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### Health Care Delivery in Maine III: Evaluating the Level of Hospital Performance

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## Health Care Delivery in Maine III: Evaluating the Level of Hospital Performance

JOHN E. WENNBERG, M.D., ALAN GITTELSON, Ph.D. and NANCY SHAPIRO

# Health Care Delivery in Maine III: Evaluating the Level of Hospital Performance

JOHN E. WENNBURG, M.D.,\* ALAN GITTELSON, Ph.D.\*\* and NANCY SHAPIRO†

Hospitalizations for common surgical and medical conditions vary extensively among different planning regions and Hospital Service Areas in the State of Maine.<sup>1,2</sup> We have suggested these differences should be taken into account in reaching planning or regulatory decisions and in selecting problems for peer review. However, to be taken into account, they must be measured directly or by surrogate indicators. Traditionally, the measures of use of health care by the population-at-risk have not been available for regional planning and regulation or for decision making by hospital administrators and physician staffs. The indicators of performance that are generally available provide comparisons among individual hospitals in their intensity of care per case treated, their need for facilities and the efficiency of management but not of their individual or collective impact on populations living in neighboring communities.

The purpose of this article is to test the utility of institutional indicators in predicting variations in per capita expenditures and bed-use rate. We are interested in the relative importance of intensity of care measures, length of stay, cost per case and cost per day in hospital, and the incidence of hospitalization in determining resource use. Studies are made of admissions for specific diagnoses and procedures and of hospitalizations for all causes. We examine the value of the occupancy rate and bed turnover rate in predicting per capita expenditures and the availability and use of beds.

Our studies show that institutional indicators are poor predictors of population rate of use and that a direct, epidemiologic approach to evaluation of performance is necessary if basic issues concerning medical necessity and distributional equity are to be identified. Case studies of selected hospital service areas in Maine and Vermont are presented to illustrate that planning, management or regulatory de-

isions which rely solely on institutional indicators are in hazard of increasing inequalities in distribution of resources among neighboring communities which show no evidence of differences in need for service. On the other hand, population-based data can aid decision makers in distinguishing inappropriate use of hospitals from shortage of bed supply.

## METHODS

The measurement of per capita use of hospital services by residents of hospital service areas (HSAs) or planning regions has been described in previous articles.<sup>1,2</sup> Data on incidence and resource use for individual procedures and for the condition causing admission to hospitals are for Maine hospital service areas, 1973. The medical conditions studied in this paper are acute and chronic infections of the respiratory tract; the International Classification of Diseases used in these diagnostic groupings have been previously given.<sup>2</sup> Per capita hospital bed use is measured by the patient day rate which is the number of days residents of an HSA spend in hospitals per 1,000 residents. In determining the rate, all hospital days are counted, whether the hospitalization is at a local or out-of-area facility. Incidence rates likewise reflect total population use. Since all Maine and Vermont short-term hospitals contribute data to the study, our statistics include nearly all uses of hospitalizations by residents of these areas.

For specific medical conditions and surgical procedures, the importance of average length of stay and incidence in predicting bed use is studied across the 13 largest Maine HSAs. All the HSAs have populations greater than 20,000 persons. Area-wide average length of stay is obtained by dividing the number of resident patient days by the number of resident discharges from hospital, without regard to location of hospital. Average charge per case is reported only by hospitals participating in the Maine Data Service Program and is therefore not available for all Maine hospitals. For the 8 HSAs with populations ranging from 20 to 50 thousand persons, data are available for each local hospital, and in these areas we use charges as our estimator of cost per case and per capita cost per procedure. For tonsillectomy, hysterectomy, her-

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niorrhaphy, hemorrhoidectomy and cholecystectomy, charges per case data is available. Within each area, the majority of these procedures is performed at local hospitals. For a given procedure, total area charges are estimated by multiplying for each local hospital the number of procedures performed on area residents by the hospital specific average charge per case and summing across the experience of all hospitals performing the procedure on area residents. Out-of-area hospital use included some hospitals not reporting average charge per case and these are estimated by the State average of all reporting hospitals.

