Measuring Community Hospital Services in Michigan

John R. Griffith, Joseph D. Restuccia, Philip J. Tedeschi, Peter A. Wilson, and Howard S. Zuckerman

Using discharge abstracts from Michigan hospitals, we divided the state into hospital use communities with measured populations. We constructed population-based rates measuring use, cost, and some aspects of quality. The results cover 54 communities comprising 90 percent of the Michigan population and ranging in size from Detroit (population 600,000) to very small (population < 25,000) communities. Age-adjusted patient days per 1,000 population, length of stay, cost per person per year, hospitalization rates for surgery, trauma and vascular disease, and childbirth problems show large variations, generally ranging from 2 to 1. High values usually are positively associated with each other and with population size. Patient days per 1,000 (mean 1,114, range 600–1,700) and cost per person (mean $223, range $110–$290) are distributed such that almost 75 percent of communities are below the mean. We believe this information will be useful to community hospital trustees, physicians, and administrators.

This research is supported by the W.K. Kellogg Foundation and the Health Care Financing Administration, DHHS, under grant no. 05-P-97227/5.

Address communications and requests for reprints to John R. Griffith, Professor and Director, Department of Hospital Administration, SPH II—Rm. M3212, The University of Michigan, 1420 Washington Heights, Ann Arbor, MI, 48109. Joseph D. Restuccia is Assistant Professor, Health Care Program and Operations Management Department, Graduate School of Management, Boston University, Boston, MA. Philip J. Tedeschi is Research Associate, Department of Hospital Administration, The University of Michigan. Peter A. Wilson is Assistant Professor, Department of Hospital Administration, The University of Michigan. Howard S. Zuckerman is Assistant Professor and Associate Director, Department of Hospital Administration, The University of Michigan.

0017-9124/81/1602-0135/$02.50/0

INTRODUCTION

Population-based measures of hospital use are known to vary widely under different circumstances of geography and medical care delivery. Unexplained variations in patient days per 1,000 population, length of stay, and per capita cost have been detected at regional levels [1], state levels [2], between Blue Cross plans [3], and between conventional and HMO organizations [4,5]. Few efforts have been made to pursue these variations at smaller geographical levels. The principal prior work by Wennberg and Gittelsohn shows major variations, generally ratios of 2 to 1 between high and low, in these measures for communities in Vermont [6] and Maine [7]. Other work, dealing mostly with surgical incidence, shows similar variations among ostensibly similar small areas [8–10].

This article presents the first comprehensive report on community hospital services for a major industrial state. It provides measures of use and cost and some indicators of quality, broadly defined. Values are reported for data from the first six months of 1978, on 54 Michigan communities with a combined population of 8,000,000; these data cover 90 percent of Michigan's lower peninsula. The communities include Detroit and several adjacent suburban areas, all other places with populations over 100,000 with the exception of Lansing, and 27 smaller rural communities in the lower peninsula. Many hospitals in the upper peninsula, a large land area with less than 400,000 people, declined to participate in the study. Generally, the measures show even larger variation than previously reported; there is wide diversity within regions of the state and a tendency for larger cities to have higher rates of use and cost.

THE COMMUNITY HOSPITAL PERFORMANCE MEASURES PROJECT

For decades, community hospital decision-makers operated in an environment of seemingly unlimited financial support and apparent public enthusiasm for expansion and modernization. In recent years, however, concern has developed over the effects of this growth, particularly with regard to costs and the increasing burden on taxpayers. Containing costs is by no means a simple matter, for serious questions arise regarding access, quality, and employee compensation. The planning and operating environment has changed dramatically, necessitating reconsideration of hospital goals and mechanisms for evaluating hospital performance. To meet these changing responsibilities, hospital decision-makers require information on such fundamental matters as the nature of the community they serve, how much care the community uses, how much the care costs, and the quality of the care.

The Community Hospital Performance Measures Project[1] is an effort to provide decision-makers in each Michigan community with a few uniform well-understood measures that describe the use, cost, and quality of hospital care. The measures are based on the community served; they are expressed in per-person terms because this permits easy comparison between communities and because cost and use per person are related to larger economic units at the state and national level. The measures are analogous to standard financial reports, balance sheets, and income statements and thus may be used as guides to current conditions and trends when making decisions that will affect the future directions of a community.

Given information on their own and comparable communities, local decision-makers can set explicit goals for the direction and magnitude of changes. A decision-maker might, for instance, reasonably infer that increases in cost and use influence the community's ability to compete in nonhealth sectors, through the impact of insurance premiums on production costs. Decreases in health care costs may reduce local employment in health care and impair patient satisfaction, physician recruitment, or quality of care [11]. The quality indicators can serve as guides both to problems and opportunities.[2]

DATA SOURCES

The Michigan measures were compiled from six sources: the most recent Minor Civil Division population estimates were taken from Series P25 of the U.S. Bureau of the Census [13]; age estimates were taken from the Michigan Department of Management and Budget [14]; and more current county population estimates were taken from Series P26 [15]. (Local estimates by the Southeast Michigan Council of Governments were used within the seven-county area around Detroit, but the total was adjusted to equal Series P26.) Patient care abstracts for each hospital discharge were obtained through a statewide program known as the Patient Origin and Hospital Use Study, which is processed by the Commission on Professional and Hospital Activities [16]. Cost reports, submitted routinely by hospitals to Blue Cross and Blue Shield of Michigan, were used for cost data. All sources of information currently exist; thus, no additional data were required from hospitals. Certain quality indicators were supplemented from Vital Statistics files [17].

HOSPITAL SERVICE COMMUNITIES

The notion of a community hospital suggests that there is a service population. Using the population and patient origin data, we define, for each hospital in the state, a service population reflecting the actual choices made by individuals, following the method outlined by Griffith [18]:

> If discharge abstracts are collected covering all patients of all hospitals over a large geographic area . . . and if each abstract contains a code identifying the patient's residence in terms of a small geographic area, it is possible to identify quite precisely both the amount of hospital use in each small area and the preference of users for specific hospitals. The most common small geographic area is the postal zip code area. The hospital preferences of small area residents are called "Relevance Indexes" (R.I.) and are mathematically defined as follows:
>
> $$\text{R.I. for Hosp. A.} = \frac{\text{Discharges from Hosp. A.}}{\text{Discharges from all hospitals}}$$
>
> There is a relevance index for each hospital used by residents of each small area. The sum of all the numerators (Hosp. A, B . . .) is "Discharges from all hospitals" for the small area in question. The sum of all R.I.s for a given small area is 1.0.
>
> In actual tests, most hospitals serve several zip codes and most zip code populations use several hospitals. The service community for each hospital can be defined in terms of the Relevance Indexes for all the zip code areas it serves. The service population of a specific hospital can be numerically estimated by multiplying the population of each zip code by its relevance index and summing over all, or all the important, zip codes served. A hypothetical "Hospital A" might have the following service population:

Zip Code Number	*Zip Area Population*	*R.I. (Hosp. A)*	*Contribution to Service Population (Col. 2) × (Col. 3)*
1*	30,000	0.7	21,000
2	10,000	0.6	6,000
3	7,000	0.4	2,800
4	20,000	0.2	4,000
All other	(very large)	(neg)	(neg)
Service population			33,800

*Hospital A is located in zip code 1.

