A RAND NOTE

Variations in the Use of Medical and Surgical Services by the Medicare Population

Mark R. Chassin, Robert H. Brook, R. E. Park,
Joan Keesey, Arlene Fink, Jacqueline Kosecoff,
Katherine Kahn, Nancy Merrick, David H. Solomon

January 1986

RAND

The research described in this report was supported jointly by the Commonwealth Fund; the John A. Hartford Foundation; the Pew Memorial Trust; and the Robert Wood Johnson Foundation.

Published by The RAND Corporation
1700 Main Street, P.O. Box 2138, Santa Monica, CA 90406-2138

A RAND NOTE

N-2678-CWF/HF/PMT/RWJ

Variations in the Use of Medical and Surgical Services by the Medicare Population

Mark R. Chassin, Robert H. Brook, R. E. Park,
Joan Keesey, Arlene Fink, Jacqueline Kosecoff,
Katherine Kahn, Nancy Merrick, David H. Solomon

January 1986

Prepared for
The Commonwealth Fund
The John H. Hartford Foundation
The Pew Memorial Trust
The Robert Wood Johnson Foundation

RAND

SPECIAL ARTICLE

VARIATIONS IN THE USE OF MEDICAL AND SURGICAL SERVICES BY THE MEDICARE POPULATION

MARK R. CHASSIN, M.D., M.P.P., M.P.H., ROBERT H. BROOK, M.D., SC.D., R.E. PARK, PH.D., JOAN KEESEY, ARLENE FINK, PH.D., JACQUELINE KOSECOFF, PH.D., KATHERINE KAHN, M.D., NANCY MERRICK, M.D., AND DAVID H. SOLOMON, M.D.

Abstract We measured geographic differences in the use of medical and surgical services during 1981 by Medicare beneficiaries (age ≥65) in 13 large areas of the United States. The average number of Medicare beneficiaries per site was 340,000. We found large and significant differences in the use of services provided by all medical and surgical specialties. Of 123 procedures studied, 67 showed at least threefold differences between sites with the highest and lowest rates of use. Use rates were not consistently high in one site, but rates for procedures used to diagnose and treat a specific disease varied together, as did alternative treatments for the same condition.

These results cannot be explained by the actions of a small number of physicians. We do not know whether physicians in high-use areas performed too many procedures, whether physicians in low-use areas performed too few, or whether neither or both of these explanations are accurate. However, we do know that the differences are too large to ignore and that unless they are understood at a clinical level, uninformed policy decisions that have adverse effects on the health of the elderly may be made. (N Engl J Med 1986; 314:285-90.)

NEARLY 50 years have passed since Glover reported a 10-fold difference in tonsillectomy rates among various geographic areas in England.[1] Since then, other researchers have documented similar variations in hospital admissions, lengths of stay, and specific surgical procedures in many parts of the developed world.[2-24] Virtually all these studies, however, have been limited to a few procedures, to small geographic areas, or to foreign locations. In the United States, most work on variations has analyzed care provided in small hospital-service areas in three rural northeastern states.

The purpose of this paper is twofold. We will first present, for 18 percent of the population throughout the United States that is eligible for Medicare, age- and sex-adjusted population-based data on the use of selected specific medical and surgical services. We will also discuss the use of these data in establishing policies on health care.

METHODS

To develop population-based use rates, we obtained a complete file of physician claims for the calendar year 1981 from the Medicare part B insurance carriers in Arkansas, Colorado, Iowa, Massachusetts, Montana, Pennsylvania, South Carolina, and northern California. These sites were selected because they represented the diversity of the population eligible for Medicare and of the medical system; they contained populations that did not often leave their own areas to obtain medical care; and their insurance carriers used sophisticated systems to process claims. All carriers also provided demographic data on patients from their eligibility files and data on physician specialty from their provider files.

From the Health Program of The Rand Corporation, Santa Monica, Calif., and from the Departments of Medicine and Public Health of the University of California at Los Angeles. Address reprint requests to Dr. Chassin at The Rand Corporation, 1700 Main St., Santa Monica, CA 90406-2138.

Supported in part by grants from The Commonwealth Fund (6137), The John A. Hartford Foundation (83172-2H), The Pew Memorial Trust (Glenmede Trust), and the Robert Wood Johnson Foundation (7309). The opinions, conclusions, and proposals in the text are those of the authors and do not necessarily represent the views of any of these foundations or of The Rand Corporation.