The relationship of institutional indicators and hospital discharge rate to per capita expenditure and bed use for all hospitalizations is studied using data from 13 Vermont and 28 Maine HSAs. The smallest Maine HSA has 10,000 residents; the smallest Vermont HSA, 8,000. Vermont data are for 1969; Maine data are for 1971, and patient day data are not available for this year.<sup>†</sup> In areas with more than one local hospital, institutional indicators are a weighted average of the experience of each local hospital. Percent of occupancy is obtained by dividing the average daily census by the number of available beds. The bed turnover rate is defined as average number of patients treated per bed per year. Average cost per day in hospital was obtained from Blue Cross and is available for Vermont only.

Estimates for total per capita hospital expenditures in an area are obtained by allocation of annual total expenditure of each individual hospital to the HSA of residence of its patients. For example, if 10 percent of the patients admitted to a given hospital live in a particular HSA, 10 percent of the hospital's annual expenditures are assigned to that area. The sum of all hospitals' contributions to the service area provides a measure of total expenditure. An estimate of per capita availability of beds is obtained by allocating the bed supply of each hospital to the area of origin of its patients, using the same estimating procedure as for per capita expenditures. Data on planning decisions in Vermont are from published reports or from planning documents available to the authors.

The principal statistical issue is the correspondence between two ways of viewing hospital performance: from the perspective of the institutions and from the perspective of the populations who are served by the institutions. We are interested in learning the extent of the association of institutional performance indicators with the population's availability and use of beds or expenditures.

We also want to know the extent to which variation in use of dollars and beds relate to variations in incidence of hospitalization. The statistic we use to characterize the correspondence among indicators is the "explained variance" or "R<sup>2</sup>" statistic which is square of the correlation coefficient. The correlation coefficient itself ranges from -1.0 to +1.0; the stronger the relationship the nearer the value of the coefficient is to 1.0; weak relationships are near zero. The sign of the coefficient indicates the direction of association (a negative sign means the value of one indicator increases as the other decreases). The squared correlation coefficient is usually expressed as a percent and represents an estimate of the variance or difference among the values of one variable which is explained by difference among the value of a second.

## RESULTS

### *Determinants of Per Capita Expenditures and Bed Use*

The mean, range and coefficient of variation of all variables and the correlation coefficients between relevant variables are given in the Appendix.

*For specific medical and surgical conditions.* Average length of hospital stay and cost per case are not important predictors of per capita use of beds or charges for common surgical conditions and for respiratory disease illnesses (Figures 1 and 2). In only one of the ten cases do they explain a majority of the variation in per capita consumption. In contrast, there are strong linear associations between bed use and per capita charges and the incidence rate of hospitalizations for specific conditions and procedures. Although the variation in length of stay and average charge per case for specific procedures and conditions is substantial, these measures show little correlation with incidence rate (Appendix Tables). Incidence rates of hospitalization show greater variation than length of stay and are the immediate determinant of variation in bed use and per capita charges.

*For all hospitalizations.* For all causes, the relationship between incidence and bed use and expenditures is considerably weaker than for specific conditions or procedures (Table 1). Among the 28 Maine Hospital Service Areas, the incidence rate accounts for about 34 percent of the variation in estimated expenditures. In Vermont, incidence rate has little value in predicting per capita expenditures or bed use. The weakening of the relationship between incidence and resource use reflects the difference in mix of procedures and conditions treated in hospitals in the neighboring areas. Variation in average length of stay also counts for little of the variation in per capita expenditures. The strongest relationship is between per capita expenditures and average charges per day in hospital. However,

<sup>†</sup>Maine data for this part of the study were obtained during a feasibility study of developing a population-based data system for Maine.

FIGURE 1

CONTRIBUTION OF AREA-WIDE AVERAGE LENGTH OF STAY AND INCIDENCE OF HOSPITALIZATION TO PER CAPITA USE OF HOSPITAL BEDS FOR COMMON SURGICAL PROCEDURES AND RESPIRATORY DISEASES. THIRTEEN LARGEST MAINE HOSPITAL SERVICE AREAS, 1973.

