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We report herein patterns of use of surgical procedures among geographically distinct Hospital Service Areas in the State of Maine. Our purpose is to measure differences in the use of surgical procedures throughout the State and to discuss possible causes and implications. The data are presented as age-adjusted incidence rates by area for all surgical discharges and for the nine common surgical procedures: tonsillectomy, hysterectomy, dilation and curettage of the uterus, appendectomy, cholecystectomy, inguinal hernia repair, prostatectomy, hemorrhoid ectomy and stripping of varicose veins. Surgical incidence rates in Maine and Vermont are compared. The cost implications of differences in use of surgery are considered. Patterns of intra-area differences in use of surgery are studied.

METHODS

Measurement of the per capita use of surgery is based on the cooperation of all hospitals in Maine in providing a uniform discharge abstract for each patient. The hospital record contains information on diagnosis, operative procedures and the patient's age, sex, and town of residence.++ All abstracts of discharges occurring in the calendar year 1973 have been assembled in a single data file: Two distinct steps have been undertaken, the first to group towns of residence into Hospital Service Areas and the second to compute the incidence rates by area.

Definition of Hospital Service Areas. Like most New England states, Maine is well situated for small area analysis of health care delivery. The State is organized administratively into over 500 towns which average about 36 miles in area. Geo graphic areas for study were defined by assigning each of Maine's 500 towns to a unique Hospital Service Area (HSA). A simple procedure was fol lowed: Patient records were classified initially by town and hospital and towns were then assigned to the hospital used by the plurality of residents. To avoid possible confusion between mailing address and town of residence, zip code-town border rela tionships were investigated to make certain that no town was assigned to an HSA that did not contain its post office. Forty-two areas were defined; 35 areas contain a single hospital, 4 contain two; two contain three, and one contains four hospitals. The popula tion size of the 42 areas ranges from 1,080 to 170,879. Five areas have more than 50,000 persons; 13 more than 20,000; there are 12 areas with popu lations between 10,000 and 20,000; 17 areas have less than 10,000 inhabitants.

Calculation of utilization indicators. In this analysis, rates of individual procedures are pre sented for the areas with 20,000 persons or more. These areas are shown in Figure 1. The extreme rates in surgical discharges are presented for smaller areas. For a study of patterns of intra-area varia tions, the five largest HSAs are used. The 1970 census populations for each town (grouped into HSAs) serve as the basis for computing surgical procedure rates. The numerators include resident surgical cases irrespective of whether the proce dure was performed in or out of the area, and the rates therefore estimate the total incidence of sur gery. Age adjustment to Maine population permits direct comparisons of areas with differing age struc-

ture (thus eliminating age as a possible explanation of differences). Admission to hospitals for materni

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++Records contain no information identifying individual patients.