The files of physician claims from these sites contained more than 75 million claims for all services, both inpatient and ambulatory (office-based), that were billed by physicians for elderly persons eligible for physician services under Medicare part B (97 percent of all elderly persons in all the areas). The only services provided to this population that were not reflected in those files were those rendered by the small number of salaried, hospital-based physicians whose services are not billed directly to Medicare part B — mainly hospital-based pathologists, although there were some anesthesiologists and radiologists.

We defined clinical procedures that were consistent across the different coding systems used by the eight insurance companies by combining detailed procedure codes into aggregates. For example, one carrier used six codes to describe various inguinal herniorrhaphies and another used five; we incorporated all these variations into a single procedure group. In this way, we derived 153 procedure groups, which together accounted for 87 percent of total physician charges under Medicare part B and which included all procedures that accounted for at least 0.1 percent of those charges.

We edited the data to ensure that even though bills from two or more physicians were received for a procedure, the procedure performed by them jointly was counted only once. We excluded claims from anesthesiologists and assistant surgeons and, when appropriate, counted a specific procedure performed on the same patient on the same day only once. Claims that were denied by the carrier and carrier adjustments to claims were not counted as separate procedures. To make the populations in the separate sites as comparable as possible, we excluded Medicare beneficiaries under the age of 65 (those eligible to receive Medicare benefits because of various disabilities, including chronic renal disease).

We report here the frequency with which physicians practicing in each of the 13 sites provided services to Medicare part B enrollees who resided in that site. On the basis of studies of the origins of Medicare patients[25] that delineate patterns of migration to obtain hospital care, we divided both northern California and Pennsylvania into three smaller areas and Massachusetts into two smaller areas. The boundaries were drawn so as to minimize the number of patients who crossed borders to receive hospital care.[26] We excluded claims for patients residing outside an area who came into it for services, primarily because we could not measure the population at risk from which these patients were drawn. We also excluded services performed for residents of an area by physicians practicing outside that area, because such services did not directly reflect medical practice within given areas, which was the primary focus of our study.

Using Medicare data,[25] we determined the proportion of hospitalized patients residing in each of our sites who received their hospital care outside the site. This proportion was small; it account-

Reprinted from the *New England Journal of Medicine*, 314:285-290 (January 30), 1986, © 1985, by the Massachusetts Medical Society. Reprinted by permission.

ed for 10 percent in three sites, 6 to 8 percent in five sites, and 3 to 5 percent in five sites.

The denominator for calculating the rates of use of procedures was the number of persons 65 years of age or older eligible for Medicare part B who resided in each area. We adjusted the rates for age and sex differences among the 13 sites by calculating specific use rates for age and sex subgroups and applying these rates to a standard population distribution (the population of the United States that was over 65 in 1980). It should be noted, however, that the age and sex distributions among Medicare beneficiaries who were 65 or older in the 13 sites were similar enough so that this adjustment did not substantially change the unadjusted rate in any site.

We tested the statistical significance of the differences in rates across sites by use of a chi-square test. The null hypothesis was that the rate at each site was equal to the standardized rate for all the sites combined. The test statistic was compared with the critical value of chi-square with S − 1 degree of freedom (where S = number of sites compared) to determine whether the observed differences in rates across sites were statistically significant.[26]

Results

Selected characteristics of the 13 sites are shown in Table 1. These sites, which have an average Medicare population of 340,000, encompass a wide spectrum of geographic location and physician availability. If there are variations in the use of medical services in large populations — i.e., variations that are not produced by the behavior of a few physicians or groups of physicians — they should appear in these data.

Table 2 summarizes the variations among the 13 sites in the rates of use of 30 selected medical and surgical services. For each procedure, we present the highest, the mean, and the lowest age- and sex-adjusted rates. The mean rate is the total number of procedures performed in all sites, divided by the total number of beneficiaries of Medicare part B in all sites, adjusted for age and sex. Table 2 also shows two summary measures of variation in the use rates. The ratio of the highest to the lowest rate has been widely used in previous studies and is not without interest, despite its statistical instability and unreliability. The more statistically appropriate coefficient of variation (standard deviation divided by the mean) is also presented. The standard deviation that we used in calculating the coefficient of variation was weighted to account for the unequal size of the 13 sites. Data from all 13 sites on all 123 procedures, including the precise definitions of procedure groups, are available elsewhere.[26] Laboratory procedures are excluded because of their high degree of incomplete representation in part B claims.