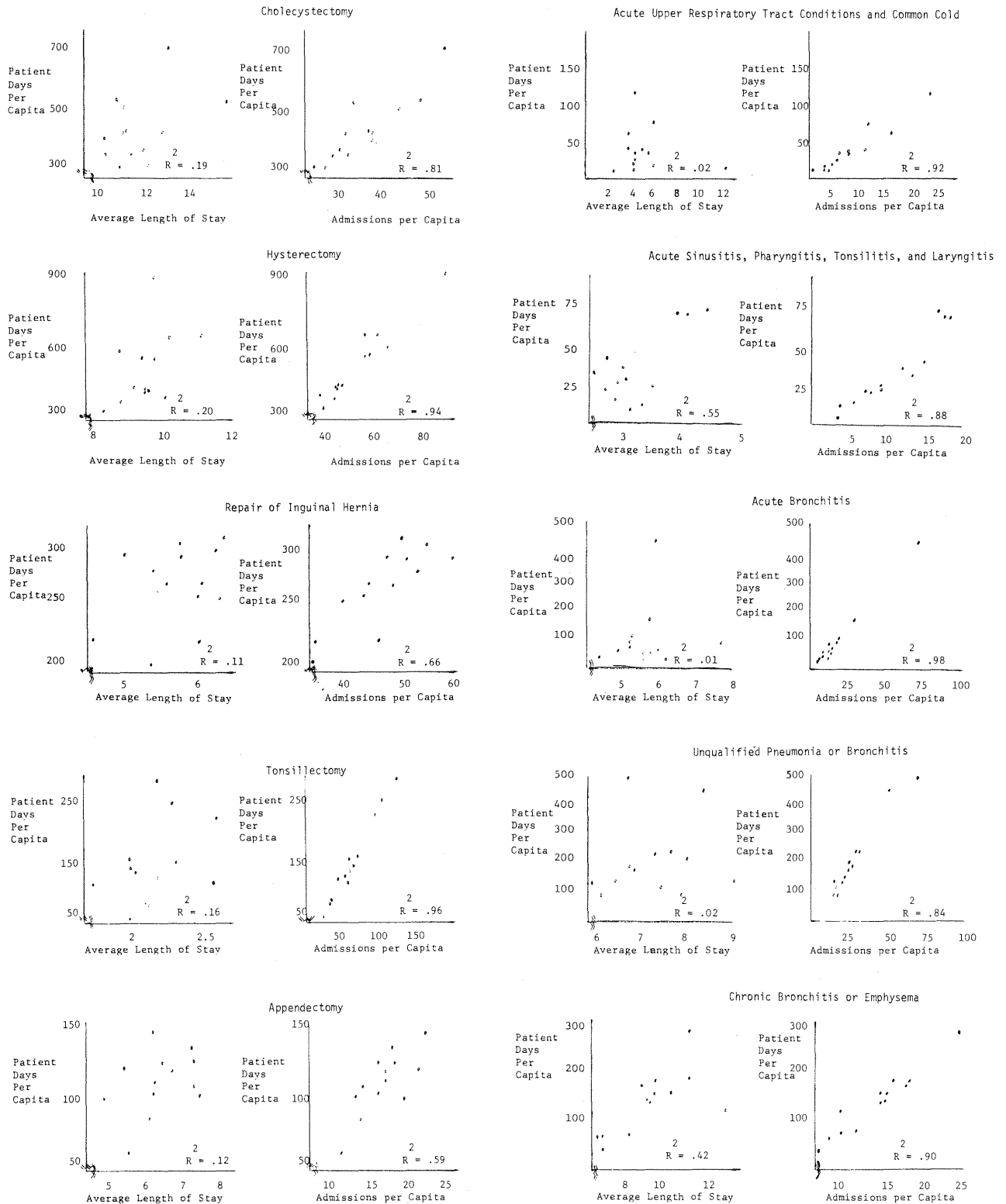
