

Dartmouth College

Dartmouth Digital Commons

Open Dartmouth: Peer-reviewed articles by
Dartmouth faculty

Faculty Work

Fall 10-1975

Health Care Delivery in Maine II: Conditions Explaining Admission to Hospital.

John E. Wennberg MD, MPH

Dartmouth College, john.e.wennberg@dartmouth.edu

Alan Gittelsohn

Johns Hopkins University

David Soule

Maine Health Data Service

Follow this and additional works at: <https://digitalcommons.dartmouth.edu/facoa>



Part of the [Medicine and Health Sciences Commons](#)

Dartmouth Digital Commons Citation

Wennberg, John E. MD, MPH; Gittelsohn, Alan; and Soule, David, "Health Care Delivery in Maine II: Conditions Explaining Admission to Hospital." (1975). *Open Dartmouth: Peer-reviewed articles by Dartmouth faculty*. 2591.

<https://digitalcommons.dartmouth.edu/facoa/2591>

This Article is brought to you for free and open access by the Faculty Work at Dartmouth Digital Commons. It has been accepted for inclusion in Open Dartmouth: Peer-reviewed articles by Dartmouth faculty by an authorized administrator of Dartmouth Digital Commons. For more information, please contact dartmouthdigitalcommons@groups.dartmouth.edu.

*Reprinted from the October 1975 Issue of
The Journal of the Maine Medical Association
Vol. 66, No. 10 Pages 255-261 and 269*

Health Care Delivery in Maine II: Conditions Explaining Hospital Admission

JOHN E. WENNBERG, M.D. ALAN GITTELSON, Ph.D.

and DAVID SOULE

*Reprinted from the October 1975 Issue of
The Journal of the Maine Medical Association
Vol. 66, No. 10 Pages 255-261 and 269*

Health Care Delivery in Maine II: Conditions Explaining Hospital Admission

JOHN E. WENNBERG, M.D.* ALAN GITTELSON, Ph.D.** and DAVID SOULE†

The incidence of surgery has been shown to vary extensively among Hospital Service Areas in Maine,¹ a finding consistent with previous studies of patterns of use of surgery among neighboring communities.²⁻⁶ In the present study, our purpose is to examine the incidence of hospitalization and bed use according to the conditions explaining hospital admission and to consider the significance of our findings for hospital facility planning. Data are presented comparing hospitalization rates among the populations of the five Maine Comprehensive Health Planning Regions and among their constituent Hospital Service Areas (HSAs). The differences among Planning Regions in hospital use for treating patients with conditions belonging to 13 major International Classification of Disease (ICDA) groups are studied. For patients with diseases of the respiratory system, we show the specific conditions assigned as the cause of hospital admission.

Our results show little difference among Planning Regions in use of hospital for patients with congenital anomalies and for conditions associated with pregnancy. However, for illnesses of the respiratory tract, for infectious and parasitic illnesses and for ill defined conditions or symptoms, the range of differences among the Planning Regions in use of hospitals is greater than two-fold. For several common, nonsurgical illnesses of the respiratory

tract, the range in incidence rates is more than five-fold, a variability greater than that for tonsillectomy. The variety of use of hospitals for many common medical and surgical conditions indicates the importance of taking population-based data on patient mix into account in interpreting the need of communities for expansion of their bed supply.

METHODS

The methods of measuring per capita use of hospital care are presented in the first article of this series.¹ A discharge abstract for each patient admitted to any Maine hospital in 1973 provides information on diagnoses, procedures and patient characteristics, including town of residence. Utilization rates are computed for HSAs, which are groups of adjacent Maine towns around given facilities, and for the five Maine Comprehensive Health Planning Regions based on total residential use of health services, irrespective of whether care was obtained in or out of the local area or planning region. The latter include the Southern Maine, Tri-County, Kennebec Valley, Northeast, and Aroostook regions. The locations of the five Maine Comprehensive Health Planning Regions and 42 Maine Hospital Service Areas are shown in Figure 1. Appendix Table 1 lists, for each Comprehensive Health Planning Region, the populations and number of hospital beds of its constituent HSAs.

The condition causing hospitalization is entered on the discharge abstract as the "principal diagnosis" and is defined as "the condition, determined after study, that occasioned the patient's admission to the hospital."⁷ The frequencies of use by all Maine hospitals of each of 13 major ICDA groups are presented in Appendix Table 2. Diseases of

*Assistant Professor of Social and Preventive Medicine and Senior Associate, Harvard Center for Community Health and Medical Care.

**Professor of Biostatistics, Johns Hopkins School of Hygiene and Public Health.

†Data Analyst, Maine Health Data Service.

Supported in part by Maine Regional Medical Program (Grant #5G03 RM 000054-06A3).

