagnoses	X	X	X	X
Number of Visits for Diagnoses Judged to be Serious	X	X	X	X
Number of Visits for Chronic Diagnoses	X	X	X	X
Characteristics of Hospitalizations by Primary Diagnosis				
Alcoholism		X	X	
Chronic Respiratory Disease		X	X	
Anemia		X	X	
Angina		X	X	
Arthritis		X	X	
Cardiac Arrhythmias		X	X	
Diabetes		X	X	
Hypertension		X	X	
Malignancy		X	X	
Neurologic Disorders		X	X	
Average Number of Diagnoses on Admissions		X	X	
Number of Different Admissions			X	
F Value*	**	270	176	220
R^2		.32	.24	.23
N	65549	16213	16213	16213

*Two regression models were fit for each analysis, one for each adjacent two-year period. The results reported here are for the period 1974–76. Complete results as well as detailed variable definitions available on request to authors.

**This was analyzed using a logistic regression model. Fraction of concordant pairs of probabilities and responses was .79; rank correlation between predicted probability and response was .60. The other regressions are generalized least square linear regressions with their respective F values and R^2 reported.

days per primary patient, the length of stay measures showed a weak negative relationship ($r = -.08$). The summary measure—total days of hospitalization per primary patient—would appear to provide the best estimate of the impact of a physician's hospitalization practices on the health care system.

Adjusting for gross but important characteristics of a physician's case-mix removed some, but not all, of the marked range in hospitalization practices across physicians. Thus, after adjustment, the per cent of primary patients hospitalized continued to range from 7 to 56 per cent, the mean number of readmissions per primary patient hospitalized ranged from 0 to 1.9, mean length of stay for hospitalized patients ranged from 5.9 to 23.9 days, and mean days per patient ranged from .8 to 20.0. These adjusted figures can be compared with the unadjusted ranges of these variables contained in Table 1.

Physicians were grouped according to their quartile rank on the adjusted summary measure, total days of hospitalization per primary patient. Those in the lowest quartile averaged 2.6 days of hospitalization per patient while those in the highest quartile averaged 7.8 days (Table 3). The range in this measure was similar regardless of the specialty or consulting practice of the primary physician.

To test whether primary patients of physicians in the highest quartile were similar to those of physicians in the lowest quartile, an independent sample of approximately 6,000 Manitoba residents was drawn, and each individual's primary physician's quartile rank on the adjusted hospitalization measure ascertained. Table 4 shows few systematic differences in case-mix across lowest/highest quartile physicians (e.g., 14.4 versus 12.6 per cent, respectively of their patients visited the physician for a problem diagnosed as angina).

The similarity of primary patients of physicians in different quartiles was further tested (bottom half of Table 4) using data derived from interviews with a large representative sample of elderly.[8,9] The primary patients of physicians in the three highest quartiles were quite similar in terms of factors putting individuals at risk of hospitalization: the degree to which the respondent required help from a proxy in completing the interview, and scores on such measures as the mental status test,[14] self-rated health status, the number of health conditions reported, and the number of basic disabilities reported.

On each of these measures, patients of physicians in the lowest quartile scored somewhat better, suggesting that they might be somewhat healthier than others despite the case-mix

TABLE 3—Hospitalization Rates of Primary Patients According to Physicians' Quartile Rank on Case-Mix Adjusted Measure: Total Days Hospitalization per Primary Patient

All Primary Physicians	Physician Classified According to Quartile Rank			
	Lowest Quartile*	Medium Low	Medium High	Highest Quartile
Number of hospital days per primary patient	2.6**	3.9	5.1	7.8
Percent primary patients hospitalized	.17	.21	.26	.34
Mean number readmissions per primary patient	.41	.53	.71	1.00
Average length of stay	10.7	11.4	10.7	10.4
Number of Hospital Days Per Primary Patient by Specialty of Primary Physician				
General Practitioner	2.6	3.9	5.1	7.8
Internist/Consultant	—	3.8	5.2	9.5
Other Internist	2.9	3.9	5.0	7.6
General Surgeon/Consultant	—	3.8	4.8	8.3
Other General Surgeon	2.5	3.8	5.2	—
Obstetrician/Gynecologist	2.5	—	—	7.9

*Number of physicians in each category (lowest to highest) were as folows: all 143, 145, 145, 144; general practitioner 111, 106, 102, 116; internist/consultant 4, 9, 10, 5; other internist 5, 13, 10, 6; general surgeon/consultant 4, 9, 10, 7; other general surgeon 10, 7, 9, 4; obstetrician/gynecologist 9, 1, 4, 6. Note—data for cells containing fewer than five physicians are not reported.