Table 1. Selected Characteristics of Geographic Sites.

Site	1981 Medicare Part B Enrollees	Physicians per 1000 Enrollees*	Enrollees per Square Mile
Arkansas	296,000	9.9	6
Coastal Calif.	671,000	27.8	21
Northern Calif.	178,000	18.9	5
Valley Calif.	127,000	14.9	6
Colorado	236,000	25.4	2
Iowa	381,000	10.1	7
Western Mass.	182,000	15.7	43
Eastern Mass.	513,000	26.3	145
Montana	83,000	13.2	1
Western Pa.	549,000	12.6	26
Central Pa.	497,000	11.6	23
Philadelphia	437,000	24.4	201
South Carolina	270,000	16.1	9

*Source: American Medical Association.[27]

The data presented in Table 2 show large variations in use rates. Statistically, the probability that these differences were due to chance alone is very small — less than 0.001 in each case. Of 123 procedures studied, 76 had coefficients of variation greater than 0.30, and 67 had at least threefold differences between the highest and lowest rates. When we divided 117 procedures (physician visits were excluded) into 67 surgical procedures and 50 nonsurgical procedures, we found that the average coefficient of variation (0.44) for the nonsurgical procedures was greater ($P<0.001$) than that for the surgical procedures (0.31).

Tables 3 and 4 present the rates of use of selected cardiovascular and gastrointestinal procedures in all 13 sites. Several observations emerge from examination of these data. First, the differences summarized in Table 2 were not produced simply by one or two atypical sites: rather, for almost all the procedures, there was a distribution of rates that spanned the range between the sites with the highest rates of use and those with the lowest rates. Second, individual sites did not exhibit the highest or lowest rates with any degree of consistency. Instead, the same site often had a high rate for one procedure and a low rate for another. For example, site D (Table 3) had low rates of use of coronary-artery bypass surgery and coronary angiography but the highest rate of transvenous pacemaker implantation. Similar examples can be seen in Table 4. We also observed these patterns in many other procedures.[26]

Third, the use of procedures employed to diagnose and treat the same disorder usually varied together. For example, the first three procedures listed in Table 3 — electrocardiographic stress testing, coronary angiography, and coronary-artery bypass surgery — are all used primarily in the diagnosis or treatment of ischemic heart disease. Thus, geographic areas with high rates of coronary-artery bypass surgery generally also had high rates of the related diagnostic procedures, and vice versa. The same was true for cholecystography and cholecystectomy (Table 4). We found similar patterns for other combinations of diagnostic and therapeutic procedures, including colonoscopy and colectomy and skin biopsy and excision of a malignant skin lesion.[26]

The rates of use of procedures that can be employed as alternative treatments for the same condition also varied together. Table 4 includes two such procedures — injection of hemorrhoids and hemorrhoidectomy. Geographic differences in the use of either of these procedures might be interpreted as a simple reflection of a preference for one of them by particular communities of physicians. In fact, however, areas

Table 2. Rates of Use of Selected Medical and Surgical Procedures in 13 Sites by Medicare Beneficiaries 65 Years Old or Older during 1981.*