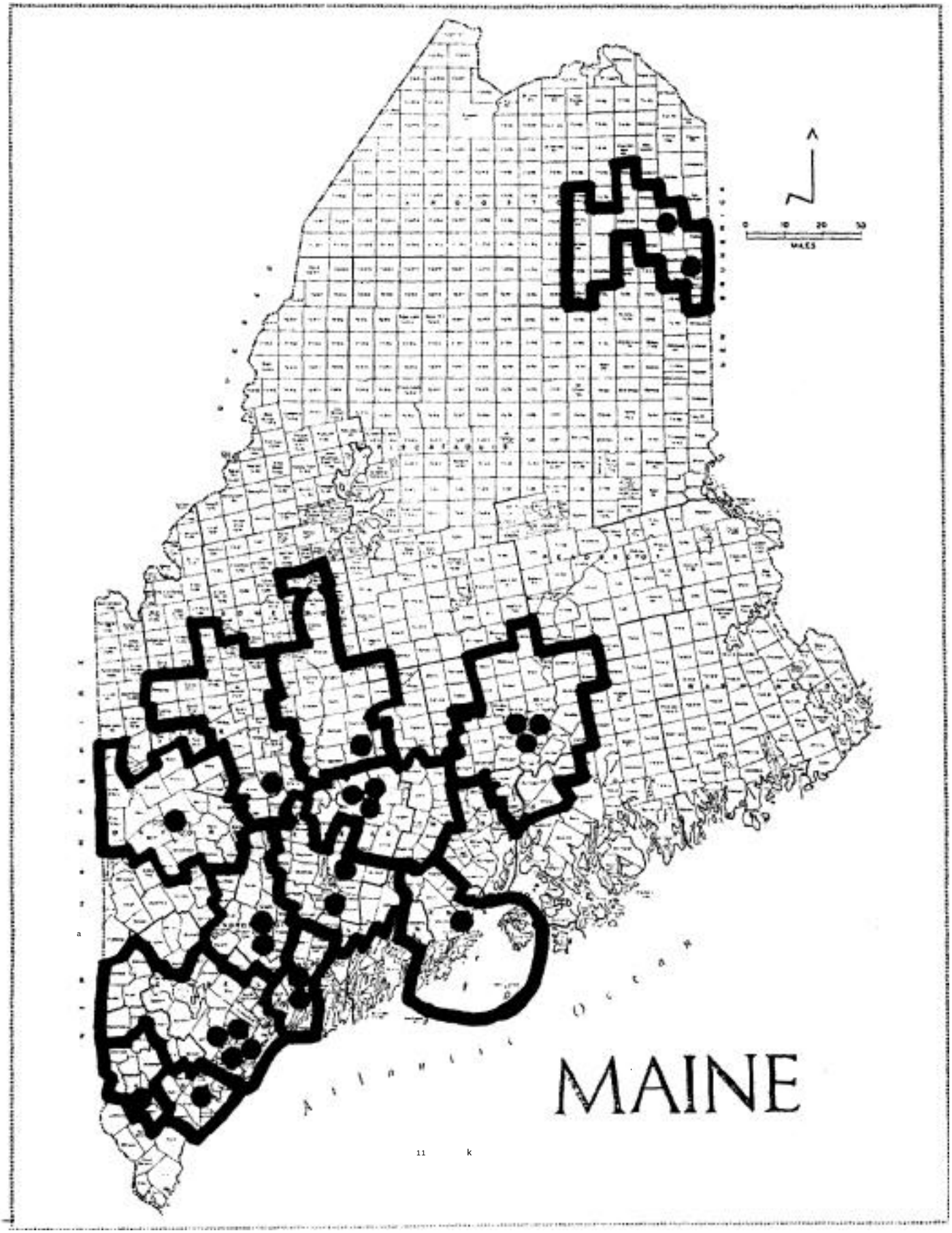


Fig. I ~ Map of Maine showing minor civil divisions, the Maine town (lighter line), Darker line shows boundaries of Hospital Service Areas which contain the principal populations studied in this article. Circles represent hospitals,

TABLE 1

PERCENTAGE OF ALL RESIDENT SURGICAL PROCEDURES PERFORMED AT LOCAL HOSPITALS: FIVE LARGEST MAINE HOSPITAL SERVICE AREAS, 1973

Procedures	ICDA Code	Area I	AreaII	Area III	Area IV	Area *V*
All		96	87	75	93	92
Tonsillectomy	21.1-21.2	98	86	78	98	95
Appendectomy	41.1	94	91	82	94	91
Hemorrhoidectomy	51.3	95	95	87	98	89
Hernia	38.2	96	87	87	93	92
Prostatectomy	59.1-58.3	98	94	29	94	98
Cholectystectomy	43.5	97	92	88	94	96
Hysterectomy	69.1-69.5	97	95	67	95	94
D&C	70.3	97	90	81	92	94
Varicose Veins	24.4	98	85	93	97	95

TABLE 2

1973 AGE-ADJUSTED INCIDENCE OF SURGICAL DISCHARGES AND NINE COMMON PROCEDURES IN MAINE AND MAINE HOSPITAL SERVICES AREAS WITH POPULATIONS OF 20,000 OR GREATER. PROCEDURES PER 10,000 POPULATION.

Area	*All Surgical Discharges*	*Appendectomy*	*Prostatectomy* (males)	*Inguinal Hernia* (males)	*Hysterectomy* (females)	*Varicose* Veins	*Hemorrhoidectomy*	*Dilation & Curettage* (females)	*Tonsillectomy*	*Cholecystectomy* (females)
State as a whole	689	17	25	45	59	5	7	77	62	35
1	613**	18	18*	40	46**	4	6	58**	36**	37
2	670	11**	22	37	59	6	3*	86	23**	46*
3	742**	13**	35**	47	63	4*	4**	83*	54**	33
4	606**	17	28	45	41**	3	5	49**	47*	36
5	594**	14	18	45	48	6	5	84	35**	31
6	640*	21	26	51	47	6	6	87	60	35
7	688	17	27	49	93**	6	9*	76	59	34
8	738**	17	40**	45	67	4	7	117**	55	50**
9	688	15	20*	53	39**	10**	9	74	62	29
10	864**	19	25	52	58	5	9	114**	105**	55**
11	954**	22**	33**	49	60	8*	19**	86	122**	39
12	579**	19	18**	35**	51**	5	5**	67*	77**	29*
13	764**	19	31	60*	48	7	14**	78	77**	27

*Chi-square significant at the .05 level
**Chi-square significant at the .01 level

ties and common surgical and medical treatments tend to be highly localized. For example, in the five largest HSAs between 75 and 96 percent of resident discharges for surgery were from local hospitals Table 1). For the individual procedures studied in this report, outmigration of resident population for more than one-third of services occurred in only one area (area 111) and for only one procedure (prostatectomy). For most procedures in most areas, over 90 percent were performed in local hospitals. There is thus a close correspondence between the medical community of an area and the residents hospitalized from that area. Because of small size of the HSAs (and the absence of significant regionalization), a relatively small cohort of physicians are the dominant suppliers of medical services to the resident populations and their decisions can be studied by observing population based rate profiles.

