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COMPARATIVE ANALYSIS OF HOSPITAL UTILIZATION IN URBAN AND RURAL COUNTIES

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ABSTRACT - Hospital utilization, when measured as patient days per population, exhibited generally insignificant relationships with factors concerning population characteristics, hospital resources, financial assistance, and degree of urbanization. Adjusted multivariate linear regression results indicated that number of physicians per population did possess significant effects, while other indepedent variables remained significant. Additional research, as well as refinement of present data, appear paramount to further validation procedures.

The notion that hospital utilization (HU) is greater in urban than rural areas nationally has been forwarded informally by observers familiar with the health care industry and tested empirically by Kelly and Schieber(1972). To date, no studies of urban and rural hospital utilization in Minnesota have been attempted. Weckwerth (1961) reported utilization rates in the Minneapolis-St. Paul metropolitan area in the early 1960's, but results of an expanded investigation of the entire state's facilities has not been published. Such a statewide study would be valuable in determining the validity of the location-affected utilization rate hypothesis and in evaluating the present efficacy of hospital utilization.

This paper endeavors to test the hypothesis that greater utilization of hospital facilities occurs in urban areas than in rural areas. In order to test this hypothesis, it is assumed that population characteristics, hospital resources, financial assistance, and the degree of urbanization are the most significant factors affecting the rate of utilization.

Test Data from 81 Counties

Multivariate linear regression analysis was applied to data from 81 of the 87 Minnesota counties. Excluded were Benton, Cass, Dodge, Douglas, Olmsted, and Sherburne counties. Benton, Cass, Dodge, and Sherburne counties were eliminated because they have no hospitals. Douglas County data were incomplete. Olmsted county, where the Mayo Clinic and very large St. Mary's Hospital are located, was excluded because the great number of out-of-state patients created a potential for inaccurate data. Additionally, hospital facilities of the University of Minnesota, and state or federal facilities were eliminated since they draw on a unique clientele. For example, Veteran's Administration hospitals admit only former military personnel. At the University of Minnesota, almost 80 percent of the patients in 1973 were referred from other hospitals. That would significantly distort observations if the University Hospitals had been included in the data of Hennepin County, where the institution is located.

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The Dependent Variable: Hospital Utilization

The dependent variable, hospital utilization by the residents of each county, is measured in patient days per 1,000 population (PD). Data were gathered by the Minnesota Department of Health and Minnesota Hospital Association on a hospital-by-hospital basis. In order to account for intercounty patient flows, PD data were altered by an adjustment factor yielding PD.

The observed data contained inconsistencies in that both residents and non-residents of the counties were initially counted in determining the patient days per 1,000. Adjustment factors were then applied to the dependent variable to produce a 'corrected' figure for patient days per 1,000 population close to the actual number. Divided into two portions, the adjustment factors, 'INFLOW' and 'OUTFLOW,' compensate for those patients originating from outside a county's boundaries and the "emigration" of patients from their county of residence to hospitals elsewhere.

The OUTFLOW adjustment is merely a measure of the portion of an area's patients using area hospital facilities. Its purpose originates from an attempt to determine the emigration of 'County A' residents to hospitals outside County A. Using the number of patients discharged as a measure of hospital usage, outflow is expressed as follows:

$$\text{OUTFLOW} = \frac{\text{County A residents discharged from A hospitals}}{\text{All A residents discharged from all Minnesota hospitals}}$$

As such, outflow is merely a reflection of the proportion of any county's residents using in-county hospitals. Through the use of this adjustment measure, a better indication of total hospital resource utilization by members of a specific county can be obtained than is possible from raw county-by-county data.

A hypothetical numerical example readily explains the function of the outflow adjustment variable. Suppose County A reported 85 patients discharged from its hospitals in a given time period and, furthermore, assume that all 85

were residents of County A. Analysis of the data from other counties at the same time revealed that a total of 100 County A residents were discharged from all hospitals. OUTFLOW from A would then be .85. County hospital records would indicate 85 patients, while a more complete survey reveals 100 County A residents hospitalized and discharged. Because the interest of this study remains in total hospital usage by county and not merely in-county hospital usage, the County A hospital records would have to be adjusted to reflect out-of-county usage by County A residents. Obviously, in my hypothetical example, dividing in-county data by the outflow adjustment factor (85 .85) would produce an adjusted level of 100, which is a better measure of total County A residents hospital usage than the raw County A observation. Data are typically collected on a hospital-by-hospital basis, without any allowance for patient shifts within a county.

By relaxing the earlier assumption and assuming 115 patients are released from County A hospitals and only 85 were County A residents, a similar adjustment of the 115 figure (115 .85) produces an adjusted 135.3 patients. should 85 percent of County A patients go to County A hospitals, then the actual figure will be obtained by dividing the total observed County A hospital patients by .85.