Procedure	Rate of Use			Coefficient of Variation	Highest/Lowest Rate Ratio
	High	Mean	Low		
	per 10,000 beneficiaries				
Greatest variation among sites					
Injection of hemorrhoids	17	7	0.7	0.79	26.0
Hip arthroplasty (not total hip)	18	9	2	0.69	11.4
Destruction of benign skin lesion	750	360	94	0.67	8.0
Arthrocentesis	1100	390	120	0.66	8.8
Skin biopsy	190	95	41	0.58	4.8
Humeral fracture repair	21	13	3	0.51	7.9
Total knee replacement	20	9	3	0.47	6.0
Lumbar sympathectomy	4	2	0.9	0.44	4.0
Mediastinoscopy	7	3	1	0.42	6.7
Coronary-artery bypass surgery	23	13	7	0.41	3.1
Moderate variation among sites					
Carotid endarterectomy	23	14	6	0.39	4.0
Hiatus hernia repair	5	2	0.8	0.38	5.9
Excision of malignant skin lesion	260	150	77	0.37	3.3
Endoscopic retrograde cholangiopancreatography	6	4	0.3	0.32	17.2
Coronary angiography	51	33	22	0.32	2.3
Excision of benign breast lesion	21	13	9	0.31	2.2
Craniotomy	8	5	3	0.31	2.6
Total hip replacement	24	15	8	0.31	3.0
Arterial grafts of lower extremities	19	13	6	0.28	3.5
Colles' fracture repair	34	26	15	0.25	2.3
Least variation among sites					
Bronchoscopy	78	50	35	0.21	2.2
Appendectomy	5	3	2	0.19	2.2
Abdominal aortic aneurysm repair	10	7	5	0.17	2.2
Mastectomy	21	17	8	0.17	2.7
Diagnostic upper gastrointestinal endoscopy	150	120	94	0.16	1.6
Colectomy	42	33	24	0.15	1.8
Cholecystectomy	52	41	34	0.14	1.6
Prostatectomy	97	82	57	0.12	1.7
Lens extraction	180	140	120	0.11	1.5
Inguinal hernia repair	53	45	38	0.10	1.4

*Rates are adjusted for age and sex. Chi-square tests are significant for all procedures at the 0.001 level. Rates greater than nine are rounded to two significant figures. Ratios and coefficients of variation are calculated from raw data.

with a high rate of use of either of these procedures also had a high rate of use of the other ($r = 0.66$, $P<0.02$). Our investigation of another alternative treatment combination — lower-extremity arterial reconstruction and amputation — also revealed the rates of use of these procedures to be positively correlated.[26]

In general, we found no significant relation between rates of use and the proportion of simple or complex procedures. Table 5 shows that neither the percentage of coronary-artery bypass operations in which one vessel was grafted nor the percentage in which more than one vessel was grafted was significantly related to the overall rate of bypass surgery. In fact, the likelihood of receiving more than one graft varied directly with the use rate ($r = 0.44$, $P = 0.16$). We expected the opposite result because we had hypothesized that people with less severe disease who required fewer grafts might have a relatively increased chance of undergoing coronary-artery bypass surgery in areas where the procedure had high rates of use.

Using similar reasoning, we looked for correlations between the rates of cholecystectomy and the proportion of cases that included exploration of the common bile duct, the rates of colonoscopy and the proportion of cases in which biopsies or polypectomies were done, and the rates of sigmoidoscopy and the proportion of those procedures that included biopsies or polypectomies. The correlations were not significant ($P>0.05$).

There was also no significant relation between use rates and the proportions of procedures done by physicians in particular specialties. Table 6 shows the proportion of patients who had diagnostic upper gastrointestinal endoscopy performed by physicians in various self-designated specialties. The proportion of all endoscopies done by gastroenterologists varied according to site, from 5 to 72 percent. The proportion performed by internists varied from 12 to 65 percent, and that done by general surgeons varied from 4 to 28 percent. There was, however, no relation between the overall rate of use of endoscopy in a site and the proportion of endoscopies performed by physicians in a particular specialty. For instance, the correlation between the rate of use and the percentage of endoscopies performed by gastroenterologists was 0.26 ($P = 0.45$); that between the rate of use and the percentage done by general surgeons was -0.19 ($P = 0.57$). We found similar results for colonoscopy, cholecystectomy, coronary angiography, and carotid endarterectomy.[26]

Discussion

Our data document large geographic variations in the rates of use of many different medical and surgical services by Medicare beneficiaries during 1981. These differences involve procedures performed by physicians in almost all medical and surgical specialties and subspecialties,[26] in both outpatient and inpatient settings. Because of the large size of the differences observed and of the geographic areas studied, the variations cannot have been due to the behavior of a few physicians or groups of physicians. For instance, if the site with the highest rate of use of upper gastrointestinal endoscopy had had the rate observed in the site with the lowest rate of use of that procedure, more

Table 3. Rates of Use of Selected Cardiovascular Procedures by Medicare Beneficiaries 65 Years Old or Older during 1981.