Note: the relevance indexes of Hospital A do *not* sum to 1.0 (or any other predictable number), and the percentage of Hospital A's discharges who come from an area is called the Commitment Index. It has little predictable connection with the R.I. and should not be confused with it.

In many parts of Michigan, two or more hospitals are important to a geographically-related group of small areas; that is, their service populations overlap extensively. In such cases, service populations are combined and performance measures are reported for the group of hospitals sharing responsibility for a common population. These groupings of hospitals are referred to as "clusters." We identified the clusters by means of a computer algorithm that detected overlapping service areas and combined them. The output of the algorithm, which often included alternative possibilities for combination, was reviewed by specially designated committees composed of hospital administrators and HSA staff for each of the seven HSAs in the lower peninsula [19].

Calculation Procedures

AREA POPULATIONS

It is necessary to have population estimates for zip code areas because discharge data are coded by zip codes. We translated Minor Civil Division (MCD) population estimates for each of four age categories (0–14, 15–44, 45–64, and 65+) into zip code areas using computerized estimates of geographic boundaries. To allocate population from the MCD to the zip code, we used the ratio of the area of intersection of a zip code with an MCD to the inhabited area of the MCD [20]. (Large forests, parklands, and lakes were excluded from the area calculations.)

SERVICE COMMUNITIES

The principal problem in calculating population-based measures for monitoring, control, and planning purposes lies in attributing populations to institutions under circumstances of customer and/or physician choice. It has long been known that there is a tendency for people to select a nearby hospital for care [21], but that tendency is neither overwhelming nor uniform [22,23]. Thus it is important to estimate service populations empirically, rather than arbitrarily. The usual measure relies upon market penetration or a fraction of the total admissions from a given small geographic area to the hospital(s) under study [22–32]. This statistic requires a massive data collection effort, because significant numbers of people travel long distances for care, and the omission of a source will distort the resulting calculations. (Any arbitrary stopping point to data collection creates some distortion, particularly for nearby communities. Heavy traffic out of the area under study is likely to be disabling.)

Once the mechanical problem of data collection is solved, a second knotty issue emerges. How should the boundary of the community be determined? In the town or city where a hospital is located, the market penetration is usually over 75 percent, and for well-equipped specialty centers it can exceed 95 percent. But in some metropolitan areas where there are numerous hospitalization opportunities, market penetration can go below 60 percent even within the immediate area. The further the geographic area is from a hospital, the lower the market penetration, but the rates of decay differ with geography. Arbitrary solutions—for example, the city or the county—hide a great deal of disparity in the actual number of people served by local institutions.

Two basic solutions to this problem have previously been attempted. Lembcke [33] used all of the population where the market penetration is 50 percent or more (the equal likelihood method). Wennberg [34] appears to have used a rule assigning each small area to the hospital(s) having a plurality (the plurality method). Our solution is to use a weighted population sum, the product of the small area population and the market penetration of the hospital(s) taken over a set of small areas where market penetration is significant (the product moment method).

Unlike the Lembcke and Wennberg approaches, the product moment approach has no arbitrary cutoff point. All the relevance indexes, anywhere in the state, are multiplied by the population of each small area and summed. We performed the product moment calculation at five levels of market share: 50 percent, 25 percent, 12.5 percent, 6.25 percent, and any market penetration. These levels yielded different use rates (as described below). Study of the rates at each level shows that the variance in rates is largest at the 50 percent level, and that substantial averaging occurs among the clusters at the zero, or total service population, level. The change in rates is more pronounced when moving from the 50 to the 25 percent level, and from the 6.25 percent to the zero level. However, some communities have very small populations at the 50 percent level, and the accuracy of the population estimate deteriorates as the population becomes smaller. As a result of these considerations, we selected service areas defined at the 12.5 percent level for all use-related measures [35,36].

Use of a market penetration level of 12.5 percent and higher for summing ameliorates the weaknesses of the product moment approach by limiting the overlap. Since medical referrals are usually less than 5 percent of hospitalizations, this has the effect of removing remote referrals to large referral communities. It does not, however, replace the patients referred from smaller communities. Work is underway to study the impact of the product moment and equal likelihood methods on rates for Michigan communities. In the meantime, considerable caution is desirable.

In reporting the results of our calculations to Michigan communities, our two major precautions are the 12.5 percent limit and the use of comparison groups of similar-sized communities. Reports are prepared for each community in the state, and data bases are prepared for statistical investigation.

Results

USE MEASURES

Three key measures are reported here: patient days, discharges (both excluding obstetrics patients and adjusted for age [37]), and a ratio indicating actual average length of stay as a proportion of expected average length of stay.

Patient Day Rate

The effect of age adjustment on patient day rates is significant, with 24 percent of the communities experiencing a shift of greater than 10 percent from the unadjusted rate. Adjustments of this magnitude raise serious questions about the usefulness of crude data.

Figure 1 portrays the distribution of the age-adjusted day rate for 54 communities. The range is greater than 2.5 to 1, with a median of 978, an unweighted mean of 1,027, and a population-weighted mean of 1,144 patient days per 1,000 population. From these statistics, it can be inferred that the distribution is skewed toward high use, with an association of use and community size. Large ranges (nearly 2 to 1) exist among communities of similar sizes and referral rates.