Statistical analysis and comparisons. The International Classification of Disease Codes for the procedures under study are presented in Table 1. Statistical differences among HSAs are based on Chi square distributions with one degree of freedom with the null hypothesis stating that an individual area does not differ from the State average rate. Comparisons between Vermont and Maine are based on the 13 largest hospital service areas in each state. The number of person-years of experience in the smallest Vermont area is 28,700; among Maine areas, the minimum number is 20,980. Vermont data are from a published source' providing rates for 1969-1971. The Vermont rates have been age adjusted to the Maine population by the direct method of age-adjustment. In the study of intra-area patterns of variations, for each of the nine procedures, the ratio of the observed to the expected number of cases is used as a standardized index of incidence with the State average serving as the standard. The expected number of cases within each HSA was obtained by multiplying the population in each age group by the corresponding State-

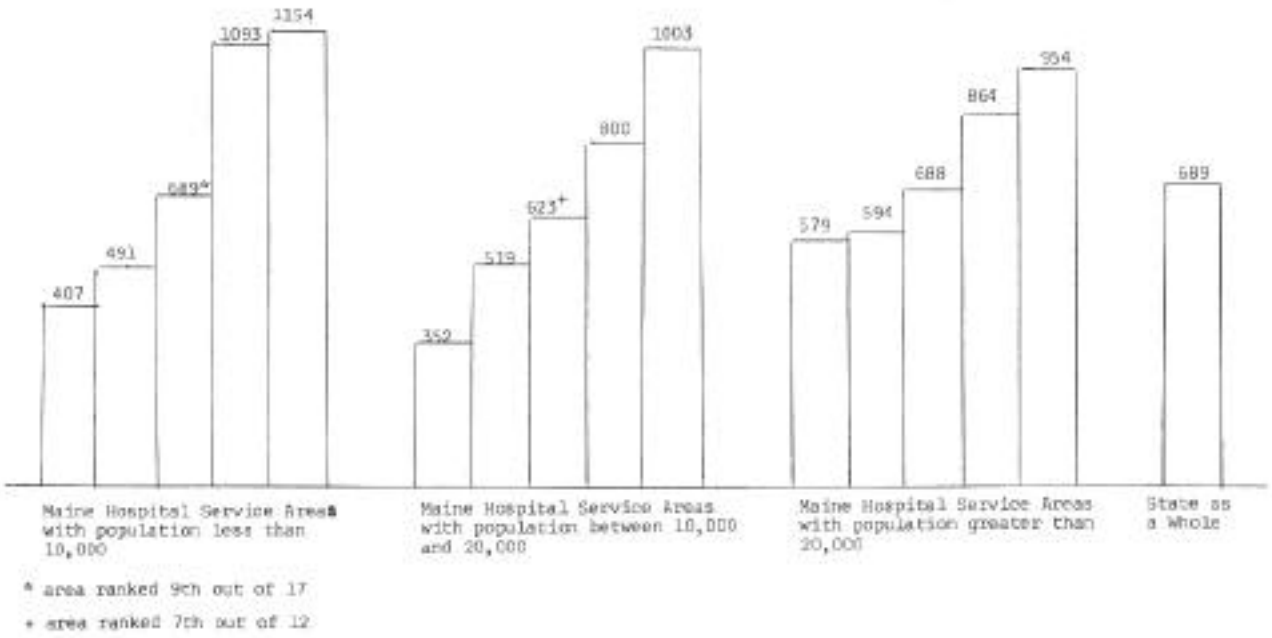


Fig. 2. Variations in Age-adjusted Surgical Rates Among Two Highest, Median, and Two Lowest Ranked Areas. 1973. Maine Hospital Service Areas Grouped by Population Size. Surgical Discharges per 10,000 population.

wide age specific rate and summing the age-specific expected number of cases across all age groups. Estimates of expenditures are based on State-wide average cost per case by hospitals participating in Maine Data Service; physician costs are computed using California Relative Value Index (one 1969 California Relative Value Unit = $25.00).