PROCEDURE	SITE*													MEAN
	A	B	C	D	E	F	G	H	I	J	K	L	M	
	rate per 10,000 beneficiaries‡													
Coronary-artery bypass	15	14	15	9	7	9	10	11	16	8	16	19	23	13
Coronary angiography	39	37	38	23	NA†	26	26	NA†	51	22	33	41	50	33
Electrocardiographic stress test	148	94	77	49	46	43	69	62	182	63	57	141	99	75
Implantation of transvenous pacemakers	49	47	52	64	59	53	50	58	48	41	22	44	50	50
Carotid endarterectomy	11	14	20	6	11	10	12	12	20	9	16	15	23	14

*Sites are not necessarily given in the order in which they appear in Table 1.

†NA denotes data not available because procedure codes used in that site were nonspecific.

‡Adjusted for age and sex.

than 1500 fewer procedures would have been performed on the elderly Medicare beneficiaries in that area in 1981. Similarly, if the site with the lowest rate of electrocardiographic stress tests had experienced the rate found in the site with the highest rate of use of that procedure, more than 7000 additional people would have undergone such tests.

A small proportion of patients in each site did receive care elsewhere; 3 to 10 percent were hospitalized outside their areas. However, this low level of migration cannot begin to account for the differences we measured, many of which were 300 percent or greater.[26]

These differences in rates of use by the elderly population in large geographic areas are difficult to compare with those found in other studies, because those investigations involved only small geographic areas. For example, McPherson and his colleagues reported data on seven procedures from small areas of New England, Norway, and England.[18] The coefficients of variation we observed for the six procedures that we and McPherson et al. both studied were similar for hernia repair, appendectomy, and cholecystectomy, but were lower for prostatectomy, hysterectomy, and hemorrhoidectomy. We would expect to find less variation in our data because we intentionally studied large areas to avoid variations that were due solely to the actions of a few physicians. However, 62 percent of the procedures we studied had a coefficient of variation that was greater than 0.30, a level considered "highly variable" in the study by McPherson et al.

Studies of variations in small areas have suggested that the degree of variation observed for a particular procedure is linked directly to the degree of medical consensus concerning the indications for its use.[10,18] Our findings are partly consistent with such observations. For example, the rates for appendectomy and inguinal hernia repair — procedures about which consensus exists — have usually exhibited little variation in other studies, and they followed a similar pattern in our study. However, some procedures for which a clear consensus about use is less well developed (such as bronchoscopy and endoscopy) also showed low variations in rates of use in our study. In addition, the large variations in use that we observed in other procedures (e.g., repair of humeral fracture) were surely not related to a lack of consensus regarding treatment but were presumably due to differences in the occurrence of the condition that required such treatment.

Our data do not provide evidence that variations can be explained by differences in physician preference for alternative procedures to treat the same clinical problem. We were able to study alternative treatment of two conditions — hemorrhoids and peripheral vascular disease. In each instance, the rates of use of the two alternative treatments varied together, with a positive correlation.

Our data provide no evidence that physicians in high-use areas perform procedures less appropriately than do those in low-use areas. If that were the case, the rate of use of less complex procedures, such as one-vessel coronary-artery bypasses or colonoscopy without biopsy or polypectomy, might be expected to be higher in high-use areas; however, our data did not reflect such a pattern. Similarly, a correlation might be expected between the specialty of physicians per-

Table 4. Rates of Use of Selected Gastrointestinal Procedures by Medicare Beneficiaries 65 Years Old or Older during 1981.

PROCEDURE	SITE*													MEAN
	A	B	C	D	E	F	G	H	I	J	K	L	M	
	rate per 10,000 beneficiaries†													
Diagnostic upper endoscopy	149	153	100	144	100	139	129	111	94	117	114	107	102	122
Colonoscopy	62	70	81	104	71	72	95	84	43	50	76	52	70	76
Oral cholecystography	197	307	142	74	131	78	67	127	123	212	75	185	83	120
Cholecystectomy	48	50	37	36	40	40	43	40	45	42	52	50	34	41
Hemorrhoidectomy	21	13	16	31	17	23	17	15	18	13	17	20	20	19
Injection of hemorrhoids	14	8	2	17	2	9	2	1	2	0.7	16	4	8	7

*See footnote to Table 3.