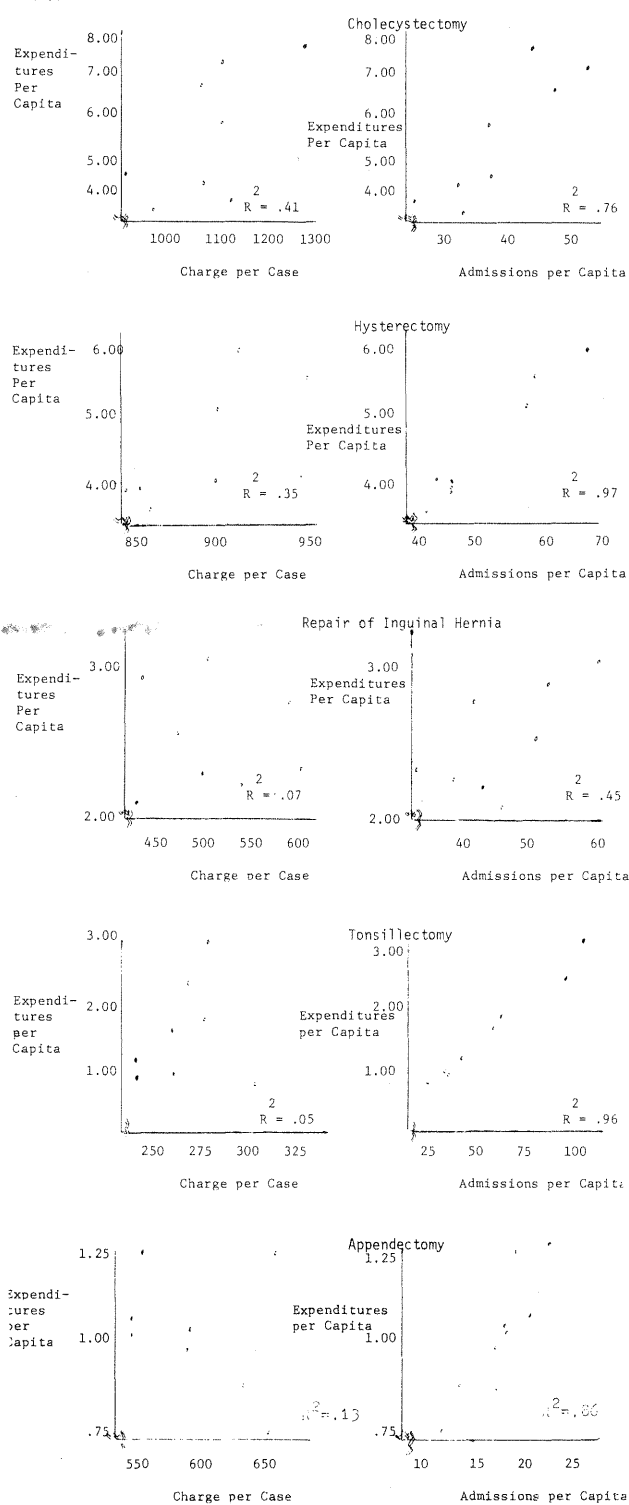