**Case-mix standardized rates are presented here and in Tables 5, 6 and 8. For each measure, the physician's observed rate is divided by his expected rate and the resulting observed/expected ratio multiplied by the provincial average.

TABLE 4—Characteristics of Primary Patients According to Physicians' Quartile Rank on Case-Mix Adjusted Measure: Total Days Hospitalization per Primary Patient

	Quartile Rank of Physician			
	Lowest Quartile	Medium Low	Medium High	Highest Quartile
	%	%	%	%
Characteristics of Physicians' Primary Patients (All Ages)*				
75–84 years	16.1	21.6	20.7	21.6
85 years and older	5.5	6.4	6.1	7.1
Died over two-year period	5.9	6.6	5.6	5.6
Had one or more visits over two-year period for:				
Angina	14.4	16.4	13.5	12.6
Hypertension	21.5	20.0	22.3	22.5
Diabetes	5.5	5.7	5.4	5.5
Malignancy	3.2	5.1	3.8	4.3
Characteristics of Patients (Aged 65 years and older)**				
A proxy was needed to complete the interview	3.5	8.4	6.8	7.4
8 or fewer questions correct on mental status test	13.0	16.6	13.0	18.5
Interviewer rates respondent's mind as weak and unsteady	9.7	12.4	9.9	10.6
Self-rated health fair, poor or bad	30.3	39.5	39.5	41.3
Reported health conditions				
1 or 2	49.4	43.8	47.5	42.4
3 or more	33.9	39.2	39.4	44.0
Reported 1 or more basic disabilities	11.6	16.0	14.5	15.9
Eight years or less of education	57.2	59.4	67.2	71.3
Have difficulty living with current income	26.7	23.5	26.6	24.4
Ethnic origins were other than Canadian, British or US	20.9	29.6	23.2	18.1
Was widowed or divorced	31.4	35.0	32.8	33.5

Observations are weighted by number of patients in the physicians' practice.

*Data from provincial health registry sample. Number of patients in each quartile (lowest to highest) were as follows: 1221, 1654, 1467, 1577.

**Data from interview study with the province's elderly. Number of patients in each quartile (lowest to highest) were as follows: 459, 672, 786, 853.

adjustment. Patients varied consistently across the four quartiles only on the education measure. Several other measures showed no consistent differences in patient characteristics across the four groups of physicians. In summary, most of the differences were relatively small and did not vary consistently with medium low, medium high, and high quartile physicians. Patients of physicians who were high hospital users appeared to be remarkably similar to patients of all but those physicians in the lowest quartile.

Table 5 examines variations in the hospitalization patterns according to such physician characteristics as age, place of training, practice size, etc. Physicians with appointments at teaching hospitals averaged significantly fewer days per primary patient (4.2 versus 5.2) as did physicians with higher-risk primary patients. These results seem counterintuitive; one would anticipate that patients of both types of physicians would spend more—not fewer—days in hospital. They suggest that case-mix standardization has worked well, and that the heavy hospital usage patterns of rural physicians (table 6) who are not appointed to teaching hospitals may influence these results. Younger physicians, physicians with smaller numbers of primary patients, and physicians who trained outside Canada and Britain also averaged more days per patient. None of the other variables examined—organization of practice (whether solo or group), or overall size of practice (number of different patients seen in a year)—was related to the summary measure.

Physicians practicing in rural areas differed markedly in their hospitalization patterns from those in urban areas (Table 6). Manitoba's rural areas have many more beds (6.3 per 1,000 residents versus 4.9) and considerably lower hospital occupancy rates (67 per cent versus 83 per cent) than urban areas. Rural physicians hospitalized patients much more frequently, admitting 31 per cent of their primary patients over a two-year period compared with 21 per cent for urban physicians. Despite a shorter mean length of stay per hospitalization (9.9 days versus 11.4 days), rural physicians still averaged more hospital days per primary patient than their urban counterparts (6.5 days versus 4.0 days).