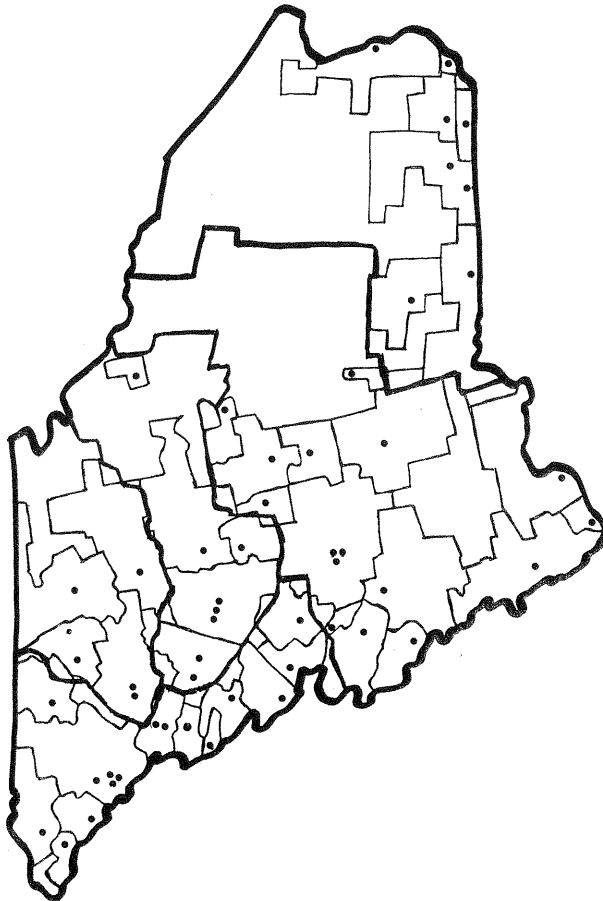


Figure 1. Showing the 5 Maine Comprehensive Health Planning Regions and the 42 Hospital Service Areas.

the respiratory system are examined in more detail in Appendix Table 3. Twelve groups of respiratory conditions are based on the acute or chronic nature of the condition, the site of the illness within the respiratory tract and diagnostic specificity. The ICDA codes within each subgroup of respiratory conditions and their frequency of use are presented below.

We measure the average daily number of beds occupied by patients per 1000 population by dividing the patient rate by 365. The patient day rate is the number of days the residents of an area spend in the hospital annually per 1000 persons at risk. Among the areas, the average number of beds occupied by the population is studied for the same groupings of ICDA codes used in the study of incidence of causes of hospitalization. The incidence and patient day rates used in the study have been age adjusted to the total Maine population to reduce the effect of population differences in age structure as a contributor to differences among areas. For the types of utilization rates studied, a number of areas are significantly higher or lower than the State average by chi square tests. Of greater interest is the extent to which areas differ which we indicate by

APPENDIX TABLE 1

POPULATION AND NUMBER OF HOSPITAL BEDS, MAINE
COMPREHENSIVE HEALTH PLANNING REGIONS AND
CONSTITUENT HOSPITAL SERVICE AREAS

| <i>Regions and Areas</i> | <i>1970 Population</i> | <i>Number of Beds (1973)</i> |
|--|----------------------------|----------------------------------|
| Comprehensive Health Planning Regions | | |
| Southern Maine Comprehensive Health Planning Region | 362848 | 1665 |
| Hospital Service Areas | | |
| Bath | 16578 | 92 |
| Belfast | 12399 | 58 |
| Biddeford | 47603 | 135 |
| Boothbay Harbor | 5156 | 36 |
| Bridgton | 8922 | 34 |
| Brunswick ¹ | 30702 | 134 |
| Camden | 5491 | 33 |
| Damariscotta | 6029 | 42 |
| Portland ³ | 170879 | 893 |
| Rockland | 28043 | 87 |
| Sanford | 20908 | 82 |
| York | 10138 | 39 |
| Tri-County Comprehensive Health Planning Region | 153099 | 690 |
| Hospital Service Areas | | |
| Farmington | 21345 | 49 |
| Lewiston ¹ | 95551 | 503 |
| Norway | 10986 | 41 |
| Rumford | 25217 | 97 |
| Kennebec Valley Comprehensive Health Planning Region | 149112 | 757 |
| Hospital Service Areas | | |
| Augusta-Gardiner ¹ | 61146 | 225 |
| Jackman | 1151 | 8 |
| Pittsfield | 11298 | 31 |
| Skowhegan | 23877 | 92 |
| Waterville ² | 51640 | 401 |
| Northeast Comprehensive Health Planning Region | 206799 | 945 |
| Hospital Service Areas | | |
| Bangor ² | 104591 | 494 |
| Bar Harbor | 8708 | 67 |
| Blue Hill | 7172 | 24 |
| Calais | 9848 | 71 |
| Castine | 1080 | 16 |
| Dexter | 6981 | 19 |
| Dover-Foxcroft | 8638 | 32 |
| Eastport | 2867 | 14 |
| Ellsworth | 13043 | 64 |
| Greenville | 2763 | 24 |
| Lincoln | 11525 | 30 |
| Machias | 13358 | 38 |
| Millinocket | 11977 | 34 |
| Milo | 4248 | 18 |
| Aroostook Comprehensive Health Planning Region | 87201 | 472 |
| Hospital Service Areas | | |
| Caribou | 12716 | 73 |
| Fort Fairfield | 5552 | 65 |
| Fort Kent | 19442 | 70 |
| Houlton | 15793 | 119 |
| Island Falls | 4399 | 21 |
| Presque Isle ¹ | 24816 | 94 |
| Van Buren | 4483 | 30 |