Discharge Rate

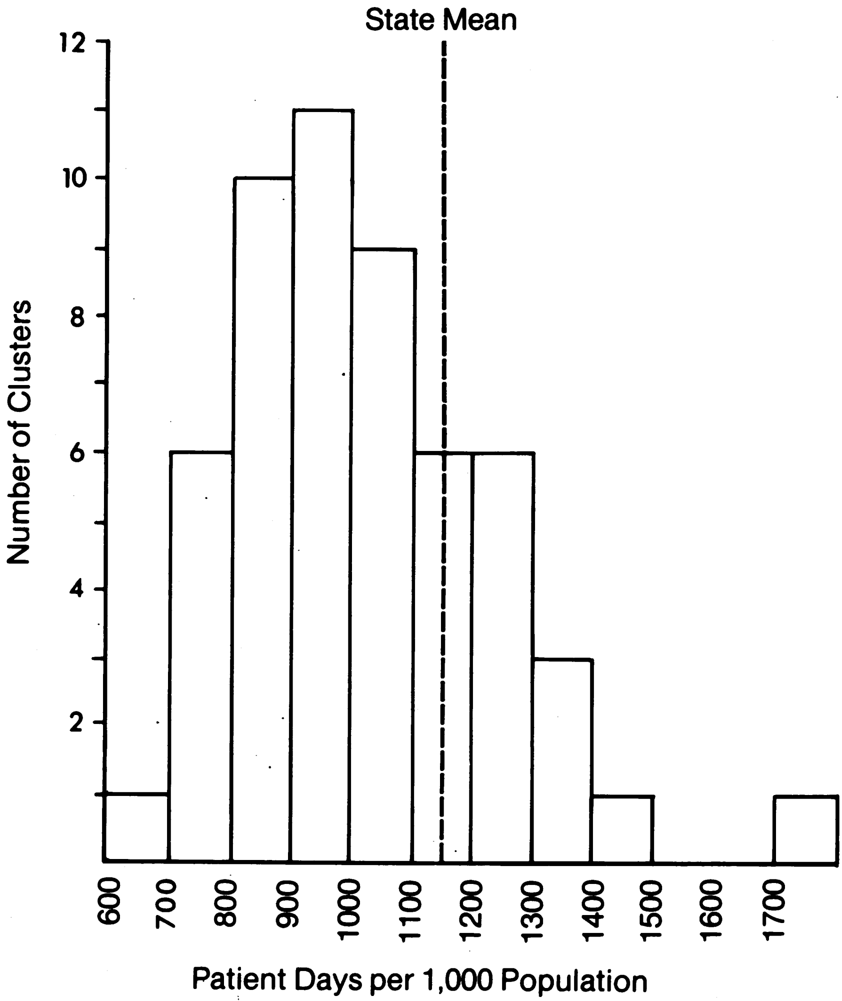
Figure 2 displays the discharge rates. The range is just under 2 to 1, with a median of 141, an unweighted mean of 143, and a population-weighted mean of 138 discharges per 1,000 population. The distribution is not skewed, and there is no apparent association of discharge rate with community size. There are large ranges among similar communities.

Length of Stay

Variations in the actual lengths of stay observed in communities reflect both differences in the use of hospital days in medical treatment and differences in the kinds of patients treated in the community. Community case-mix and the average length of stay expected for treatment vary with the range of services available. We calculated state average lengths of stay for CPHA's case-mix categories[3] [38]; the resulting expected lengths of stay indicate what would be observed if the community's patients were treated like the average of all similar patients in Michigan.

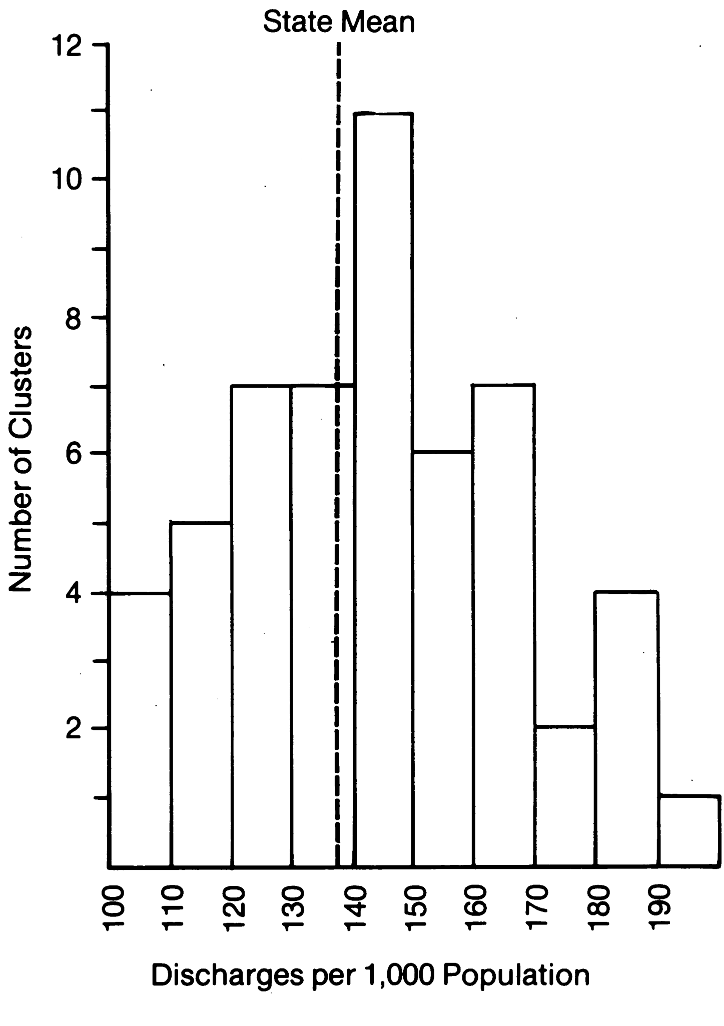
Community-specific expected lengths of stay indicate the relative effect of the community's patient mix on length of stay. Ten of the 43 communities for which data are reported have an expected length of stay

Figure 1. Age-Adjusted Patient Day Rate: 54 Clusters



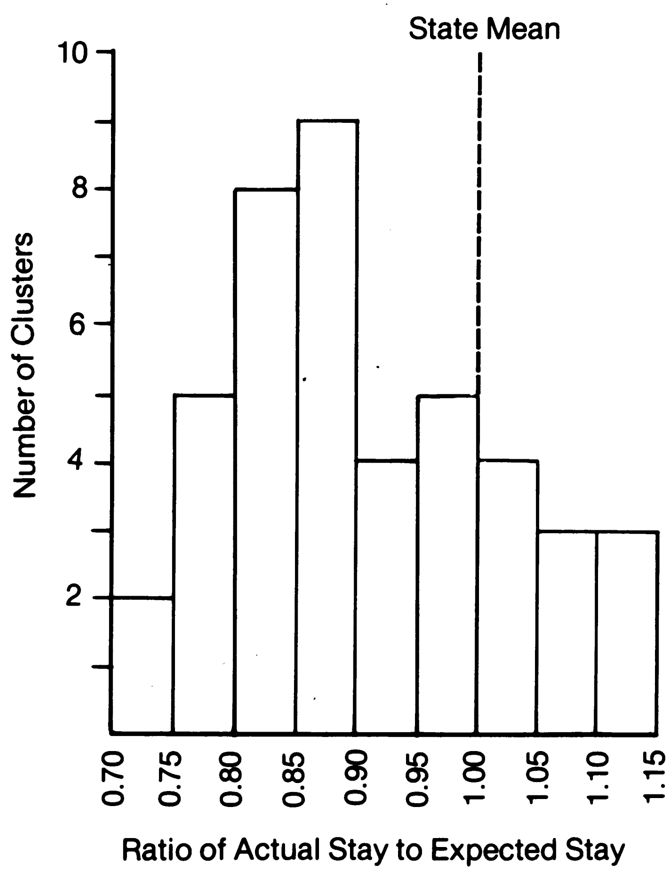
Proportion less than state mean: 75%

Figure 2. Age-Adjusted Discharge Rate: 54 Clusters



Proportion less than state mean: 40%

Figure 3. Length-of-Stay Ratios: 43 Clusters



Proportion less than state mean: 77%

varying more than 10 percent from the state mean. This finding indicates a substantial impact of case-mix variation upon crude length of stay. It supports the conclusion that crude use data can be misleading when communities are compared.