FIGURE 2

CONTRIBUTION OF AREA-WIDE CHARGE PER CASE AND INCIDENCE OF HOSPITALIZATION TO ESTIMATED PER CAPITA EXPENDITURES FOR COMMON SURGICAL PROCEDURES, EIGHT MAINE HOSPITAL SERVICE AREAS, 1973.



the differences in per capita expenditures which are "explained" by this variable are less than 40 percent and the indicator, taken alone, is an insufficient measure of population expenditure.

*Performance Evaluation and Institutional Indicators*

Table 1 shows that differences in bed turnover rates as well as length of stay and cost per day in hospital are unreliable indicators of relative per capita expenditures. It also shows that variation in percent of occupancy among areas has little correspondence with per capita expenditures, or availability and use of hospital beds. These statistical issues are illustrated in the following case studies.

*A profile of hospital performance in five Maine areas.* Table 2 shows the per capita incidence of hospitalization, expenditures and bed availability and use, and the status of three institutional indicators which are considered to be indicative of the efficiency of hospital performance and the need for beds. Although the institutional indicator of bed availability, (percent of occupancy) is nearly identical in four of the five areas, the patient day rate which describes bed use by the population varies from 800 to 1,625 days per 1000 persons per year. The area with the highest bed turnover rate (Area IV) has the highest rate of hospitalization, the most patient days and expenditures per capita, and has the most available beds. Previously we have found that this area, compared to the other four, has a high rate of common surgical procedures, particularly tonsillectomy and hemorrhoidectomy.<sup>1</sup> Area IV's length of stay is nearly the same as Area V which has the lowest incidence rate and per capita expenditures of the five areas. It is apparent that the large differences in resource use among areas are not indicated by conventional institution-based indicators.

*Public Planning and Regulation in Vermont Hospital Service Areas*

Planners and regulators depend on institutional indicators in reaching decisions on the allocation of resources and in regulating the price of health care. Because of the low correspondence between institutional indicators and the underlying consumptive patterns of the populations, the impact of public decisions on the equality of resource distribution among neighboring hospital service areas is usually unknown. In Vermont, where population-based data have been available since 1969, case studies can be made of public decisions made during that period from the perspective of the population they affect. Table 3 presents data on the number of hospitals in each area, the incidence of hospitalization, per capita expenditures and bed use and features of public decisions affecting three Vermont Hospital

APPENDIX TABLE 1

MEAN, RANGE, AND COEFFICIENT OF VARIATION. INSTITUTIONAL AND PER CAPITA INDICATORS OF HOSPITAL PERFORMANCES IN SELECTED MAINE AND VERMONT HOSPITAL SERVICE AREAS.				
	<i>Lowest Value</i>	<i>Highest Value</i>	<i>Mean</i>	<i>Coefficient of Variation</i>
Specific Medical and Surgical Causes of Admission				
Cholecystectomy				
Area-wide Length of Stay	10.22	15.26	11.51	0.12
Patient Days per 10,000	293	700	420	0.27
Admissions per 10,000	25	55	36	0.24
Charges per case (\$)*	910	1297	1083	0.11
Charges per capita (\$)*	3.58	7.94	5.52	0.31
Hysterectomy				
Area-wide Length of Stay	8.28	10.95	9.43	0.07
Patient Days per 10,000	347	882	521	0.28
Admissions per 10,000	40	92	55	0.26
Charges per case (\$)*	842	947	895	0.04
Charges per capita (\$)*	3.61	6.16	4.63	0.21
Repair of Inguinal Hernia				
Area-wide Length of Stay	4.58	6.35	5.74	0.09
Patient Days per 10,000	182	312	261	0.16
Admissions per 10,000	34	58	46	0.16
Charges per case (\$)*	432	609	525	0.11
Charges per capita (\$)*	2.14	3.27	2.66	0.15
Tonsillectomy				
Area-wide Length of Stay	1.77	2.60	2.20	0.10
Patient Days per 10,000	50	279	140	0.49
Admissions per 10,000	24	126	64	0.47
Charges per case (\$)*	242	304	268	0.08
Charges per capita (\$)*	0.74	3.00	1.51	0.53
Appendectomy				
Area-wide Length of Stay	4.92	7.51	6.44	0.13
Patient Days per 10,000	64	145	110	0.19
Admissions per 10,000	11	23	17	0.20
Charges per case (\$)*	542	657	594	0.08
Charges per capita (\$)*	0.74	1.22	1.02	0.16
Acute Upper Respiratory Tract Condition and Common Cold				
Area-wide Length of Stay	2.54	12.50	5.15	0.47
Patient Days per 10,000	11	115	38	0.79
Admissions per 10,000	0.9	25	8	0.79
Acute Sinusitis, Pharyngitis, Tonsillitis, and Laryngitis				
Area-wide Length of Stay	2.51	4.49	3.28	0.18
Patient Days per 10,000	11	77	37	0.64
Admissions per 10,000	3	19	11	0.50
Acute Bronchitis				
Area-wide Length of Stay	4.50	7.79	5.76	0.13
Patient Days per 10,000	31	427	102	1.02
Admissions per 10,000	5	72	18	0.99
Unqualified Pneumonia or Bronchitis				
Area-wide Length of Stay	6.05	8.92	7.29	0.12
Patient Days per 10,000	85	482	204	0.60
Admissions per 10,000	15	71	28	0.57
Chronic Bronchitis or Emphysema				
Area-wide Length of Stay	6.89	12.72	9.29	0.18
Patient Days per 10,000	41	281	138	0.45
Admissions per 10,000	6	26	14	0.36
1971 Maine Data Hospital Expenditures per capita (\$)				
Admissions per 1,000	33	121	79	0.24
Percent Occupancy (Local Hospital)	119	227	168	0.20
Average Length of Stay (Local Hospital)	49	93	69	0.13
Bed Turnover Rate (Local Hospital)	4.3	8.7	6.8	0.16
1969 Vermont Data Hospital Expenditures per capita (\$)				
Admissions per 1,000	28	60	38	0.21
Percent Occupancy (Local Hospital)	58	120	82	0.19
Average Length of Stay (Local Hospital)	115	196	143	0.17
Bed Turnover Rate (Local Hospital)	63	100	81	0.13
Average Cost per Day (Local Hospital) (\$)	5.6	9.5	7.5	0.16
Bed Use (Total Patient days per 1,000)	31	47	40	0.13
	32	41	36	0.14
	897	1578	1221	0.14