¹HSA contains 2 hospitals

²HSA contains 3 hospitals

³HSA contains 4 hospitals

APPENDIX TABLE 2

FREQUENCY OF CONDITIONS CAUSING HOSPITALIZATION, GROUPED
MAJOR SYSTEMS OF DISEASE; ALL MAINE HOSPITALS 1973

| <i>Diagnosis Group</i> | <i>ICDA-8</i> | <i>Number of Total Discharges</i> | <i>Percent of All Discharges</i> |
|---------------------------------------|---------------|---------------------------------------|--------------------------------------|
| Digestive System | 520-577 | 20383 | 12.97 |
| Respiratory System | 460-519 | 19893 | 12.66 |
| Circulatory System | 390-458 | 19192 | 12.21 |
| Pregnancy, Delivery, and Puerperium | 630-678 | 17932 | 11.07 |
| Genitourinary System | 580-629 | 15913 | 10.13 |
| Accidents, Injuries, and Violence | 800-999 | 15689 | 9.98 |
| Nervous | 290-389 | 11698 | 7.44 |
| Neoplasm | 140-239 | 10275 | 6.54 |
| Skin and Subcutaneous Tissue | 680-738 | 8986 | 5.72 |
| Symptoms and Ill-Defined Conditions | 780-796 | 7213 | 4.59 |
| Endocrine, Nutritional, and Metabolic | 240-289 | 4327 | 2.75 |
| Infective and Parasitic | 000-136 | 4294 | 2.73 |
| Congenital Abnormalities | 740-779 | 1838 | 1.17 |
| All Conditions | 000-999 | 157085 | 100.00 |

the coefficient of variation. It is obtained by dividing the standard deviation of the rates over areas by the mean and expressing the ratio as a percent. The coefficient provides an index of variability in the observed rates. The range between highest and lowest rates also is used as a measure of variability.

RESULTS

Variations in Incidence of Hospitalization Among and Within Planning Regions. Substantial differences exist in the incidence of hospitalization among the Planning Regions (Table 1). In the Aroostook and Kennebec regions, discharged are 23% and 21% higher than the State average while the Southern Maine, Northeast and Tri-County regions have rates lower than the State average by 8%, 7%, and 3% respectively. Comparing the highest and the lowest Comprehensive Health Planning Regions, 35% more discharges per capita occurred in the Aroostook Planning Region in 1973 than in the Southern Maine Planning Region. For the Hospital Service Areas within the five Planning Regions, the rates of hospitalization show greater variation than between the Planning Regions themselves (Table 1). The smallest range of difference is 1.43 fold in the Tri-County region; the largest is 1.96 fold in the Northeast Planning Region. While the coefficient of variation among Planning Regions is 15.6%, the intra-regional coefficients range from 15% to 22%.

The results indicate that differences in hospitalization practices within the HSAs of a Planning Region are greater than those among the regions themselves. Population size for the area and differences among HSAs in rate of use of hospitals located outside of Maine may contribute to greater variation among HSAs than among the larger regions, but we believe these effects are not the major reason for the observed differences. The effect of small population size has been reduced by excluding

areas with less than 4,000 residents from the analysis. Based on State average rates, the expected number of cases in the smallest HSA is 775. None of the lowest ranked HSAs are located on the New Hampshire border.

Incidence of Hospitalization by Major ICDA Group. The variability in use of hospitals is not similar for all conditions (Table 2). The greatest variability is among persons admitted for conditions related to the respiratory tract, for infective and parasitic diseases and for ill-defined conditions where the rates among Planning Regions show over a two-fold range of differences. By contrast, admissions for conditions associated with pregnancy and for congenital anomalies show the least variability; the highest rate is only 25% and 18% greater than the lowest, respectively. It is of note that conditions that vary least are defined by specific, well agreed upon criteria.