RESULTS

Variation in age-adjusted incidence of surgery in Maine. Figure 2 shows the range of age-adjusted rates for all operative procedures. Among HSAs with more than 20,000 residents, the lowest rate of surgical discharges is 579 per 10,000 per year and the highest is 954 per year, 65 percent over the lowest. The intermediate size group of HSAs shows a low area rate of 352 per 10,000 per year and a high of 1003 per year - very nearly a three-fold difference. Among areas with smaller populations, the lowest observed rate of surgery is 407 and the highest is 1154 procedures per 10,000. Table 2 lists incidence rates for each of the nine common surgical procedures in each of 13 largest HSAs. For each procedure, there are areas with incidence rates that are statistically different than the State average. Repair of inguinal hernia shows the least number of statistical outliers (2); tonsillectomies show the most (9).

Comparisons among Vermont and Maine Hospital Serv,ice Areas. Figure 3 provides a comparison of the Vermont and Maine surgical experience for the nine procedures. The 13 areas in each State with more than 20,000 population are used in this comparison. The pattern is one of wide variations both within and between the two States with tonsillectomies and vein stripping showing the greatest difference in state averages. Relative to population size, 37 percent more tonsillectomies are performed in Maine than in Vermont while 80 percent more varicose vein procedures are done in Vermont than in Maine. Intra-state variations in tonsillectomy rate are greater in Vermont, the lowest and highest areas being in this state. While hemorrhoidectomies are performed at approximately the same rate in both states, intra-state variations are much greater within Maine and the highest Maine rate exceeds the highest Vermont rate by 90 percent. Hysterectomies are performed 40 percent more commonly in Maine than Vermont, and the range across the high Maine area and the low Vermont area is over three-fold. Appendectomies and prostatectomies occur slightly more often in Vermont than in Maine but individual areas vary considerably: the ratio of difference for appendectomies between highest and lowest areas is 2.9; for prostatectomies it is 2.6. Although cholecystectornies and dilation and curretage are more common in Maine, intrastate variations are greater in Vermont. Hernia procedures show the least variation. The State averages are nearly identical and the intra-state differ

TABLE 3

EXPENDITURES FOR NINE COMMON PROCEDURES IN AREAS WITH HIGHEST AND LOWEST INCIDENCE RATES. THIRTEEN LARGEST MAINE HOSPITAL SERVICE AREAS, 1973 COMPARED TO STATE AVERAGE.

Procedure	*High Use Area* [1]	*Low Use* Area'	*State* A Average
Hysterectomy	*$ 6.78*	*$ 2.88*	*$ 4.30*
Cholecystectomy[2]	*4.98*	*2.51*	*3.46*
Prostatectomy	*3.54*	*1.47*	*2.34*
Tonsillectomy	*4.55*	*0.85*	*2.33*
Hernial	*2.51*	*1.64*	*1.99*
Dilation and Curettage			
Appendectomy			
Hemorrhoidectomy	*2.68*	*1.08*	*1.82*
Varicose Veins	*1.99*	*0.97*	*1.47*
All Nine Procedures	*1.43*	*0.23*	*0.54*
	0. 93	*0.30*	*0.48*
	29.39	*11.93*	*1&73*

[1] areas ranked independently on each procedure
[2] for females only
[3] for mates only

ence among HSAs is the least for this procedure.

Dollar implications of variations in incidence of surgery. Variability in use of specific procedures reflects in expenditures. For the 13 largest Maine HSAs, Table 3 estimates the per capita expenditure for each procedure in areas of high and low use. The nine procedures in the areas of highest incidence cost a total of $29.39 per capita. The corresponding figure for the low incidence rates is $11.93, nearly a 2.5 fold difference. Of the individual procedures, tonsillectomy shows the greatest range of difference in per capita expenditure. In the low use area, $.85 is expended per capita annually; in the high case area, $4.55 is expended.

The data can be used to estimate the total costs in Maine for use of the procedures and to study the cost implications of generalizing across the State as a whole the high or, alternatively, the low strategy for allocating the nine procedures.* For the nine procedures, an estimated 18.0 million dollars were expended in Maine in 1973. If the high use strategy were the "medically" necessary level of care, at 1973 average costs it would take an additional 10.2 million dollars to meet this need. On the other hand, if the low use strategy were generalized, 6.6 million *less* than was expended in 1973 would be needed for these nine procedures. Again, the cost implication of tonsillectomy stands out: currently about 2.1 million dollars are expended annually for tonsillectomies. If tonsillectomies were performed everywhere in Maine as frequently as in the high use area, an additional 2.2 million doctors would be expended. If tonsillectomy use as observed in the low area were generalized, the estimated reduction in surgical costs in Maine is 1.4 million dollars annually.