†Adjusted for age and sex.

Table 5. Relation between Use Rate of Coronary-Artery Bypass Surgery and Number of Grafts Implanted, According to Geographic Site.

SITE*	RATE PER 100,000†	NUMBER OF GRAFTS		
		1	2	≥3
		percent		
M	231	12	20	68
L	189	4	22	74
I	164	8	22	70
A	151	7	17	76
C	146	7	11	82
B	139	7	15	78
H	108	18	19	62
G	100	7	19	74
F	87	17	32	51
D	87	12	19	69
J	75	9	11	80
E	74	16	23	60

*Site K is excluded because of the use of nonspecific procedure codes.
†Adjusted for age and sex.

forming a procedure and its rate of use. High rates of use might reflect performance of a procedure by less qualified physicians. Again, this was not the case in our study.

In summary, the available data do not allow us to explain the wide variations we have observed. In addition, we cannot establish the "correct" use rates from these data. For any given procedure, geographic differences may reflect substantial inappropriate overuse in the high-use areas with very little inappropriate use in the low-use areas. On the other hand, the variations may have occurred because physicians in the low-use areas were not providing enough services to those who needed them, whereas those in the high-use areas were meeting legitimate medical needs in an appropriate manner. A third possibility is that the rates of use of procedures were appropriate in both high- and low-use areas and that the differences in rates resulted from differences in the incidence of diseases. Finally, some combination of all three possibilities may have been responsible for our findings.

Whatever the actual explanation for our results, data like these will be employed increasingly by groups such as peer review organizations that are pursuing cost containment. Policy makers seem ready to equate high use with inappropriate use. Such an assumption is both uninformed and dangerous. It is uninformed because at present we have no clinical data that would allow us to judge the difference in appropriateness of the use of any particular procedure between high-use and low-use areas. It is dangerous because such an assumption will surely result in policies that restrict access to care. Thus, if the assumption is wrong, patients will suffer.

Only a concerted effort by the medical community can bring rationality to the debate about geographic differences.[28] In particular, physicians must resolve the thorny issue of how to define appropriateness in both the presence and the absence of clinical studies that define the efficacy of a procedure. Better use of consensus techniques[29] and decision analysis will be necessary to address this question.

The best medical wisdom will be required to determine the indications for which services are provided to patients and to evaluate the appropriateness of performing procedures for these indications. Interpretation of the results of such an effort may be difficult and at times may not favor the medical profession. Nevertheless, if substantial inappropriate overuse of procedures is found, the medical profession will then be in a position to devise a strategy for correcting it. If underuse is demonstrated, the medical profession may constitute the most informed voice in helping to alleviate it. Perhaps this endeavor will lead not only to a fairer reimbursement system for physicians and hospitals but, more important, to one that protects the health of everyone in the United States, especially the elderly.

REFERENCES

1. Glover JA. The incidence of tonsillectomy in school children. Proc R Soc Med 1938; 31:1219-36.
2. Pearson RJC, Smedby B, Berfenstam R, Logan RFL, Burgess AM Jr, Peterson OL. Hospital caseloads in Liverpool, New England, and Uppsala. Lancet 1968; 2:559-66.
3. Bunker JP. Surgical manpower: a comparison of operations and surgeons

Table 6. Relation between Use Rate and Specialty of Physician Performing Upper Gastrointestinal Endoscopy.

SITE*	RATE PER 100,000†	SPECIALTY OF PHYSICIAN					
		GENERAL PRACTICE/ FAMILY PRACTICE	GENERAL SURGERY	INTERNAL MEDICINE	GASTROEN-TEROLOGY	UNSPECIFIED‡	OTHER SPECIALTY
		percent of procedures					
A	1495	4	6	61	24	3	2
D	1435	0	4	19	72	1	4
F	1386	0	19	22	52	4	3
G	1292	0	9	18	66	5	2
K	1141	4	28	26	20	18	4
H	1107	0	7	23	44	20	6
L	1065	6	21	65	5	0	3
M	1021	0	4	32	44	18	3
E	1003	0	14	15	49	15	6
C	1002	1	6	28	35	27	3
I	935	0	12	12	52	21	2

*Sites B and J are excluded because of incomplete data on specialty.
†Adjusted for age and sex.
‡Procedures by physicians in group or clinic practice whose specialty was not specified.