Incidence of Hospitalization for Specific Respiratory Conditions. Age-adjusted rates of use of hospitals for the major ICDA group of respiratory diseases show greater than a two-fold range of difference among Planning Regions. Specificity concerning the patient mix which contribute to these differences in rates is obtained by examining use of each individual ICDA code (Appendix Table 3). About 45% of respiratory admissions are for acute infections of the respiratory tract, 32% for hypertrophy of the tonsil, and 11% for chronic lung conditions. A group of less common conditions make up the remaining 12% of cases. Table 3 shows how the Planning Regions differ with respect to use of hospitals for acute and chronic respiratory tract conditions and for tonsillectomy. For hypertrophy of the tonsils, the Kennebec region exceeds the lowest area by 207%. For acute infections, the highest region is Aroostook which exceeds Kennebec by 32% and Southern Maine by 268%. Upper respiratory infections contribute most to the dif-

APPENDIX TABLE 3

| FREQUENCY OF USE OF INTERNATIONAL CLASSIFICATION DISEASE CODES FOR RESPIRATORY DISEASE MAINE HOSPITALS, 1973 | | | |
|--|----------------------------|---|--|
| <i>ICDA Number</i> | <i>Number of Cases</i> | <i>Percent of All Respiratory Cases</i> | <i>Disease Label</i> |
| 460 | 103 | 0.50 | Common Cold |
| 461 | 46 | 0.22 | Acute Sinusitis |
| 462 | 362 | 1.75 | Acute Pharyngitis |
| 463 | 383 | 1.85 | Acute Tonsillitis |
| 464 | 409 | 1.98 | Acute Laryngitis |
| 465 | 878 | 4.25 | Acute Respiratory Infection, Unspecified |
| 466 | 1,835 | 8.89 | Acute Bronchitis |
| 470 | 635 | 3.07 | Influenza, Unqualified |
| 471 | 45 | 0.22 | Influenza with Pneumonia |
| 472 | 145 | 0.70 | Influenza, Other Respiratory Cold |
| 473 | 45 | 0.22 | Influenza with Digestive Manifestations |
| 474 | 4 | 0.02 | Influenza with Nervous Manifestations |
| 480 | 215 | 1.04 | Viral Pneumonia |
| 481 | 334 | 1.62 | Pneumococcal Pneumonia |
| 482 | 97 | 0.47 | Other Bacterial Pneumonia |
| 483 | 39 | 0.19 | Pneumonia from Other Specified Organism |
| 484 | 28 | 0.14 | Interstitial Pneumonia |
| 485 | 947 | 4.59 | Bronchopneumonia |
| 486 | 2,178 | 10.55 | Unspecified Pneumonia |
| 490 | 652 | 3.16 | Bronchitis, Unqualified |
| 491 | 424 | 2.05 | Chronic Bronchitis |
| 492 | 1,144 | 5.54 | Emphysema |
| 492 | 764 | 3.70 | Asthma |
| 493 | 6,570 | 31.81 | Hypertrophy of Tonsils |
| 501 | 67 | 0.32 | Peritonsillar Abscess |
| 502 | 17 | 0.08 | Chronic Pharyngitis |
| 503 | 185 | 0.90 | Chronic Sinusitis |
| 504 | 496 | 2.40 | Deviated Nasal Septum |
| 505 | 132 | 0.64 | Nasal Polyp |
| 506 | 65 | 0.31 | Chronic Laryngitis |
| 507 | 21 | 0.10 | Hay Fever |
| 508 | 344 | 1.67 | Other Disease of Upper Respiratory Tract |
| 510 | 32 | 0.15 | Empyema |
| 511 | 127 | 0.61 | Pleurisy |
| 512 | 142 | 0.69 | Spontaneous Pneumothorax |
| 513 | 19 | 0.09 | Lung Abscess |
| 514 | 77 | 0.37 | Pulmonary Congestion |
| 515 | 4 | 0.02 | Pneumoconiosis |
| 516 | 1 | — | Other Pneumoconiosis |
| 517 | 83 | 0.40 | Chronic Interstitial Pneumonia |
| 518 | 69 | 0.33 | Bronchiectasis |
| 519 | 487 | 2.36 | Other Diseases of Respiratory System |
| 450-519 | 20,650 | | |