\*for 8 Maine Hospital Service Areas included in Cost Study, 1973





APPENDIX TABLE 4

CORRELATION MATRIX: PARAMETERS OF HOSPITAL UTILIZATION, 28 MAINE HOSPITAL SERVICE AREAS, 1971.  
(Pearson Correlation Coefficients)

	(1)	(2)	(3)	(4)	(5)
Hospital Expenditures Per Capita (\$)	(1)	.59	.13	.22	-.11
Admissions per 1,000		(2)	-.04	-.21	.17
Percent Occupancy (local hospital)			(3)	.16	.42
Average Length of Stay (local hospital)				(4)	-.76
Bed Turnover Rate (local hospital)					(5)

APPENDIX TABLE 5

CORRELATION MATRIX: PARAMETERS OF HOSPITAL UTILIZATION, 13 VERMONT HOSPITAL SERVICE AREAS, 1969.  
(Pearson Correlation Coefficients)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Hospital Expenditures per capita (\$)		.21	-.07	.46	-.58	.68	.47
Admissions per 1,000			-.17	-.37	.32	-.43	.73
Percent Occupancy (local hospital)				.57	.28	.00	.24
Average Length of Stay (local hospital)					-.62	.48	.22
Bed Turnover Rate (local hospital)						-.59	.02
Average Cost per Day (local hospital) (\$)							-.15
Bed Use (Total Patient Days per 1,000)							

determining price of premiums for the program. The funds for Medicare Part B are from a 50% contribution from the enrollee and a 50% contribution from the Federal treasury, based on the *national* average per capita rate of reimbursement. However, because medical resources are used differently there are subsidizations (income transfers) among areas. In 1972, the National average reimbursement under Medicare Part B was about 139 dollars per enrollee. Enrollees living in Area 1 enjoyed a subsidy of 23 dollars per enrollee while enrollees in Area III contributed 47 dollars per capita towards the subsidization of enrollees living in high expenditures areas.†

*Assessing need for hospital beds.* Two of the three areas share a common border with Hill-Burton planning areas and it is possible to relate the Hill-Burton's agency's assessment of need for additional facilities with concurrent consumption rates.<sup>4</sup> In 1969, the Hill-Burton Agency determined that the hospital located in the area of high utilization (Area II) needed a 44 percent increase in bed supply. (Compared to all Vermont areas, Area II ranged second in incidence of hospitalization and first in use of surgery in 1969). In contrast, the area ranking lowest among the thirteen areas in use of surgery, incidence of hospitalization and bed use was assigned a low (2%) need for additional resources. Hill-Burton determinations were based on percentage of occupancy indicators.

*Surgical facilities.* The Vermont State Comprehensive Health Planning Agency was asked to review an application for building additional surgical

†This estimate assumes an average contribution to the Federal Treasury in each area.