*Statewide estimates are made by multiplying area per capita expenditures by *1970* populations of Maine.

Int-area patterns of variation in incidence. Figure 4 shows the relative rate of use of total surgery and of selected common surgical procedures within the five largest Hospital Service Areas in Maine. Patterns of use of specific procedures within and among areas can be easily compared because area procedure rates are expressed as the ratio of area to Statewide average incidence rate. The figure shows that the rates at which specific procedures are performed within an area vary markedly and to a large degree independently of the total operation rate. For example, while area 11 and area III have the same total operation rate, area 11 exceeds in hysterectomies (doing 56 percent more than the State average) and area III exceeds in varicose veins (doing 84 percent more than the State average). In contrast, in area 111, the hysterectomy rate is well below the State average and one-third the rate in area It. Of the five procedures, in each of the five areas a different procedure is performed most often; in four of the five areas, the least performed procedure is different.

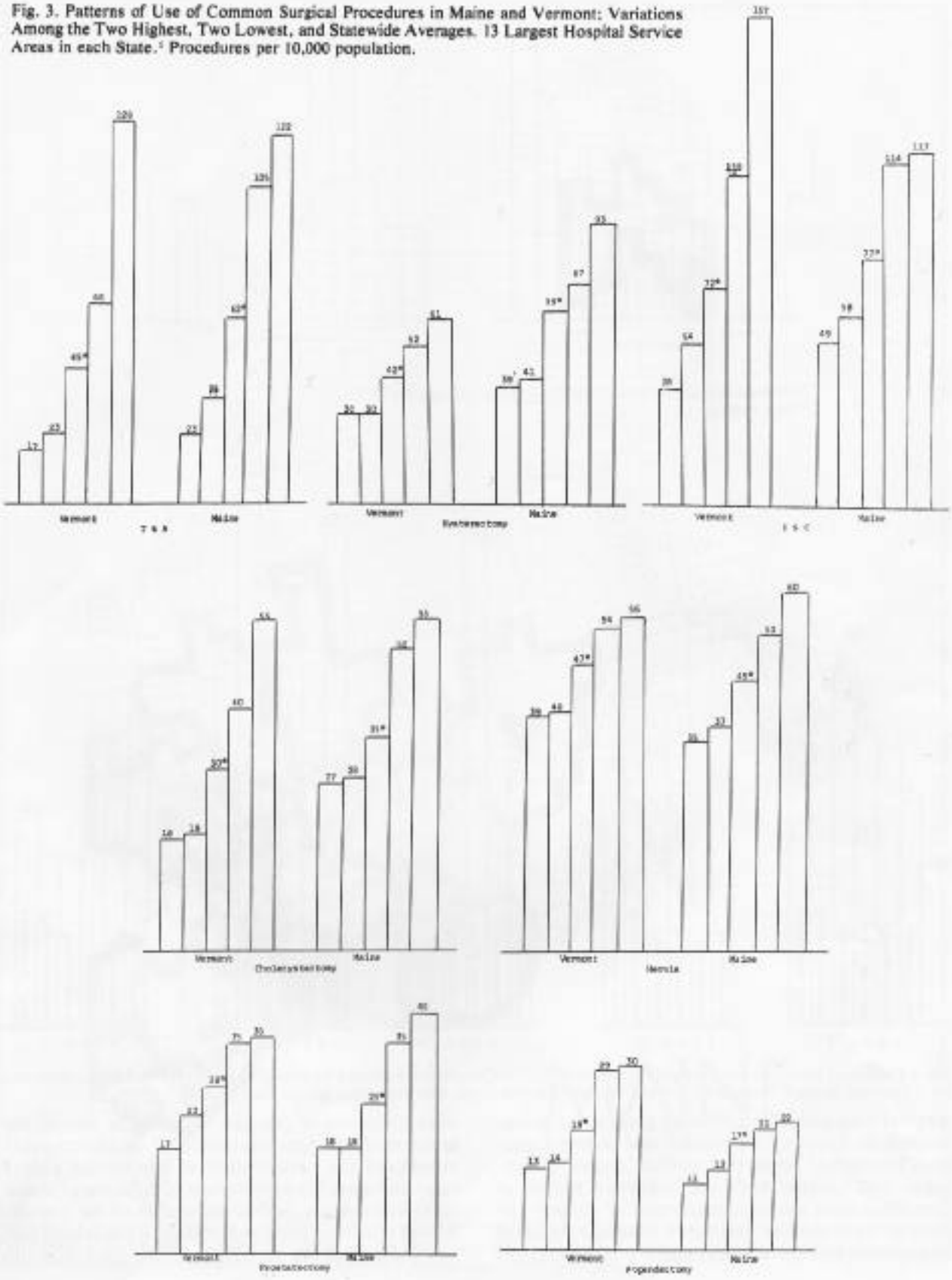
DISCUSSION

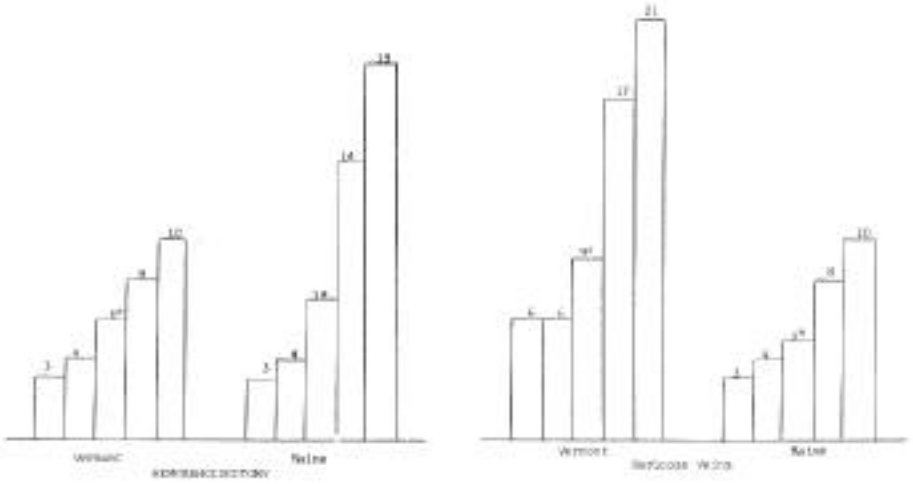
Variation among geographic areas (ire the rule. The findings of this study are consistent with previous studies of the incidence of surgery among geographically defined populations. Variability in use of procedures has been documented across national boundaries; Bunker[2] has shown the incidence of common surgical procedures in the United States to be double that of the United Kingdom. Lichtner and Pflanz[3] found appendectomy rates in West Germany nearly three times the United States rate. Vayda and Anderson have recently demonstrated that the extreme rates of incidence of common procedures vary about two-fold across Canadian Provinces[4]

It has become clear that variations among neighboring communities are also extensive. Lembcke's[5] finding of differences in common procedures among Rochester suburbs (neighboring communities with apparently homogenous populations) have been substantiated in Kansas[6], in Vermont[7] , and, with this study, in Maine. Small area geographic variations in use of surgical procedures are a rule for which there is yet no exception.

Variations in incidence of surgery reflect the distribution of physicians and facilities. The incidence of illness, socio-economic circumstances, the number and kinds of physicians doing surgery, the organization of care and methods of payment for service have each been postulated as reasons for geographic variations. While each factor undoubtedly contributes in some degree to patterns of health care consumption, the thrust of the evidence is that supply factors are more important than consumer behavior in determining the relative rates of use of

Fig. 3. Patterns of Use of Common Surgical Procedures in Maine and Vermont: Variations Among the Two Highest, Two Lowest, and Statewide Averages. 13 Largest Hospital Service Areas in each State.[1] Procedures per 10,000 population.