TABLE 1

| AGE-ADJUSTED DISCHARGES FROM HOSPITAL PER 1000 POPULATION, MAINE COMPREHENSIVE HEALTH PLANNING REGIONS AND CONSTITUENT HOSPITAL SERVICE AREAS (1973) | | | | | |
|---|---------------------------|-------------------|-----------------|------------------|------------------|
| | <i>Southern Maine</i> | <i>Tri-County</i> | <i>Kennebec</i> | <i>Northeast</i> | <i>Aroostook</i> |
| Region as a Whole | 150 | 157 | 197 | 152 | 204 |
| <i>Hospital Service Areas Ranked within Regions:</i> | | | | | |
| Highest | 212 | 192 | 235 | 249 | 309 |
| 2nd Highest | 193 | 158 | 234 | 230 | 283 |
| 2nd Lowest | 127 | 153 | 204 | 146 | 185 |
| Lowest | 117 | 134 | 157 | 127 | 172 |
| Ratio of highest to lowest ranked Hospital Service Areas | 1.81 | 1.43 | 1.50 | 1.96 | 1.80 |
| Coefficient of variation* | 18% | 15% | 18% | 21% | 22% |

*The coefficient of variation includes all HSAs within a planning region except those with populations less than 4,000.

TABLE 2

AGE-ADJUSTED DISCHARGE RATE BY CONDITIONS CAUSING HOSPITALIZATION IN FIVE MAINE
COMPREHENSIVE HEALTH PLANNING REGIONS. RATES PER 10,000 POPULATION, 1973

| Condition* | Southern Maine | Tri-County | Kennebec | Northeast | Aroostook | Ratio of highest to lowest | Coefficient of Variation |
|------------------------------|-------------------|------------|----------|-----------|-----------|----------------------------------|-----------------------------|
| Infective and Parasitic | 31 | 49 | 64 | 40 | 75 | 2.42 | 34.6 |
| Neoplasm | 112 | 114 | 116 | 88 | 106 | 1.32 | 10.3 |
| Endocrine | 41 | 50 | 61 | 35 | 50 | 1.74 | 21.3 |
| Nervous | 116 | 108 | 131 | 101 | 143 | 1.42 | 14.3 |
| Circulatory | 181 | 191 | 228 | 187 | 296 | 1.64 | 22.1 |
| Respiratory | 151 | 183 | 300 | 199 | 340 | 2.25 | 34.5 |
| Digestive | 190 | 202 | 256 | 206 | 271 | 1.43 | 16.0 |
| Genitourinary | 182 | 155 | 159 | 145 | 182 | 1.26 | 10.4 |
| Delivery | 191 | 193 | 197 | 182 | 158 | 1.25 | 8.7 |
| Skin and Subcutaneous Tissue | 81 | 82 | 122 | 92 | 126 | 1.56 | 22.2 |
| Congenital | 19 | 17 | 20 | 20 | 20 | 1.18 | 6.3 |
| Ill-defined | 58 | 80 | 117 | 67 | 86 | 2.02 | 28.0 |
| Injuries | 150 | 151 | 204 | 158 | 188 | 1.36 | 14.1 |
| All Conditions | 1504 | 1573 | 1975 | 1520 | 2035 | 1.35 | 15.2 |

*ICDA codes for each group are shown in Appendix Table 2.

TABLE 3

CONDITIONS CAUSING HOSPITALIZATION OF RESIDENTS WITH RESPIRATORY
ILLNESS IN FIVE MAINE COMPREHENSIVE HEALTH PLANNING REGIONS, 1973

| Condition | ICDA Code | Percent of All Respiratory Cases | Rates per 10,000 Population | | | | | Ratio of Highest to Lowest | Coef- ficient of Variation |
|--|--------------|---|-----------------------------|------------------------|-----------------------|------------------------|------------------------|-------------------------------------|-------------------------------------|
| | | | Southern Maine Rate | Tri- County Rate | Kenne- bec Rate | North- east Rate | Aroos- took Rate | | |
| Acute Upper Respiratory Tract Condition and the Common Cold | 460,465 | 4.8 | 5.2 | 6.1 | 15.0 | 6.7 | 29.7 | 5.71 | 82.7 |
| Acute Sinusitis, Pharyngitis, Tonsillitis, Laryngitis | 461-464 | 5.8 | 7.1 | 9.5 | 15.1 | 9.5 | 30.1 | 4.23 | 65.4 |
| Acute Bronchitis | 466 | 8.9 | 16.0 | 12.3 | 39.0 | 12.4 | 29.1 | 3.17 | 54.4 |
| Influenza with or without Complication | 470-474 | 4.2 | 3.8 | 5.8 | 12.7 | 9.0 | 26.2 | 6.89 | 77.2 |
| Pneumonia, Viral or Bacterial or Interstitial | 480-484 | 3.5 | 11.3 | 4.4 | 8.6 | 8.7 | 8.7 | 2.57 | 29.7 |
| Bronchopneumonia, unspecified Pneumonia unspecified, or | 485 | 4.6 | 6.4 | 8.8 | 8.9 | 10.2 | 16.3 | 2.55 | 36.7 |
| Bronchitis, unqualified | 486,490 | 13.7 | 20.9 | 31.1 | 33.0 | 32.6 | 33.8 | 1.62 | 17.6 |
| Chronic Bronchitis, Emphysema | 491-492 | 7.6 | 14.9 | 15.9 | 18.4 | 13.9 | 19.9 | 1.43 | 15.0 |
| Asthma | 493 | 3.7 | 6.7 | 4.8 | 9.1 | 7.2 | 12.1 | 2.52 | 34.7 |
| Hypertrophy of Tonsils | 500 | 31.8 | 49.8 | 64.4 | 103.0 | 66.0 | 80.7 | 2.07 | 27.7 |
| Deflected Nasal Septum | 504 | 2.4 | 6.4 | 3.1 | 5.1 | 2.9 | 9.4 | 3.24 | 49.7 |
| All Others | 501-504 | | | | | | | | |
| | 506-519 | 9.1 | 15.0 | 17.2 | 28.7 | 17.1 | 23.6 | 1.91 | 28.0 |