Classifying physicians according to the number of beds per 1,000 population in their area reinforces these tendencies. Patients of physicians practicing in bed-rich areas averaged 6.6 days in hospital compared with 4.3 days for patients of physicians in other areas (63 per cent of rural physicians practice in bed-rich areas). The education level and household income of area residents are so closely associated with living in urban areas (urban residents have higher cash incomes and higher levels of education) that no additional information was gained by further analysis.

Table 7 presents results of a multivariate analysis of factors associated with the case-mix adjusted summary measure: total days of hospitalization per primary patient. All variables significantly associated with this measure at the univariate level were included in the initial regression model. The standardized regression coefficients indicate that rural practice was most strongly associated with the summary measure; the next most important predictor was practicing in

TABLE 5—Case-Mix Adjusted Hospitalization Patterns by Characteristics of Primary Physicians

Characteristics of Physicians	Number of Physicians*	Per cent Patients Hospitalized	Readmission Rate	Average Length of Stay	Summary: Total Days of Hospitalization per Patient
Age					
25–34	89	28	.7	10.5	5.7
35–44	157	27	.8	10.4	5.4
45–54	170	25	.7	10.9	5.0
55–64	106	22	.6	11.3	4.3
65+	52	21	.6	11.1	4.3
Place of Training					
Manitoba	288	24	.7	10.7	4.9
Rest of Canada	48	22	.6	10.9	4.1
Britain	134	26	.8	10.5	5.3
Elsewhere	107	26	.7	10.7	5.5
Appointment at Teaching Hospital					
Yes	116	23	.6	10.7	4.2
No	459	25	.7	10.8	5.2
Risk Level of Primary Patients (Total Expected Days Hospitalization per Primary Patient)					
3.5 Days or More	229	23	.6	10.8	4.6
Fewer	349	25	.7	11.1	5.1
In Solo Practice					
Yes	307	25	.7	10.8	5.1
No	238	25	.7	10.8	5.0
Number of Different Patients Seen in Year					
84–1999	355	25	.7	11.0	4.9
2000 or more	202	25	.7	10.5	5.1
Number of Primary Patients in Practice					
15–749	321	26	.7	10.7	5.3
750+	257	24	.7	10.9	4.8

*Although 578 physicians were included in the analysis, the number available for each indicator in this and Table 6 varies somewhat because of missing data.

TABLE 6—Case-Mix Adjusted Hospitalization Patterns of Primary Physicians by Characteristics of the Area in Which Physicians Practice

Characteristics of Practice Area	Number of Physicians*	Per cent Patients Hospitalized	Readmission Rate	Average Length of Stay	Summary: Total Days of Hospitalization per Patient
Location of Practice					
Rural	194	31	.9	9.9	6.5
Urban	383	21	.5	11.4	4.0
Beds per 1000 Population					
5 or more	159	31	.9	10.3	6.6
Less	418	23	.6	11.0	4.3
% Occupancy Rate of Area Hospitals					
34 to 74	150	31	.9	9.9	6.5
75 or more	427	22	.6	11.2	4.3

TABLE 7—Association of Various Factors with Physicians' Score on Case-Mix Adjusted Measure: Total Days Hospitalization per Primary Patient (Results from Least Squares Regression)

Independent Variables*	Standardized Regression Coefficient
Physician Practices in Urban Area	−.505
Physician Practices in Area with 5+ Beds per 1,000 Population	.251
Risk Level of Primary Patients	−.108
Training Outside North America and Britain	.093
Appointment at Teaching Hospital	.088
R^2	.46
Number of Physicians	575

*All variables are categorized as in Tables 5 and 6. All variables were significant at $p < .01$. The physician's observed total days hospitalization rate is divided by his expected rate and the natural logarithm of the resulting observed/expected ratio is used as the dependent variable.

an area with large bed supply. The indicator of patient risk level—mean "expected" days of hospitalization per primary patient—continued to be negatively associated with the summary measure but, after controlling for other factors, physicians at teaching hospitals were somewhat more likely to hospitalize their patients or to keep their patients in hospital longer.