When actual length of stay is divided by expected length of stay, a productivity indicator related to efficiency of hospital stay is created. It is referred to as length-of-stay ratio (Fig. 3). Hospitals with values above 1.0 keep similar patients longer than the state average. The range of performance is 0.7 to 1.15, or 1.6/1; the distribution has a weighted mean of 1.0. Although this measure is not population-based, and is therefore free of the population definition arguments, the distribution of community values is modestly skewed. There appears to be a strong association of community size with high length-of-stay ratio.

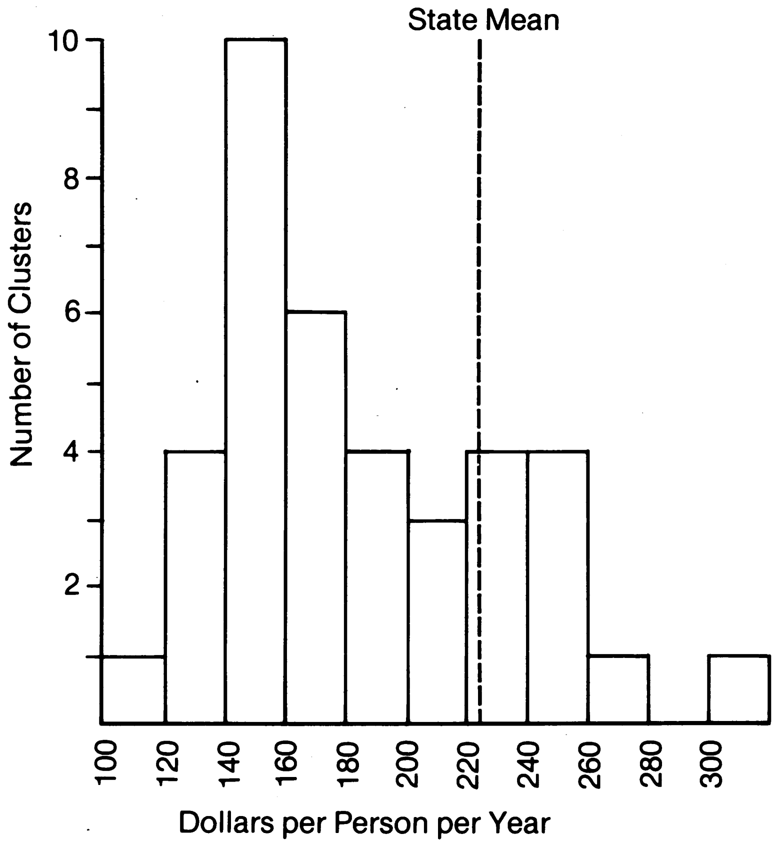
COST MEASURE

The cost question of greatest social importance is the annual per capita cost, analogous to the insurance premium or tax burden. For inpatient hospital care, this can be estimated by calculating the total inpatient cost of hospital operation in the community, divided by the total (as opposed to the 12.5 percent level) population served. The substantial impact of age on use suggests the desirability of age-adjusted hospital cost measures. We did this by multiplying the crude inpatient cost by the ratio of adjusted to crude patient-day rates.[4] Because the 12.5 percent correction is not available (it would require a patient-specific file of costs or charges), the measure is particularly susceptible to error. It is of interest, however, to compare ostensibly similar cities and discover differences of $100 per person per year. Figure 4 displays the results for the 38 communities that have released complete cost data. The range of values is 2.8 to 1, with a median of $170, an unweighted mean of $183, and a population-weighted mean of $223. The distribution is skewed to the right, with a strong association of community size with cost. It is notable that the missing cases (22 communities overall) include the three communities with medical schools and the highest tertiary services, and therefore, presumably, high costs. The data reported can be taken as reflecting primarily nontertiary care. Ranges in excess of 2 to 1 have been detected in communities of similar size.

QUALITY INDICATORS

The Project deliberately sought a broad definition of quality, akin to the economists' "taste," or Donabedian's [39] concepts of quality. Also, the measures had to be available from the existing data set. What emerged are measures that mostly stress reasons for hospitalization. They are intended to raise broad issues of health status and health maintenance; in this sense they may be said to indicate "quality." Although the hospital itself, as traditionally defined, has only partial control over these reasons for hospitalization, hospital trustees, physicians, and administrators have opportunities to influence them through their community leadership. The measures also appear consistent with the project goal of assisting management in decision-making. Decisions about cost and use will

Figure 4. Age-Adjusted Inpatient Cost: 38 Clusters



Proportion less than state mean: 75%

become more valid if they include available information about the nature of hospital use.

We convened a statewide panel of physicians which reviewed the literature on potentially useful indicators available from patient abstract data. The indicators the panel selected are not comprehensive or definitive; only diagnoses or conditions that could be obtained from the discharge data base are included [40]. An effort was made to identify indicators that are relatively free of coding errors and that occur with high frequency. A criterion for acceptance was that the indicator be amenable to change in some reasonable manner. It was understood, however, that

Table 1. Values and Associations of Quality Indicators ($N = 43$ communities)

Quality Indicator (Discharge Rate Unless Otherwise Noted)	Discharge Rates Per 10,000 Pop.			Ratio	Associations (Spearman's Rho)	
	Minimum	Maximum	Mean	Max. ÷ Min.	With Population Size	With Total Discharge Rate
Medical						
Vascular Disease	165.0	546.0	300.0	3.3	−0.21	0.36†
Ischemic Heart Disease	85.0	356.0	176.0	4.2	−0.14	0.26*
Cerebrovascular Disease	52.0	147.0	89.0	2.8	−0.19	0.29*
Hypertension	2.0	64.0	34.0	32.0	0.004	0.44†
Urinary Tract Infection	3.0	17.0	8.5	5.7	0.09	0.53†
Obstetric-Perinatal						
Pregnancy under Age 18 (percentage of all pregnancies)	2.8	12.0	6.9	4.4	−0.15	0.32*
Pregnancy over Age 34 (percentage of all pregnancies)	0.7	5.5	3.5	7.9	0.03	−0.32*
Percentage Low Birth Weight	2.0	9.8	5.7	4.9	0.30*	−0.04
Prenatal Mortality (per 1,000 live births)	5.2	26.0	16.0	5.1	0.27*	0.09
Trauma						
Pediatric	29.0	158.0	78.0	5.4	0.06	0.59†
Young Adult	78.0	317.0	163.0	4.1	−0.12	0.56†
Middle Age	54.0	200.0	97.0	3.7	−0.05	0.48†
Old Age	168.0	528.0	323.0	3.1	−0.31*	0.17