ferences in use of hospitals. Influenza admissions are nearly 7 times more common; acute upper respiratory conditions are 5.7% and acute infections of the naso-pharynx are 4.2 times more common in Aroostook Planning Region than in the Southern Maine Planning Region. For pneumonia and bronchitis, hospitalizations are 1.6 to 2.5 times more common in Aroostook Planning Region except for pneumonias in which the etiologic agent or syndrome has been identified.

Use of Hospital Beds. We have measured the differences in use of hospital beds associated with variations in patient mix treated in Maine hospitals. Table 4 shows the average number of beds occupied

per 1000 population in each of the five Planning Regions and in the high and low bed use HSAs within Planning Regions. Among the Planning Regions, the population in the region of highest utilization used 35% more beds than the population of the lowest region. Within Planning Regions, differences among HSAs in use of hospital beds is considerably greater. The greatest differences are within the Northeast region where the range in bed use patterns is from 2.4 to 4.6 beds per 1000, a 1.9 fold difference.

The variability in use of beds is not the same for each major diagnostic grouping, and the degree of variability follows closely with differences among

TABLE 4

| AVERAGE NUMBER OF BEDS OCCUPIED PER 1000 POPULATION, AGE-ADJUSTED RATES FOR FIVE MAINE COMPREHENSIVE HEALTH PLANNING REGIONS AND CONSTITUENT HOSPITAL SERVICE AREAS (1973) | | | | | |
|--|---------------------------|-------------------|-----------------|------------------|------------------|
| | <i>Southern Maine</i> | <i>Tri-County</i> | <i>Kennebec</i> | <i>Northeast</i> | <i>Aroostook</i> |
| Region as a Whole | 2.9 | 3.3 | 3.7 | 2.8 | 3.9 |
| <i>Hospital Service Areas Ranked within Regions:</i> | | | | | |
| Highest | 3.6 | 3.6 | 4.6 | 4.6 | 5.5 |
| 2nd Highest | 3.5 | 3.4 | 4.3 | 4.0 | 4.9 |
| 2nd Lowest | 2.1 | 2.9 | 4.0 | 2.6 | 3.4 |
| Lowest | 2.0 | 2.3 | 2.8 | 2.4 | 3.4 |
| Ratio of highest to lowest ranked Hospital | | | | | |
| Service Areas | 1.80 | 1.57 | 1.64 | 1.92 | 1.62 |
| Coefficient of Variation* | 20% | 19% | 20% | 21% | 20% |

*The coefficient of variation includes all HSAs within a planning region except those with populations less than 4,000.

the areas in the incidence of hospitalization. (Table 5). The pattern of bed use among the regions are quite similar for conditions which have similar rates of hospitalization. For congenital anomalies, and deliveries, bed-use ranges from 2.0 to 2.4 beds per 10,000 population, a 1.2 fold difference. On the other hand, for conditions with greater variability in incidence, respiratory, infective and parasitic diseases and the class of conditions labeled as "ill defined and symptoms," bed-use ranges from 3.6 beds per 10,000 in Southern Maine region to 7.8 beds per 10,000 in the Aroostook region, a 2.17 fold difference. The conditions with intermediate variability in incidence have intermediate variability in bed use. Again, to ascertain the specific reasons for differences among the regions, it is necessary to look more precisely at the conditions causing admission (Table 6). For example, in 1973, on an age-adjusted basis, for persons living in the Aroostook region, 1.4 beds per 10,000 were used for acute upper respiratory disease (excluding hypertrophy of the tonsils) and the flu; for persons living in Southern Maine, only 0.2 beds per 10,000 were used to treat these conditions. This represents a 7.7 fold difference in allocation of hospital facilities for these conditions.