The possibility remains that some of the 85 discharges examined under the former stringent assumptions were not County A residents, implying that accomodating adjustments are needed for the inflow of patients from other counties. The second adjustment mechanism, INFLOW, measure the portion of patients residing outside County A who utilize County A's hospital facilities. It attempts to alleviate distortions resulting from the immigration of non-residents of County A to hospitals in that County. Expressed as follows, the number of County A patients discharged as a percentage of the total number discharged is:

INFLOW=1- Discharges from hospitals in County A of residents from other counties
All discharges from hospitals in County A

Employed basically the same logic for the second manipulation as in the first adjustment process, this correction allows for a better indication of actual hospital utilization among residents of a given county.

Under the relaxed assumption that 115 patients are released from hospitals in County A, while only 85 were County A residents, a total of 30 patients therefore must have been residents of other counties. After performing a simple arithmetic operation (INFLOW = 1-30/115 = .739), an indicator of the actual utilization of hospital resources by a specific county's residents can be calculated by multiplying INFLOW times the quotient of the first adjustment. (.739 x 135.3 = 100). Since the adjusted number, 100, reflects more accurately the true County A resident hospital usage (85 in-county and 15 out-of-county) than the County A hospital data (115 discharges), the adjustment procedure apparently produces a more suitable measure for the purposes of our study.

Fortunately, crude data allowing such adjustment of hospital utilization figures exist in the form of the 'Patient Origin Studies' cosponsored by the Minnesota Hospital Association and Northlands Regional Medical Program. Assessing data obtained from a Minnesota hospital census conducted in the Spring of 1973 makes it possible to designate the origin of all patients in cooperating hospitals. Guster Davison, research analyst at Minnesota Systems Research, Inc., Minneapolis, greatly refined and made these data available.

Several caveats must be kept in mind when working with the adjusted patient day figures. Inherent in the use of this variable is the implicit assumption that the main patient stay does not vary significantly among counties. For example, in Hennepin County, 85 percent of the patients might have been accounted for only if 8 percent of the patients from the area utilized 85 percent of the total patient days. Since the unadjusted data measure patient days and the adjustment factors are based upon discharges, a hospital-stay discrepancy, such as persons arriving from other counties requiring longer hospitalization, would bias an interpretation of the adjusted data.

In addition, the short duration of the study weakens confidence in the adjustment process. The study was based on a one-month observation during a season when utilization is typically low. Nonetheless, as illustrated in the hypothetical examples, ignoring these adjustment variables altogether would produce results completely at odds with actual hospital utilization by county residents.

Factors Affecting Hospital Utilization

Hospital utilization (HU) is assumed to be a function of popular characteristics, hospital resources, financial assistance, and the degree of urbanization. An elaboration of these general explanatory variables follows.

Socioeconomic Factors: Explanatory population characteristics include education, income, and age. For the purposes of this study, education is measured in two ways, as the mean level of education of persons over 24 year of age, and as the proportion of the 14-17 year old population attending shcool. Conflicting theories of the effect of education on HU present themselves. It may be, that increased education implies increased medical awareness and, thus, that counties with higher education levels will evidence higher HU rates. Alternatively, since preventive measures might be utilized to a greater degree at higher education levels, education might indicate a more common alleviation of potentially serious illnesses before the critical stages approach. This would have the effect of lowering HU as education levels rise.

Income (i.e., main level of income for families with both parents) is expected to evidence a positive correlation with HU. As the level of income rises, an increase may be expected in the number of medical services available. But, as with education, the ability to utilize preventive measures increases with income, raising the possibility of a negative correlation between income and HU.

The final independent socioeconomic variable, age, has been subdivided into several groupings. The first consists of persons generally classified as potential pediatric patients, ages 0-14 years. The second group encompases those 65 years of age or older, who, along with the young population, have a high incidence of hospital utilization. Additional evidence linking age, sex, and hospital utilization are found in Public Health Services publications.

Availability of Hospital Resources: Hospital resources are characterized by the number of physicians per 1,000 population and the accessibility of hospital facilities to a county's residents.

It was assumed that the number of physicians directly affects residents use of medical services, including hospitals, but this study includes only those physicians practicing outside of hospitals, though they may have hospital privileges. It was felt that since most patients enter a hospital under a

doctor's supervision, as the ratio of physicians per 1,000 population increased, referrals to hospitals also would increase. Additionally, in a county with a relatively high concentration of physicians, medical information would become more readily available from various services.

It was further assumed that accessibility would be positively correlated with utilization. Conversely, as distance barriers increase, the utilization rate should be expected to decrease due to decreased net benefits derived from the services. This variable was examined in terms of hospital beds per square mile in each county.