Continued

Table 1. Continued

Quality Indicator (Discharge Rate Unless Otherwise Noted)	*Discharge Rates Per 10,000 Pop.*			*Ratio*	*Associations (Spearman's Rho)*	
	Minimum	*Maximum*	*Mean*	*Max. ÷ Min.*	*With Population Size*	*With Total Discharge Rate*
Selected Surgical Procedures						
Hysterectomies	14.6	95.1	53.2	6.5	0.02	0.03
Appendectomies	10.1	48.2	19.5	4.8	-0.49†	0.25*
Prostatectomies	3.0	50.0	30.4	16.7	0.25*	-0.02
Oophorectomies	1.6	72.8	35.7	45.5	0.19	-0.002
Cystocele & Rectocele	5.5	36.5	16.2	6.6	-0.21	0.26*
Hemorrhoidectomies	1.6	22.5	7.8	14.1	0.19	0.36†
Cholecystectomies	14.4	53.4	24.2	3.7	-0.26*	0.11
Total Nine Selected Surgeries‡	62.3	196.3	127.0	3.2	0.09	0.30*

*Significant at $0.05 \geq p > 0.01$

†Significant at $p \leq 0.01$

‡Includes laminectomy, knee resections

the method used to make changes need not be proved, and that it might go substantially beyond the hospital walls. (Trauma admission among the aged and teenage pregnancy rates provide two interesting examples.)

The quality indicators should help community decision-makers to (1) provide assurance to local communities that important patient-care needs are met; (2) identify diagnoses or conditions where potential improvement in performance may be possible after further local investigation; and (3) monitor changes that may follow changes in the delivery of medical care (e.g., addition or deletion of hospital beds, medical personnel, medical care programs) or in the per capita use or cost of hospital care.

The indicators are reported for 37 communities providing complete data and 6 communities providing at least 95 percent complete data. Obstetrics data were obtained from the Office of Vital and Health Statistics, Michigan Department of Public Health, and cover all communities in the study.

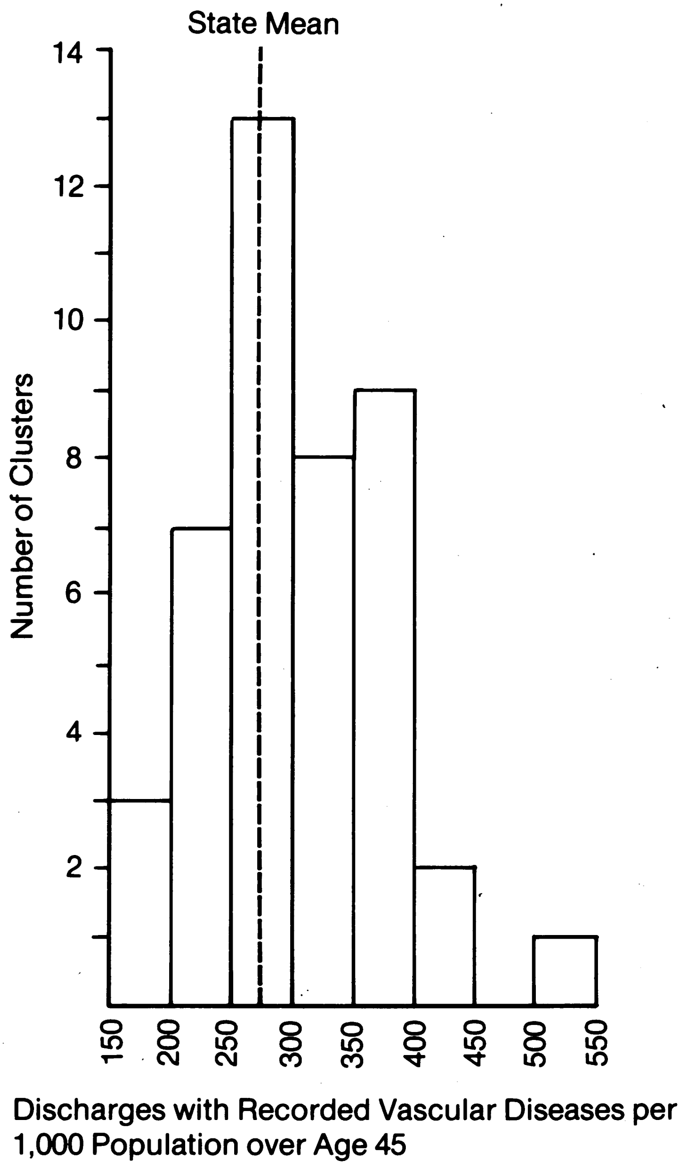
The indicators can be classified into four groups: surgical, medical, trauma, and obstetric-perinatal. Table 1 displays descriptive information for the indicators. Almost all of these measures show wide variation between communities. Most of these variations are associated with the size of the community; larger communities tend to have higher rates. The residual variation within communities of comparable size remains large, however, suggesting that there are local causes of variation that communities may wish to investigate and/or change. There are reasonable methods for changing each of the measures, although many of the methods may require actions beyond the walls of the traditional hospital. Two of the measures, selected surgical procedures and vascular disease, illustrate these points.

Selected Surgical Procedures

We selected nine surgical procedures for separate reporting. (Two, laminectomies and knee resections, proved unreliable as individual indicators.) The panel felt that since these procedures are almost exclusively performed in hospitals, there would be little distortion of rates due to outpatient surgical treatment. Also, previous studies indicated that there is substantial physicial-patient discretion over whether or not the procedure should be performed; as a result, differing views or styles of medicine would yield different rates.

The aggregated age-adjusted rate of the nine procedures shows an exceptionally high range (over 3 to 1) in Table 1. The measure is not associated with population size; there is variation between communities of comparable size. The specific age-adjusted rates of each of the nine

Figure 5. Vascular Disease Rate: 43 Clusters



surgical procedures also show high ranges. Since some of these procedures—especially prostatectomy, excision of knee cartilage, and laminectomy—are rarely performed in smaller rural hospitals, we reviewed the range with communities of less than 25,000 excluded. Even with this exclusion, for each of the 9 procedures, the high community exceeds the median community by a factor of about 2 or more.

A community that wishes to lower its surgical incidence rates has a variety of mechanisms open to it. It can ask its surgeons for written criteria for specific surgery, and for medical audits [41,42]. It can direct recruitment efforts away from surgeons, restrict surgical privileges, implement second-opinion programs, and use various techniques to educate patients about nonsurgical alternatives. A community that wishes to raise its surgical rates (and some small communities do) probably needs only to recruit surgeons. (The question of the "right" rate is fascinating but too complex to discuss here. As with most such value issues, the data report actual; the community must identify desirable.)

Vascular Disease

Vascular disease includes ischemic heart disease, cerebrovascular disease, and hypertension. The measure reported is all vascular disease among hospitalized patients over 45 years of age.[5] Since vascular disease is less common among younger persons, the age specificity should improve the sensitivity of the measure. For all vascular diseases (Fig. 5), the range among communities varies from a high of 546 hospital discharges per 10,000 population to a low of 165 per 10,000, more than a threefold difference. The high is almost twice the median rate of 292.