DISCUSSION

While variations in incidence of common surgical procedures have been documented among regions and HSAs in Maine, Vermont and Kansas, we are aware of no previous report of use of hospitals in such areas according to the reasons for which the patients are admitted to the hospital. Our results indicate the importance of taking into account the case mix admitted to hospital on a per capita basis among neighboring areas in evaluating the uses made of hospitals. The overall incidence of hospitalization varies as much as 35% among the Plan-

ning Regions; however, certain classes of diseases contribute substantially more to the differences than do others. Admissions associated with pregnancy, and congenital anomalies, show the least differences among areas; infective and parasitic diseases, ill defined conditions and symptoms and respiratory diseases show the greatest. Medical as well as surgical conditions contribute to variation in hospitalization.

Studies in Vermont have shown that the volume of surgical procedures relate to differences in the specialty of active physicians and in the quantity of beds available in an area and not to differences in illness rates or access to physicians.⁸ Systematic studies of the relationship between health care system variables, the incidence of illness and rates of hospitalization for specific conditions causing admission are not available. Circumstantial evidence, however, suggest the differences relate to supply characteristics. In this study, the possible contribution of age-structure differences have been removed by age adjustment. It seems unlikely that the natural incidence of influenza, upper respiratory tract infections and hypertrophy of the tonsils will vary so as to account for the greater than five-fold differences we observed in rates of hospitalization for these conditions. Further, among the different, neighboring HSAs within a Planning Region — where differences among the populations-at-risk would seem less than when comparisons are based on Planning Regions — the use of hospitals varies more than between Planning Regions. The reason for this, we suggest, is because within a given HSA, usually one and at the most four hospitals are the principal institution involved, and there is thus a close correspondence between the medical community of an area and local rates of service. Within these areas, a relatively small cohort of physicians are the dominant

TABLE 5

| AGE-ADJUSTED AVERAGE NUMBER OF BEDS OCCUPIED PER 100,000 POPULATION IN MAINE COMPREHENSIVE HEALTH PLANNING REGIONS BY CONDITION CAUSING ADMISSION | | | | | | | |
|--|---------------------------|------------------------|-----------------|------------------|------------------|---|-------------------------------------|
| <i>Condition Ranked by Variability of Incidence Rates</i> | | | | | | | |
| <i>Condition</i> | <i>Southern Maine</i> | <i>Tri- County</i> | <i>Kennebec</i> | <i>Northeast</i> | <i>Aroostook</i> | <i>Ratio of Highest to Lowest</i> | <i>Coefficient of Variation</i> |
| Congenital | 3.6 | 3.8 | 3.9 | 3.5 | 4.0 | 1.14 | 5.5 |
| Delivery | 19.9 | 18.1 | 19.6 | 18.3 | 15.9 | 1.25 | 8.6 |
| Genitourinary | 25.0 | 26.8 | 26.6 | 23.5 | 30.3 | 1.29 | 9.6 |
| Nervous | 20.4 | 22.2 | 24.4 | 17.9 | 22.0 | 1.36 | 11.3 |
| Neoplasms | 29.5 | 35.7 | 33.1 | 26.3 | 29.9 | 1.36 | 11.7 |
| Digestive | 38.2 | 46.7 | 48.0 | 40.6 | 52.5 | 1.37 | 12.8 |
| Injuries | 33.0 | 33.1 | 42.7 | 30.1 | 38.1 | 1.42 | 14.1 |
| Circulatory | 55.2 | 61.6 | 66.3 | 50.8 | 79.1 | 1.56 | 17.5 |
| Skin and Subcutaneous Tissue | 17.7 | 17.8 | 26.6 | 19.8 | 24.3 | 1.50 | 18.9 |
| Endocrine | 9.4 | 12.7 | 12.6 | 7.9 | 11.3 | 1.61 | 19.4 |
| Ill-Defined | 8.5 | 13.2 | 17.9 | 9.3 | 11.8 | 2.12 | 30.7 |
| Infective and Parasitic | 5.1 | 8.0 | 9.3 | 6.4 | 12.9 | 2.53 | 36.0 |
| Respiratory | 22.0 | 26.7 | 40.5 | 27.9 | 53.0 | 2.41 | 37.1 |