TABLE 1

## PERCENT OF VARIANCE IN PER CAPITA BED USE AND EXPENDITURES ASSOCIATED WITH VARIANCE IN INCIDENCE OF HOSPITALIZATION AND OF INDICATORS OF INSTITUTIONAL PERFORMANCE FOR ALL CAUSES OF ADMISSION. 13 VERMONT (1969) AND 28 MAINE (1971), HOSPITAL SERVICE AREAS.

	Per capita expenditures		Bed Use
	Maine	Vermont	Vermont
Average length of stay in local hospital(s)	4	21	5
Average cost per day of care in local hospital(s)	NA	38	5
Percent of occupancy in local hospital(s)	1	<1	5
Bed turnover rate in local hospital(s)	1	33	<1
Per capita incidence rate in area for all hospitalization	34	5	21

facilities at one of two hospitals located in Area I. Although the area ranked third from highest among the 13 areas in overall surgery rates and highest in per capita expenditures, institutional needs and indicators were the criteria for the decision which resulted in the construction of the proposed surgical facilities.<sup>5</sup>

*Coronary care beds.* Table 4 shows the status of investment in coronary care units (CCUs) in ten Vermont HSAs in 1971. The areas are ranked on per capita expenditures. During 1971, clinical management of coronary care was regionalized through a management committee established under Regional Medical Program auspices. The committee was responsible for establishing and publishing guidelines for the treatment of patients in the CCU of each of the region's hospitals. It was also responsible for making recommendations on the necessity of further capital investment in coronary

TABLE 2

PROFILE OF INDICATORS OF PERFORMANCE IN FIVE LARGEST MAINE HOSPITAL SERVICE AREAS, SHOWING INCIDENCE OF HOSPITALIZATION, PER CAPITA EXPENDITURES, PER CAPITA USE AND AVAILABILITY OF BEDS AND THE STATUS OF THREE INSTITUTIONAL INDICATORS							
	Incidence of hospitalization <sup>o</sup>	Patient days <sup>o</sup> of care	Available beds <sup>o</sup>	Per capita expenditures <sup>o</sup>	INSTITUTIONAL INDICATORS		
					Percent of occupancy <sup>+</sup>	Average length stay <sup>o</sup>	Bed turnover rate <sup>+</sup>
Area I	145	1,104	4.1	102	73	7.6	33
Area II	153	1,244	5.0	92	73	8.1	31
Area III	157	1,054	4.2	75	65	6.7	34
Area IV	235	1,625	5.7	109	72	7.0	39
Area V	127	831	3.8	72	72	6.9	32

<sup>o</sup>For 1973 population rate per 1,000 population; incidence rate is age-adjusted

<sup>+</sup> For 1971

TABLE 3

PROFILE OF POPULATION INDICATORS OF PERFORMANCE AND STATUS  
OF PLANNING OR REGULATORY DECISIONS IN THREE VERMONT  
HOSPITAL SERVICE AREAS (1969-1972)

	Area I	Area II	Area III
Number of local hospitals	2	1	1
Incidence of hospitalization			
All cases	145	195	122
Surgical cases	58	69	36
Hospital per capita expenditures	120	92	63
Reimbursement per enrollee,			
Medicare Part B	\$162	\$141	\$92
Bed availability	4.5	5.9	3.4
Planning or regulatory decisions			
Hill-Burton ascertainment			
of need (1969, percent			
increase in beds "needed")	NA	44%	2%
Surgical facilities built	Yes	NR	NR
Price commission exception			
to 5% limit on price	NR	Yes	No
Net flow of Medicare dollars			
in or out of area	+\$23	+\$2	-\$47

care units and for providing population-related data on each CCU admission. In 1971, the local hospital in Area I wished to increase the bed size of its CCU. The performance characteristics listed in Table 4 were reviewed by the management committee; based on its relative per capita ranking in utilization, resource use, bed availability, and the committee's knowledge of practice patterns at the hospital, the committee recommended against expansion of facilities and proposed, instead, further educational efforts to improve screening of patients prior to hospitalization.