Vascular disease rates may be affected by educational and treatment programs dealing with smoking, obesity, and physical fitness. Presumably, any community with high rates, and perhaps any community at all, would wish to investigate the possibility of eliminating hospitalization by prevention. Hypertension control appears particularly promising in this regard. Utilization review procedures may also be useful. Home care and office care can be improved. While these approaches go well beyond conventional definitions of hospital management, the decision-makers in local communities have considerable influence and can bring other community systems, such as schools and the workplace, into educational programs.

ASSOCIATIONS

Table 2 is a rank correlation matrix using Spearman's Rho. Correlations appear for the 43 communities that have complete data for quality variables. The measures studied are service population, age-adjusted

Table 2. Simple Rank Order Correlations for Key Measures of Michigan Hospital Services ($N = 43$ communities)

Variable Number	*1* Service Population	*2* Discharges /Pop.	*3* Patient Days /Pop.	*4* Inpatient Cost /Pop.	*5* Surgical Discharges /Pop.	*6* Case-Mix Index	*7* Length-of-Stay Ratio
SP 1	1.0	—	—	0.62	0.68	—	0.62
DSRT 2		1.0	0.63	—	—	0.53	—
PDRT 3			1.0	0.55	0.46	—	0.55
IPCST 4				1.0	0.61	—	0.50
SDSRT 5					1.0	—	0.40
LOSINDEX 6						1.0	—
LOSRATIO 7							1.0

Spearman rank correlation; all measures except *service population* are age adjusted; *case-mix index* is ratio of expected length of stay to state mean, using CPHA length-of-stay adjustment algorithm for age, diagnosis, surgery, and complication; length-of-stay ratio is ratio of actual LOS to case-mix-expected LOS.

—not significant at $p \leq 0.05$; $Rho_{0.05} = 0.35$, $Rho_{0.01} = 0.46$.

nonobstetric discharge rate and patient day rate, the length-of-stay index (indicates case-mix complexity) and length-of-stay ratio (indicates length-of-stay efficiency as compared with the state average), the age-adjusted rate for all surgeries, and the age-adjusted per capita inpatient costs.

As the weaknesses of the population measure would predict, several key variables are associated with size of population. Michigan's larger cities have higher costs and higher surgical discharge rates. They do not, on balance, treat longer-stay cases (Rho = 0.04) as measured by the state case-mix standard, but they do keep the same cases longer. The cost finding is predictable: labor costs are higher in the cities, and fewer small places have completely equipped secondary referral hospitals. At least part of the association of surgical rate with size is attributable to referrals that do not count in the small hospitals' indicators.

Not unexpectedly, high costs per capita are associated with high surgical rates and longer than average case-mix-adjusted lengths of stay (length-of-stay ratios greater than 1.0). The last two indicators are associated with each other as well. It appears that a number of communities could launch a successful attack on costs via length of stay and rate of surgery.

We performed a two-way analysis of variance for selected key variables using as independent variables HSA location and POPSTRATA (a categorical variable with the following categories: Detroit and immediate suburbs; large cities with population greater than 100,000; small cities with population less than 100,000 but greater than 25,000; and rural areas with population less than 25,000). After we discounted population differences, we found HSA location to be of little or no predictive significance.

Discussion

Our findings provide a rich opportunity for further analysis. The Project will undertake studies of specialized populations, in particular the Medicare age group and the portions of the population insured by Medicaid and Blue Cross. We will study a number of demographic variables (race, income, rural residence, mortality, etc.) to determine their impact upon the major measures. In addition to analytic activities, we are visiting each of the Michigan communities to acquaint local decision-makers (hospital trustees, medical staff, and administrators) with the situation in their community and to suggest ways in which the measures can be used for hospital operating decisions. We believe that such feedback will lead to operational changes. On the whole, the findings suggest a number of complex factors affecting the measures. It is likely that changes will be related to factors well beyond the traditional scope of hospital management control.

Several conclusions are supported by the initial data. One of the most important of these is that age adjustment is necessary to permit reliable comparisons between communities. (This is obvious, but it is frequently overlooked in planning and policy discussions. The very strong dependence of hospital use upon age makes it unwise to compare crude rates.) Clearly it would be desirable to have finer categories of ages. Because of the small numbers of the very young and very old, it is not possible to estimate these populations reliably. Thus further improvement must await the results of the 1980 census.

The distributions of cost and patient day rates are notably skewed to the right. This effect is attributable only in part to the fact that smaller communities are more numerous and tend to have lower values because of estimation problems. About three-quarters of the communities in Michigan fall below the means. This finding has significant policy implications: policies for planning and cost control based upon state averages can be predicted to have a widely varying impact on communities of different sizes.

The ranges of hospital services on key measures are in line with previous reports, but are generally larger than the Wennberg-Gittelsohn findings. This may be attributable to the greater diversity of the Michigan population compared with Maine and Vermont. Michigan has one large conurbation around Detroit, generally defined as coincident with HSA

1—seven counties with a population of 4,800,000. Michigan also has many more cities in the large urgan category and the large rural category. At the time of collection of the Wennberg data, only one city in Maine or Vermont had more than 50,000 people.

Population size is an important predictor of hospital use. This may mask estimation problems and a variety of socio-economic factors related to community size. For the adjusted patient day rate, small rural communities are disproportionately in the lowest quartile, and cities over 100,000 are disproportionately in the highest quartile. Preliminary studies of geographic measures indicate that this tendency persists, although in diminished form. However, it is noteworthy that large ranges occur even *within* population groups. The contribution of small rural communities is in total quite small; these communities account for less than five percent of the total population reported.

Region, on the other hand, is a poor predictor of community hospital use. The lower peninsula of Michigan is divided into seven HSA regions, which to a large extent parallel the historic groupings of hospitals and counties that existed in Michigan more than 20 years ago [44]. In spite of this fact, interregional differences are not great, and appear to be partially explicable on the basis of variation in population size. After controlling for size, there are no significant regional differences between the major measures. The regions also have a history of economic differentiation. HSAs 1, 5, and 6 are heavily within the orbit of the auto economy. Large segments of their populations are insured by Blue Cross and Blue Shield, and the prevailing contracts in these areas resemble those of the auto workers. Nonetheless, there is almost as much variation in hospital use within these regions as there is between them and the balance of the state. It appears unlikely that a simple geographic variable can explain major portions of this variance. Study of the detailed data indicates that large differences exist between ostensibly similar communities. During a 150-mile drive along one of the major highways, one would pass, in order, communities with the following patient day rates per 1,000 population: 900, 1,000, 1,300, 1,400, 900, and 900. Five of these six communities are large cities. Twice in the trip, a 30-mile drive would bring more than a 20 percent change in the use rate.

There is, in general, a positive association between the measures. That is, a community found to be high on any one of the measures tends to be high on most of the measures. These association generally have correlation coefficients (Rho) on the order of 0.3 or less. Only the largest exceed 0.6. While statistically significant, most explain only modest portions of the variance in hospital use. One would assume that some fraction of the variance is attributable to differences in morbidity among the communities. Empirical data on morbidity are, unfortunately, difficult to obtain. Available household surveys of activity limitation are not reliable at the community level. Reportable diseases other than carcinoma are mostly communicable diseases treated outside the hospital.