'Vermont data are for years 1969-71 - Maine data are for 1973
*State average

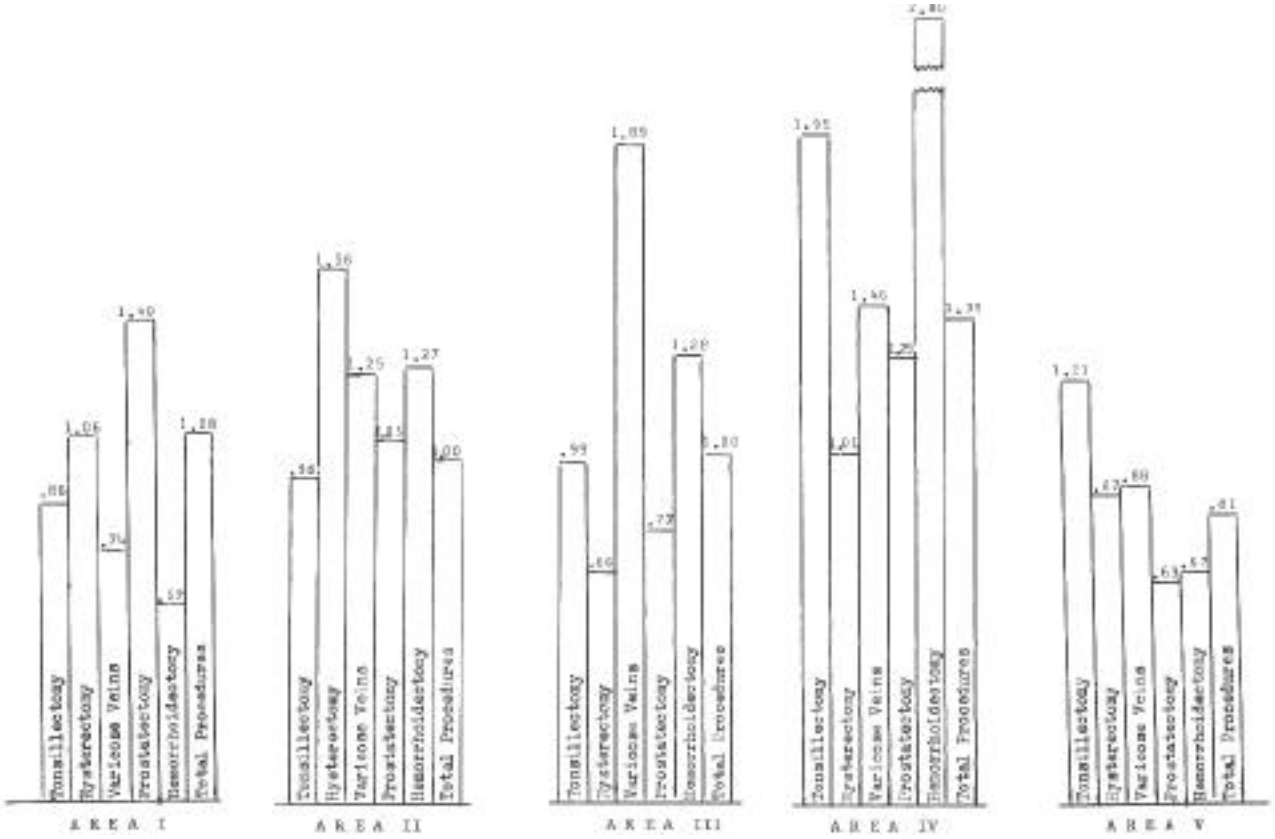


Fig. 4. Patterns of I Intra-area Use Of Surgical I Procedures: Ratio of Observed to Fxpected Number of Cases in 1973 for A I I Procedures and for 5 Common Surgical procedures; 5 Maine Hospital Service Areas with population greater than 50,000.

Surgical care among neighboring geographic areas. Studies in Kansas,' Vermont,[7] and across Canadian Provinces [4] show that overall supply of surgeons and hospital beds are important statistical correlates with the incidence rates of surgery. In these studies, insurance coverage, method of payment (fee-for-service) and the basic method of organization of practice were similar among the areas studied. Age-adjustment of incidence rates minimized the contribution of age-related illness rates as a possible explanation of differences in use care; in Vermont, additional studies o fthe popula- of tion-at-risk have been undertaken: a household sur vey shows that the population of the HSA with the

highest and the lowest rate of surgery have similar rates of illness, income, racial and social background, and insurance coverage; in fact, residents from these two HSAs contacted their physicians in equal portions on an annual basis and for episodes of acute illness.[8]

Formal surveys have not been undertaken among Maine HSAs to determine if the constituent populations vary in their need, ability or wish to consume health care. However, the pattern of variations suggests that as in Vermont and Kansas, population differences are not the important reason for variations. Patterns of variations in the five largest HSAs in Maine illustrate this point best. These areas are contiguous and sufficiently large so that chance variations are not plausible explanations for patterns of surgery incidence. In three of the areas, the overall rate of surgery is similar. Yet from area to area, the pattern of allocation of surgical technology is not consistent. The procedure performed most commonly is different in each area; the procedure least often used is different in four of the five areas. Remuneration to the surgeon for surgical work is standardized across areas and is based, primarily, on time surgeons spend in the operating room.[9] It is, therefore, not at all clear that there is an economic incentive for physicians to select one procedure over another. A similar intra-area pattern of allocation was observed among Vermont areas. We suggest this variety in use of specific technology reflects differences among physicians in their belief about effectiveness or in their judgments concerning how health care needs are defined.