The economic implications of physicians' hospitalization patterns can be examined in Table 8. The physicians in the highest quartile served 26.9 per cent of the primary patients; these patients consumed 42.0 per cent of the hospital days. Put somewhat differently, about one-fourth of the physicians (i.e., those from the highest quartile) acted as gatekeepers to almost half the hospital days consumed by Manitoba's adult population. The medium low physicians (shown to have patients very similar to the highest quartile) treated 26.8 per cent of Manitoba's adult population and used only 21.4 per cent of the hospital days.

Discussion

Although any attempt to empirically describe physician hospitalization patterns is fraught with difficulties, the large

TABLE 8—Proportion of Patients and Proportion of Hospital Days Attributable to Physicians According to Quartile Rank on Case-Mix Adjusted Measure

Physicians Classified According to Total Days Hospitalization per Primary Patient (Case-Mix Adjusted)	Mean Days per Patient	Proportion of Primary Patients Assigned to Physicians in Quartile (N = 58,785)*	Proportion of Total Hospital Days Consumed by Physicians' Primary Patients**
		%	%
Lowest Quartile	2.6	19.6	10.2
Medium Low	3.9	26.8	21.4
Medium High	5.1	26.7	27.6
Highest Quartile	7.8	26.9	42.0

*Although the analysis is based on the 65,549 adult sample, 6,764 people were excluded because their primary physician had less than 15 patients expected to be hospitalized in each of the two two-year periods.
**A total of 388,792 hospital days were used by the 58,785 patients.

physician-to-physician variation in our summary measure (total hospital days per primary patient) suggests that physicians make very different hospitalization decisions. This conclusion is supported by research of Connell, *et al,*[15] on patterns of hospitalization for diabetes mellitus. They found that hospitals (i.e., physicians) in areas with high population-based admission rates for diabetes admitted a greater proportion of patients with mild illness than did hospitals in low-rate counties. Our results suggest that practice style differences are not limited to diabetes or cardiac diagnoses (where marked differences in length of stay have been reported[16]) and have important implications for hospital bed consumption.

To a large extent, these differences in style are influenced in Manitoba by the practice setting. Urban physicians practicing in tertiary care centers with limited bed supplies and high occupancy rates admit and readmit their patients much less frequently than do rural physicians. In rural areas, patients likely travel farther to obtain care, and in questionable situations it may be safer to hospitalize for observation. Distances rather than bed supply may be the key variable. However, some rural physicians score low on the hospitalization index and in urban areas some physicians have high scores. Such styles may be based on what Linn, *et al,*[17] have called "private habits or rituals" and are likely related to clinical ambiguity and uncertainty.[18]

Our work complements the findings of others that small groups of patients consume a disproportionate share of health care resources.[19,20] The research also suggests that utilization reviews which focus on length of stay, such as those based on diagnosis related groups (DRG), will not address the major factors influencing the number of days consumed by a population. Our analysis, as that of others,[1,13] indicates that admission rates, and readmission rates, are the strongest determinants of the total days consumed per capita. Since the diagnostic testing and monitoring of patients by nurses are much more intensive at the start of a hospital stay, the impact of admission rate on health system costs is undoubtedly stronger than even our analysis suggests. In summary, physicians' decisions to admit patients to hospital contain a major element of discretion and may be amenable to prospective guidelines and review.

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APPENDIX

Building on a previous study of practice style with regards to hysterectomy,[21] various rules for assignment to a primary physician were tested: 1) assigning individuals to the physician seen most frequently over a two-year period (plurality rule); 2) assigning to physician only if 50 per cent or more of visits were to that physician (majority rule); 3) assigning to physician based on plurality rule but weighing each assignment by per cent of visits to that physician; and 4–6) use of definitions 1, 2, and 3 on an adjacent two-year period of utilization. Estimates of the number of primary patients aged 25 or older in a physician's practice were very stable, with Pearsons r ranging from .93 to .98 across the two time periods depending on the measure used. Independent measures of practice size (number of different patients, all ages) were also available for each physician. These measures were significantly correlated with our measures based on the 80,000 sample (Pearsons r = .53).

As indicated in the text, 6,978 (9 per cent) of the 80,000 sample could not be assigned to a physician because no visits were made over a four-year period. An additional 21.6 per cent of the sample were assigned to their primary physician on the basis of one visit. These infrequent visitors were distributed equally across the four physician quartiles. At the other end, 35.5 per cent made five or more visits to their primary physician. The hospitalization experience of each physician's primary patients over the two adjacent two-year periods provided the numerator for the "observed" rate calculations.