Mortality data are one possible proxy for morbidity. Measures of standardized mortality, infant mortality [45], and cancer mortality [46] are available on a county basis; we have converted these to estimates for the communities. In addition, from the quality indicators, low birth weight, trauma discharge rates, and cardiovascular discharge rates might be taken as morbidity indicators, although there are some hazards in doing so. Analysis of these measures does not support the hypothesis that morbidity is associated with age-adjusted use. Spearman rank coefficients for each of these measures and the adjusted patient-day use rate are not significant. In short, there is no evidence that variation in morbidity explains a significant portion of variation in hospital use.

One is left with the impression that the performance of the Michigan communities is dependent upon many causes, at least some of which are highly localized. The opportunity for local communities to review and consider these findings may lead over a period of time to substantial revision of local goals and behavior. Discussions with local community hospital staffs have already begun, and early participation is more promising than expected. Our presentations are made in two stages: first to administrators only, and later to administrators, trustees, and medical staff representatives. Some community members have been chagrined but have taken a "let's get to work on this" approach. Although we have been questioned closely on methodological issues, we have encountered no serious objections to the study. Doctors have been particularly attentive to methodological issues but thus far have accepted the project and, in some cases, inquired about further presentations to their colleagues.

One community, whose high level of hospital use is obvious from crude estimates and insurance claims, had already begun working on length-of-stay reduction. They were pleased to see that their stay, which had dropped one full day in recent years, is now close to state averages on a case-mix-adjusted basis. (Length of stay is the only measure calculable solely from local data; case-mix-adjusted comparisons with other Michigan communities are new.) Discharges per capita have remained high, however, and are now a priority target. The community is pursuing a broad-scale program to reduce both measures, using utilization review, prevention programs, physical and patient education, and substitutes for inpatient care. The presentation helped renew the vigor and breadth of their attack.

Communities with low use and cost have not been smug; they have tended to look on state averages as a cause for concern over what could occur. In one large city with low use and cost, an administrator noted that to make up the difference between their use and average state use would "require another hospital the size of [hospital X], which would cost $100 per person per year." Several doctors and administrators cautioned the group about the dangers of going lower, citing concerns about delays for admissions and beds available for emergencies. The chairman of the trustees of a second hospital noted that the expected population growth in the 1980s would require careful, collaborative planning if satisfactory care is to be given, over-building is to be avoided, and costs are to be held at current levels.

It remains to be seen whether the measures fulfill their purpose. They are imperfect, and particularly in the "quality" area, they are incomplete. They are also very difficult to use. Because most hospitals are located in multihospital towns or cities, the measures call for a community approach rather than an individual hospital approach. (Unilateral actions taken by single hospitals can be ineffective and in some cases dangerous; for example, a hospital that presses too hard to reduce surgery or length of stay can drive physicians and patients away and erode its financial base.) The steps that may be taken to achieve the goal of use and cost reduction—utilization review, contraceptive education, second-opinion surgery, etc.—are tenuous and in some cases based on speculation. Lay trustees must face hard questions for which they are unprepared, such as how much surgery is enough? (Doctors may be no better prepared to answer this!)

There are, on the other hand, several positive features of the measures. The focus on per capita use and cost permits a conceptual link to issues of premium cost, taxation, and overall economic impact of hospital care—a link that has been unavailable to the well-intentioned hospital decision-maker. The focus on the community rather than the individual institution reaffirms a basic but often forgotten truth: people are trustees *of* the hospital but *for* the community. The inability to derive institution-specific data, sometimes noted as a weakness of the project, may be its strength: in multihospital communities, the important issues of hospital care cannot be understood from the perspective of a single hospital. The level of analysis, stressing a few key measures rather than a lengthy compilation, is both a strength and a weakness. Managers at the governing board level must focus on global issues rather than detail because they are the only ones with the authority and opportunity to do so. Any five surgeons can monitor an agreed-upon normal tissue rate, and a well-trained assistant administrator can keep costs to budgeted levels. Only trustees can sensibly discuss what increase in total costs should be budgeted, or whether the community should actively recruit surgeons. The broad focus does mean, however, that the measures do not indicate specific causes or corrections; questions that require additional, more sophisticated, data will therefore frequently arise.

The analogy to standard financial reports is instructive. Balance sheets and profit-and-loss statements seem to have evolved rather than to have been invented. The calculations are established by rules, and some rules seem highly arbitrary. Arguments about the accuracy of calculations and the design of reports are incessant. Financial statements are confusing for the unsophisticated, and they are deliberately manipulated by the sophisticated. They provide no guide either to what is "right" for a given entry or how to fix it if it is wrong. Yet few experienced managers would attempt to operate any sort of enterprise without them. Perhaps the measures used by the Project will evolve in such a way, providing for hospital management the data from which realistic health care goals can be set and achieved.

Notes

1. Formerly the Hospital Performance Measures Project. The Project is sponsored by the Michigan Health Data Corporation, a consortium of 14 governmental and voluntary agencies in Michigan. One hundred eighty-three acute general hospitals (of 200 in the lower peninsula) facilitated the project by releasing the data for study.
2. The relationship between health care expenditures and overall economic performance is complex and depends heavily on the local situation. Our measures do not eliminate the complexity, but they do offer empirical information. Cost per capita, use by the population, and the available quality indicators focus community attention on the possibilities. Local decision-makers must weigh these in the light of many other factors. Conceptually, the hospital service information that decision-makers can use to influence the directions of their community falls into three categories: (1) the size, location, and services of health care facilities; (2) the annual budgets of these facilities; and (3) the number and specialization of physician appointments [12].
3. CPHA's case-mix adjustment algorithm establishes expected stays from pooled data for 349 primary diagnosis groups, 5 age categories, presence or absence of additional diagnosis, and presence or absence of surgery.
4. An adjustment is made for service to non-Michigan patients based on the per diem cost. To adjust accurately to individual smaller communities, or to improve the age adjustment, would require patient-specific data, available only by adding an entire new data set on hospital charges to the system. While desirable, such an addition is costly and has not been attempted.
5. Detailed statistics on the three components are also being collected. However, prior work has indicated considerable variation in reporting [43].

References

1. Moienn, E.M. National Center for Health Statistics, *Inpatient Utilization of Short Stay in Hospitals by Diagnosis, U.S. 1975*, Series 13, No. 35, 1976.