Strategies for reducing uncertainty. The bases for differences in professional opinions on use of procedures are complex. In some instances, they undoubtedly involve differential diffusion of knowledge on the indications for treatment or the value of the procedure. Particularly in these cases, feedback of information to physicians on the population incidence rate may serve as an impetus for review of the indications for procedures. There are indeed a few examples where such feedback may have had some effect on rate of use. Lembcke[5] demonstrated changes in incidence of pelvic surgery following initiation of a peer review process in which feedback of population incidence rates played apart. Blowers and Parker attribute temporal changes in tonsillectomy rate in a Vermont hospital service area in part to similar feedback. They also attribute change to the introduction of a process of consultation between pediatrician and surgeon to reach a joint decision on recommending tonsillectomy.[10] A recent study on rate of elective surgery among union members shows that use of consultations can change surgery rates.[11] This evidence suggests that in the development of quality assurance programs, particular attention should be given to the value of a second opinion (particularly from a member of a second specialty) in reducing geographic variation in use of medical care.

It must be recognized, however, that a fundamental reason for variations in incidence of surgery is uncertainty concerning the relationship between the use of a specific treatment and the health status of the receiving individuals. A large portion of common medical and surgical practices have not been rigorously evaluated prior to their widespread use. An excellent review of the extent of the problem of uncertainty concerning the effectiveness of conventional medical practices is provided by Cochrane.[12] The importance of reducing uncertainty concerning which level of use of procedures is appropriate can be justified on the basis of social costs alone. To provide every area in Maine with the nine procedures at the rate observed in the highest area would require an additional investment of ten million dollars. Use of procedures at the low rate means a saving of over six and one half million dollars- a sum which presumably could be invested in other health producing services; but since the costs and benefits of the procedures and the alternatives are commonly unknown, the health implications of the varying levels of resource use cannot be fully evaluated. Without such information it is not possible to project accurately health care costs, or, indeed, to plan rationally for the development of health care systems which maximize the health of the population.

These considerations lead us to suggest that quality assurance programs seek to deal with the problem of geographic variations. In cases where variations cannot be attributed reasonably to differences in access of the population-at-risk to physician care, they should be interpreted as an indicator of the range of difference in professional opinion on use of specific technologies. Extensive review of the indications for the procedure and instigation of joint decision making by two or more physicians may lead to a lesser range of variation. But when professional disagreement on the nature of need or the value of a procedure persists, the disagreement should be openly recognized (as a necessary part of the art and science of medicine) and this recognition should lead to well designed studies to further resolve uncertainty. Such studies, we suggest, should become an integral part of a quality assurance program.

CONCLUSION

The incidence of total surgical discharges and nine common surgical procedures show extensive variation across neighboring Hospital Service Areas in the State of Maine. The pattern of variation and the findings of studies in other geographic areas sug-

gest they occur because of differences in opinion among physicians concerning the effectiveness of specific treatments or in the way physicians define health care needs. Differences in opinion may in some cases relate to differences in the rate of diffusion of new knowledge about medical practices. Agreement may be fostered or differences resolved by participation of two or more physicians in decision making at the individual case level. However, in some cases, professional uncertainty may be resolved only by empirical studies on outcome. A role in the undertaking of activities to deal with geographic variations is suggested for quality assurance programs.

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REFERENCES

1. Cooperative Health Information Center of Vermont, Inc.: Vermont Surgery Study 1969-1971. Burlington, Cooperative Health Information Center of Vermont, Inc., pp. 153-156, 1974.
2. Bunker, J. P.: Surgical Manpower. A Comparison of Operations and Surgeons in the United States, England and Wales. N. Eng. of Med., 285: No. 3, 135-144, January 1970.
3. Lichtner, S., Pflanz, M.: Appendectomy in the Federal Republic of Germany: Epidemiology and Medical Care Patterns. Medical Care, 9: No. 4, 311-330, July-Augist 1971.
4. Vayda, E., Anderson, G. D.: Comparison of Provincial Surgical Rates in 1968. The Canadian J. of Surgery, 18: 18-26, January 1965.
5. Lembcke, P. A.: A Scientific Method for Medical Auditing. Hospitals 33: 65-71, 1959.
6. Lewis, C. E.: Variations in the Incidence of Surgery. N. Eng. J. of Med., 281: 880-884, 1969.
7. Wennberg, J. E., Gittelsohn, A.: Small Area Variations in Health Care Delivery. A population-based health information system can guide planning and regulatory decision-making. Science, 182: 1102-1108, 1973.
8. Unpublished report.
9. Hughs, E. F. X., Fuchs, V. R., Jacoby, J. E., et al: Surgical Work Loads in Community Practice. Surgery, 71: 315-327, 1972.
10. Personal communication.
11. McCarthy, E. G., Widmer, G. W.: Effects of Screening by Consultants on Recommended Elective Surgical Procedures. N. Eng. J. of Med. 291-25, 1331-1335, Dec. 1974.
12. Cochrane, A. L.: Effectiveness and Efficiency: random reflections on health services. London, Nuffield Provincial Hospital Trust, 1972.