in the United States and in England and Wales. N Engl J Med 1970; 282: 135-44.
4. Lewis CE. Variations in the incidence of surgery. N Engl J Med 1969; 281:880-4.
5. Bunker JP, Brown BW Jr. The physician-patient as an informed consumer of surgical services. N Engl J Med 1974; 290:1051-5.
6. Lembcke PA. Measuring the quality of medical care through vital statistics based on hospital service areas. I. Comparative study of appendectomy rates. Am J Public Health 1952; 42:276-86.
7. Wennberg J, Gittelsohn A. Small area variations in health care delivery. Science 1973; 182:1102-8.
8. Stockwell H, Vayda E. Variations in surgery in Ontario. Med Care 1979; 17:390-6.
9. Lichtner S, Pflanz M. Appendectomy in the Federal Republic of Germany: epidemiology and medical care patterns. Med Care 1971; 9:311-30.
10. Vayda E. A comparison of surgical rates in Canada and in England and Wales. N Engl J Med 1973; 289:1224-9.
11. Bunker JP, Wennberg JE. Operation rates, mortality statistics and the quality of life. N Engl J Med 1973; 289:1249-51.
12. Roos NP, Henteleff PD, Roos LL Jr. A new audit procedure applied to an old question: is the frequency of T&A justified? Med Care 1977; 15:1-18.
13. Roos NP, Roos LL Jr, Henteleff PD. Elective surgical rates — do high rates mean lower standards?: tonsillectomy and adenoidectomy in Manitoba. N Engl J Med 1977; 297:360-5.
14. LoGerfo JP. Variation in surgical rates: fact vs. fantasy. N Engl J Med 1977; 297:387-9.
15. Roos NP, Roos LL. High and low surgical rates: risk factors for area residents. Am J Public Health 1981; 71:591-600.
16. Roos NP, Roos LL Jr. Surgical rate variations: do they reflect the health or socioeconomic characteristics of the population? Med Care 1982; 20:945-58.
17. Wennberg J, Gittelsohn A. Variations in medical care among small areas. Sci Am 1982; 246(4):120-35.
18. McPherson K, Wennberg JE, Hovind OB, Clifford P. Small-area variations in the use of common surgical procedures: an international comparison of New England, England, and Norway. N Engl J Med 1982; 307: 1310-4.
19. National Center for Health Statistics. Utilization of short-stay hospitals: annual summary for the United States, 1980. (Series 13, No. 64). Hyattsville, Md.: Department of Health and Human Services, March 1982. (DHHS publication no. (PHS)82-1725).
20. Gornick M. Medicare patients: geographic differences in hospital discharge rates and multiple stays. Soc Secur Bull 1977; 40:22-41.
21. *Idem*. Trends and regional variations in hospital use under Medicare. Health Care Financ Rev 1982; 3(3):41-73.
22. Deacon R, Lubitz J, Gornick M, et al. Analysis of variations in hospital use by Medicare patients in PSRO areas, 1974-1977. Health Care Financ Rev 1979; 1(1):79-108.
23. Connell FA, Day RW, LoGerfo JP. Hospitalization of Medicaid children: analysis of small area variations in admission rates. Am J Public Health 1981; 71:606-13.
24. Chassin M. Variations in hospital length of stay: their relationship to health outcomes, Washington, D.C.: Government Printing Office, 1983. (Health Technology case study 24. OTA publication no. OTA-HCS-24.)
25. Office of Statistics and Data Management. Medicare patient origin and destination data by PSRO, 1979. Baltimore: Health Care Financing Administration, March 1981.
26. Chassin MR, Brook RH, Park RE, et al. Variations in the use of medical and surgical services by the Medicare population. Santa Monica, Calif.: Rand Corporation (in press).
27. Physical characteristics and distribution in the U.S. Chicago: American Medical Association, 1981.
28. Brook RH, Lohr KN, Chassin MR, Kosecoff J, Fink A, Solomon D. Geographic variations in the use of services: do they have any clinical significance? Health Affairs 1984; 3(2):63-73.
29. Fink A, Kosecoff J, Chassin M, Brook RH. Consensus methods: characteristics and guidelines for use. Am J Public Health 1984; 74:979-983.