2. Griffith, J. and R. Chernow. Cost effective acute care facilities planning in Michigan. *Inquiry* 14(3):29, Sept. 1977.
3. Blue Cross Association. *The Use of Hospitals by Members of Blue Cross Plans in 1973.* Research Series 13. Chicago: Blue Cross Association, 1975.
4. Roemer, M. and W. Schonick. HMO performance: The recent evidence. *Milbank Memorial Fund Quarterly,* 271, Summer 1973.
5. Gaus, C. R., B. S. Cooper, and C. G. Hershman. Contrasts in HMO and fee-for-service performance. *Social Security Bulletin,* May 1976.
6. Wennberg, J. and A. Gittelsohn. Small area variations in health care delivery. *Science* 182:1102, Dec. 1973.
7. Wennberg, J. et al. Health care delivery in Maine: I—Patterns of use of common surgical procedures; II—Conditions explaining hospital admission; III—Evaluating the level of hospital performance. *J. Maine Medical Association* 66:123, 255, 298, 1975.
8. Bunker J.P. Surgical manpower. *New England Journal of Medicine* 282, Jan. 1970.
9. Detmer, D. E. and T. J. Tyson. Delivery of surgical care: Inferences based on hospital discharge abstract data. *Surgical Forum* 27:460, 1976.
10. Lewis, C. E. Variations in the instance of surgery. *New England Journal of Medicine* 281:880, Oct. 1969.
11. Ellwood, P., W. J. McClure, and J. C. Rosala. *How Business Interacts with the Health Care System,* pp. 11, 12. Washington, DC: National Chamber Foundation, 1978.
12. Griffith, J. R. *Measuring Hospital Performance,* pp 11, 12. Chicago: Blue Cross Association (*Inquiry*), 1978.
13. U.S. Bureau of the Census. *Current Population Reports: Federal-State Cooperative Programs for Population Estimates,* Series P25. Washington, DC: U.S. Government Printing Office, 1976.
14. Michigan Department of Management and Budget. Michigan Population Estimates (annual).
15. U.S. Bureau of the Census. *Current Population Reports: Federal-State Cooperative Programs for Population Estimates,* Series P26. Washington, DC: U.S. Government Printing Office, 1976.
16. The Commission on Professional and Hospital Activities, 1968 Green Road, Ann Arbor, Michigan.
17. Michigan Department of Public Health, Office of Vital and Health Statistics. Measures of Perinatal Mortality (annual).
18. Griffith, J. R. *Measuring Hospital Performance,* pp. 16, 17. Chicago: Blue Cross Association (*Inquiry*), 1978.
19. Thomas, J. W., J. Griffith, and P. Durance. *The Specification of Hospital Service Communities in a Large Metropolitan Area.* Hospital Performance Measures Project Technical Paper No. 5, Program and Bureau of Hospital Administration, University of Michigan, 1979.
20. Tedeschi, P., H. Strand, and J. Griffith. *Translating Population Estimates from Minor Civil Divisions to Hospital Communities.* Hospital Performance Measures Project Analytic Paper No. 3, Program and Bureau of Hospital Administration, University of Michigan, 1979.
21. Lembcke, P. A. Measuring the quality of care through vital statistics based on hospital service areas: Comparative study of appendectomy rates. *American Journal of Public Health* 42:276, Mar. 1952.
22. Morrill, R. L. and R. Earickson. Hospital variation and patient travel distances. *Inquiry* 5(4):26, Dec. 1968.

23. Griffith, J. R. and B. Wellman. Forecasting bed needs and recommending facilities plans for community hospitals. *Medical Care* 17(3) Mar. 1979.
24. Griffith, J. R. *Quantitative Techniques for Hospital Planning and Control.* Lexington, MA: Lexington Books, D.C. Heath and Co., 1972, chap. IV.
25. Poland E. and P. A. Lembcke. Delineation of hospital service districts—Methodology and statistical appendices. Community Studies, Inc., Kansas City, 1962 (multilith).
26. Drosness, D. L. and J. Lubin. Planning can be based on patient travel. *Modern Hospital* 106(4):92 Apr. 1966.
27. Lash, M. P. and R. J. Caswell. Current legislation enhances health care planning prospects. *Hospitals, J.A.H.A.*, 49(26):59, Dec. 1975.
28. Zimmerman, P. Service areas and their needs must be re-assessed. *Hospitals, JAHA*, 49(17):46, Sept. 1975.
29. Wennberg, J. et al. Health care delivery in Maine: I—Patterns of use of common surgical procedures; II—Conditions explaining hospital admission; III—Evaluating the level of hospital performance. *J. Maine Medical Association* 66:123, 255, 298, 1975.
30. Denson, P., J. Fielding, J. Getson, et al. The collection of data on hospital patients—The Massachusetts Health Data Consortium approach. *New England Journal of Medicine* 302(3):171, Jan. 1980.
31. Deacon, R., J. Luditz, M. Gornick, et al. Analysis of variations in hospital use by medicare patients in PSRO areas, 1974–1977. *Health Care Financing Review* 1(1):79, Summer 1979.
32. Walsh, D. C. and W. Bicknell. Forecasting the need for hospital beds: A quantitative methodology. *Public Health Reports* 92(3):199, May-June 1977.
33. Poland E. and P. A. Lembcke. Delineation of hospital service districts—Methodology and statistical appendices. Community Studies, Inc., Kansas City, 1962 (multilith).
34. Wennberg, J. et al. Health care delivery in Maine: I—Patterns of use of common surgical procedures; II—Conditions explaining hospital admission; III—Evaluating the level of hospital performance. *J. Maine Medical Association* 66:123, 255, 298, 1975.
35. Leighton, E. and P. Headly. Computer analysis of length of stay. *Hospital Progress*, Apr. 1968.
36. Wilson, P. *Selection of Reporting Levels.* Hospital Performance Measures Project Technical Paper No. 6, Program and Bureau of Hospital Administration, University of Michigan, 1980.
37. Tedeschi, P. *Data Reductions Program for Hospital Performance Measures.* Hospital Performance Measures Project Technical Paper No. 7, Program and Bureau of Hospital Administration, University of Michigan, 1980.
38. Commission on Professional and Hospital Activities. *Length of Stay in PAS Hospitals.* Ann Arbor: CPHA, 1973.
39. Donabedian, A. *Explorations in Quality Assessment and Monitoring. Volume I: The Definition of Quality and Approaches to its Assessment.* Ann Arbor: Health Administration Press, 1980.
40. Restuccia, J. *Quality Measures for Hospital Performance Measures Reports.* Hospital Performance Measures Project Technical Paper No. 3, Program and Bureau of Hospital Administration, University of Michigan, 1979.
41. Lembcke, P. Medical auditing by scientific methods. *J. American Medical Association* 162:7, 1956.
42. Blackstone, M. A. Misallocation of medical resources: The problem of excessive surgery. *Public Policy* 22:329, 1974.

43. Demlo, L. K. et al. Reliability of information abstracted from patients' medical records. *Medical Care* 16:995, Dec. 1978.
44. McNerney, W. et al. *Hospital and Medical Economics*, pp. 728ff. Chicago: Hospital Research and Educational Trust, 1962.
45. Office of Vital and Health Statistics, Michigan Department of Public Health.
46. *Deaths Due to Cancer by County of Residence: Michigan 1970–79*. Lansing, Michigan: Michigan Department of Public Health, 1980.