TABLE 6

| AGE-ADJUSTED AVERAGE NUMBER OF BEDS OCCUPIED PER 100,000 POPULATION OF MAINE COMPREHENSIVE HEALTH PLANNING REGIONS BY RESPIRATORY CONDITION CAUSING ADMISSION | | | | | | | |
|--|---------------------------|------------------------|-----------------|------------------|------------------|---|---|
| <i>Condition Ranked by Variability of Incidence Rates</i> | | | | | | | |
| <i>Condition</i> | <i>Southern Maine</i> | <i>Tri- County</i> | <i>Kennebec</i> | <i>Northeast</i> | <i>Aroostook</i> | <i>Ratio of Highest to Lowest</i> | <i>Ratio of Highest to Lowest</i> |
| Acute Upper Respiratory Tract Infection and Influenza | 1.8 | 2.7 | 5.5 | 3.1 | 14.0 | 7.8 | 7.8 |
| Acute Bronchitis and Pneumonias | 9.3 | 11.1 | 17.6 | 12.3 | 19.6 | 2.1 | 2.1 |
| Asthma, Chronic Bronchitis and Emphysema | 5.0 | 5.0 | 6.4 | 5.2 | 7.7 | 1.5 | 1.5 |
| Hypertrophy of Tonsils | 2.9 | 3.6 | 6.2 | 3.8 | 5.3 | 2.1 | 2.1 |
| All others | 3.0 | 4.3 | 4.9 | 3.7 | 5.8 | 1.9 | 1.9 |

suppliers of medical services and local strategies for allocating hospitalized health care reflect in population-based rate profiles. Individual differences among physicians and facilities are more apparent under this geographic configuration than when HSAs are aggregated into larger Planning Regions.

Our observations on the variability in use of hospitals among neighboring areas have implications for facility planning. Under new Federal legislation, the states are required to establish programs to certify the need for facility construction, renovation and other changes in service in building programs that exceed \$100,000. Hospitals which do not comply with this requirement prior to undertaking construction face a cutoff of their eligibility to receive reimbursements under the Medicaid and Medicare programs. The model of "need" which planners commonly use in assessing building projects is based on the assumption that need for institutionalization is dependent largely on the natural incidence of illness. The planning issue is often interpreted as an assurance that beds are available for the next occasion when need arises, a perception that leads to a particular emphasis on improving the

efficiency of hospital operations as measured by length of stay and average daily census (percent of occupancy).

Our epidemiologic study of the incidence of hospitalization shows the importance of taking the surgical and medical patient mix into account in evaluating the need for facilities. While the relatively low variability in use of facilities for congenital anomalies, pregnancy associated conditions and neoplasms supports the belief that demand for hospitalization may be closely related to the natural incidence of the condition — and therefore accurately predicted by a model of hospital demand based on random incidence of medical conditions — hospitalization for these events represents only 18% of hospital use in Maine. The remaining causes of admission show considerably greater variability which cannot be accounted for by a demand model which postulates approximately similar rates of incidence among the regions and HSAs and consensus among the medical profession on need for hospitalization.

CONCLUSIONS

For many illnesses, the need for hospital beds

depends on physician choice of place and type of treatment. Those choices are made differently among Planning Regions and Hospital Service Areas in Maine with resultant differences in per capita use of hospital beds. Planners who seek to certify the need for hospital facilities should take into account differences in the mix of hospitalized patients. Because questions raised about the need for additional procedures and admissions for specific conditions concern the effectiveness of alternative placements and treatments, answers depend on the status of ambulatory, nursing home as well as hospital resources and these factors need to be taken into account. Since questions about effectiveness are most commonly addressed to members of the medical profession, the review process established to certify the need for facilities should, presumably, involve a panel of physicians to advise on the medical necessity of different levels of use of hospitalized care.

ACKNOWLEDGEMENTS

This analysis has been made possible through the cooperation and support of many individuals, associations and agencies. The principle parties who provided funds are the Maine State Comprehensive Health Planning Agency and Maine's Regional Med-

ical Program. Responsibility for data collection and tabulation were jointly shared by Maine's Data Service and the Cooperative Health Information Center of Vermont. The effort has been made possible by the willingness of the individual hospitals to participate in a Statewide data system.

REFERENCES

1. Wennberg, J. E., Gittelsohn, A.: Health Care Delivery in Maine I: Patterns of Use of Common Surgical Procedures. *J. of Maine Med. Assoc.*, May 1975.
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-August 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. Hodgson, David A., Ph.D., Kucken, Lawrence E., Ensign, James M.: Uniform Hospital Discharge Data Demonstration, Summary Report. Health Services Foundation, Chicago, Illinois, December 1972. p. 13.
8. Unpublished report.
9. Flagle, C. D., Huggins, W. H., and Roy, R. H.: Operations Research and System Engineering, Baltimore: Johns Hopkins Press, 1959, Ch. 25. See also, Blumberg, M. S.: Distinctive Patient Facilities Concept Helps Predict Patient Bed Needs. *Modern Hospital*, 97: No. 6, 75-81, Dec. 1961.