To adjust observed outcomes for differences in patient mix, we first estimated probability of hospitalization for each of 65,549 individuals. Individuals with very long hospital stays (90 days or longer) were excluded from the sample since these stays were less likely to be influenced by physician discretion and a single such patient could distort a physician's adjusted measure. A more stringent criteria—excluding anyone hospitalized for 30 days or more—was also examined as well as a criterion which truncated very long stays rather than excluding such cases. Neither of these methods improved nor much affected the stability of correlations in the observed/expected ratios across time periods.

The estimates of the probability of hospitalization were derived empirically through the use of least square regressions and logistic equations relating patient specific information to the outcome measures. In general, for the calculation of the estimates of an individual's being hospitalized, length of stay, etc., four groups of variables were used: 1) age, sex, and an age-sex interaction term; 2) measures reflecting individuals' ambulatory contact with the medical care system including number of different specialists contacted, number of different diagnoses, number of visits for conditions (diagnoses) defined as serious, number of visits for diagnoses defined as increasing the individual's risk of not recovering from an illness, number of visits for a chronic condition (see Mossey and Shapiro[22] for a description of the three previous measures), number of different physicians seen and number of total ambulatory physician visits; 3) dummy variables indicating the individual was one, two, or three years before death, and that the individual was one, two, or three years before admission to personal care home; 4) dummy variables indicating specialty and consultant characteristics of the individual's primary physician.

The regression model used to estimate the length of stay and readmission

measures was used only for individuals who had been hospitalized. The variables in these equations included all those discussed previously plus dummy variables indicating the reason for hospitalization (cancer diagnoses, serious heart disease, etc.), the mean number of diagnoses associated with each hospitalization (a measure of comorbidity), and the number of different admissions over the two-year period (for length of stay analysis only).

A two-step process was used to estimate the number of days an individual would be hospitalized given certain characteristics. Initially, a regression model was fit using the natural logarithm (ln) of the total hospital days over a two-year period as the dependent variable. However, we were concerned that the model was influenced too heavily by those individuals not hospitalized (75 per cent of the sample). To resolve this problem we used variables 1 through 4 discussed above in a regression model which included only individuals who had been hospitalized. Coefficients estimated from this sample of hospitalized patients were used to predict total days hospitalized for those who had never been admitted, given their characteristics (such as time till death, etc.). This estimate was then multiplied by the probability of being hospitalized derived from the logistic regression equation estimating whether or not an individual had been hospitalized. Having estimated the probability of hospitalization for each of the individuals, these individuals were then assigned to their primary physician and the probabilities summed over each physician's practice producing the "expected" measures. The impact of gross outliers and of geographic mobility was examined and determined to have little impact on the results. Our final analyses included 76 per cent of physicians overall, and 89 per cent of physicians seeing 1,000 or more patients a year. (Only the four primary care specialties were counted.) Data available on request to authors.

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Disability Prevention and Rehabilitation Conference Set

Rehabilitation International, USA will convene a major international conference from April 27–29, 1986, in Washington, DC. Entitled "Disability Prevention and Rehabilitation: A Global Challenge," the conference will bring together leaders from around the world who are working on disability in all of its dimensions through organized international efforts.

The program's format calls for an examination of the demographics of disability worldwide and an overview of the international efforts currently in place for its prevention and amelioration. Particular attention will be given to the United States involvement in this process and the ways in which that participation can be made more meaningful. Special sessions will be held in the areas of rehabilitation medicine, vocational rehabilitation, rehabilitation engineering, special education, administration and organization, social integration, rehabilitation research, and sports, recreation and leisure.

Invited speakers will include leaders from the United Nations and its agencies, elected US officials, individuals from the US Departments of State, Education, and Health and Human Services, representatives from regional organizations such as the Organization of American States, and speakers from the US Mission to the UN.

Rehabilitation International, USA is a private, nonprofit organization which has served since 1972 as the American affiliate of Rehabilitation International, a worldwide federation of 120 organizations in 80 nations dedicated to disability prevention and rehabilitation. For further information, contact Rehabilitation International, 1123 Broadway, New York, NY 10010. Tel: 212/620-4040.