### DISCUSSION

Length of stay and cost per case are indicators of the intensity of care delivered to hospitalized patients. Together with the incidence rate, they determine the per capita expenditure or days in the hospital allocated to a population:

Expenditure per capita = admissions per capita  
x average cost per case

Patient days per capita = admissions per capita  
x average length of stay

TABLE 4

PER CAPITA USE OF CORONARY CARE UNIT (CCU) RESOURCES IN  
TEN VERMONT HOSPITAL SERVICE AREAS PARTICIPATING IN A  
REGIONAL MANAGEMENT PROGRAM FOR CORONARY ARTERY DISEASE  
(Rates per 10,000 population, 40 years of age and older, 1969-70)

Area*	Available CCU Beds	Coronary Care Unit Nurses	Per Capita Expenditures
1	5.0	10.3	\$12.58
2	2.6	5.4	6.72
3	2.6	6.4	4.78
4	2.6	6.3	4.71
5	2.4	4.2	4.60
6	2.1	4.6	5.27
7	1.9	3.4	4.89
8	1.8	3.6	4.49
9	1.7	4.1	3.80
10	1.7	4.0	2.20

\*Area ranked on CCU bed availability

For the common medical conditions and procedures studied above, the variation in length of stay and cost per case (which we have estimated by charges per case) is less than the variation in the incidence rate, and differences in the measures of intensity do not correlate with the incidence rate. Therefore, the incidence rate is much more important than intensity factors in determining expenditure and patient days for common surgical procedures. We can conclude that for the conditions we have studied in this paper the resource implications of differences in management within hospitals are less important than decisions to manage patients at the ambulatory or the institutional level of care.†

In our studies of use of hospital for all conditions, variations in admission rate, length of stay or cost per day in hospital each contribute little to variations in per capita expenditures or use of hospitals. The aggregate statistics describing hospital experience of an area — overall length of stay, admis-

†At the aggregate level of use of institutional care, there is little evidence of a substitution effect between hospital and nursing home placements. In 1969, among the 13 Vermont areas, the correlation coefficient for per capita expenditures for hospitals and for nursing homes is -.11; for admissions, it is .05.

sion and cost per case — are weighted averages of the different kinds of cases admitted to the hospital and reveal little information on the effect of hospitals on the populations they serve. There is also a poor correspondence between institutional indicators of hospital efficiency and overall per capita expenditures and bed use. Variations in bed turnover rates (which have been shown to be associated with cost per case)<sup>6</sup> do not account for more than 33% of the variance in per capita expenditures. Among the five largest Maine Hospital Service Areas, the value indicating the most efficient use of hospitals was for hospitals serving the area with high admission, high tonsillectomy, high expenditure and high per capita available beds. Percent of occupancy, often viewed as an indicator of need for more beds, does not predict patient day rate or bed availability when viewed from the perspective of the population-at-risk. It is clear that this indicator — like all the institutional indicators we have studied — should be interpreted in conjunction with population based indicators.

Our review of planning and regulatory decisions in Vermont has shown that public decisions undertaken without benefit of population-based performance data can increase inequalities in distribution of resources among neighboring areas and establish income transfers through insurance mechanisms. However, when used within the context of a regionalized process for allocating capital for facility construction, experience in Vermont suggests that population-based data can help distinguish between “need” based on overutilization and need as defined by a consensus of regional experts. The key role of a regional management committee comprised principally of physicians in making the determination of need emphasizes the importance of including a properly constituted panel of physicians in the decision process established under certification of need programs.

## CONCLUSIONS AND RECOMMENDATIONS

We have shown that institutional measures of the intensity of care, efficiency of operations or need for additional facilities do not predict per capita expenditures or the per capita use and availability of beds. Public decisions undertaken without benefit of population-based indicators have increased the inequality in distribution of resources among neighboring areas, and established income transfers through insurance mechanisms. Effective documentation of hospital performance requires an epidemiologic approach to the measurement problem. We recommend that such an approach be adopted in Maine where an existing data system can be adopted for use by PSRO, the State Certificate of Need program and by the new Health System Agency.

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