Financial Assistance: 'Financial assistance,' defined as the proportion of patients not personally bearing the total cost, includes all persons who have obtained any type of medical transfer payment. It is hypothesized that HU will increase as the proportion of those receiving financial assistance increases.

Degree of Urbanization: The degree of urbanization is defined by density in terms of population per square mile. Hospital utilization may increase for various social, psychological, and economic reasons as the degree of urbanization increases. Increased urbanization may reflect greater pollution, more manufacturing jobs, along with a myriad of other effects synonymous with high population density. In these areas, health facility utilization is expected to increase.

Implications of the Hypothesis

The hypothesis that HU is dependent upon population characteristics, hospital resources, financial assistance, and the degree of urbanization fosters several policy implications. An affirmation of this hypothesis would allow more efficient health care delivery systems to be developed, estimates of this increased efficiency being derived from the signs and magnitudes of the 'policy' independent variables.

For example, in the short-run, degree of urbanization and population characteristics are stable while hospital charges and/or financial assistance are subject to policy manipulation and may be altered to alleviate apparent hospital utilization inconsistencies.

Should an uneven distribution of hospital utilization be discovered, at the least there will be increased impetus for further studies. Changes in distribution of hospitals in the state might then be proposed and studied. The establishment of decentralized clinics or, conversely, larger, more centralized hospitals in the rural areas represent potential alternatives. On the basis of further studies, organizational structures might be revised to better fit rural or urban needs.

Regression Analysis

Preliminary Results. Independent variable data from 81 Minnesota counties were regressed on adjusted hospital utilization figures on a county-by-county basis. In results shown here, t-statistics are in parentheses below the respective coefficients.

HU = 3.238 + 582.05 (Physicians per 1,000 population) - 8.16 (percent old population)

(.86) (1.15) (.85)

- .47 (14 -17-year-old education level) + .30 (beds per square mile.)

(.17) (.88)

+ .16 (greater than 24-year-old education) + .77 (percent without insurance)

(.11) (1.09)

-3.05 (percent young population) - .15 (mean family income)
(.31) (1.15)

- .18 (population density), R^2 = .134, F - 1.22
(.75)

For those independent variables, results are statistically insignificant.

As a possible explanation of the inconclusive results, it was postulated that the regression was affected adversely by inaccurate data from several counties--Big Stone, Blue Earth, Brown, Lake of the Woods, and Wilkin. Extremely high utilization was indicated in those counties, with greater than two patient days per person, while the state average was less than 1.0 patient day per person. No further explanation was attempted in this study, but an adjusted regression analysis was undertaken, with observations from the remaining 75 counties. The results, with t-statistics again in parentheses, follow:

HU = 2.45 + 913.89 (physicians per 1000 population) - 1.04
(1.37) (3.69) (percent old population) (.22)

-1.84 (14-17-year- old education) + .22 (beds per square mile)

(1.33) (1.35)

-.83 (greater than 24-year-old education) + .78 (percent
(1.20) without insurance) (.21)

+3.03 (percent young population) + .19 (mean family income)

-.14 (population density)

(.63) (.28) (1.17)

R^2 = .358, F - 4.03.

Although the coefficient for number of physicians is significantly greater than zero at the 95 percent confidence level, all other independent variables remain insignificant. It thus appears that hospital resources, in the form of the ratio of physicians, could be manipulated to produce hospital utilization changes in various counties.

It should be emphasized that the second regression is not the result of a normal statistical procedure, since the exclusion of outlying observations in order to obtain improved results is hardly "cricket". Still, the six eliminated counties had such distorted data that their inclusion could only have detracted from meaningful total results.

Since hospitals were individually responsible for reporting data to the Minnesota Hospital Association, a wide range of accuracy was possible.

Lack of suitable surrogates for the original explanatory variables lso may have caused the R^2 to be so low. For example, an ideal measure of hospital accessibility might have incorporated transportation factors. Instead, beds per square mile was chosen as the best alternative variable.

The regression findings demonstrate that a need still exists to satisfactorily define the factors affecting hospital utilization in Minnesota. Because several of the variables were shown to have ambiguous effects, further refinements are necessary. Paramount to discovery of primary determinants of HU is an improved date collection process. Improved factors to compensate for patient inflows and outflows with more general units of measurement (not the number of discharged patients) also are necassary. Using counties as the basic unitary figure may ignore regional demographic considerations. Indeed, a case can be made for regional analysis, since a disregard of state and county borders was evident in this study.

This negative finding may nevertheless be significant. We have successfully challenged a commonly-held belief that HU is locationally dependent. Recognizing what factors are minimally important in affecting hospital utilization may eventually assist in discovering the major factors affecting this relationship. Finally, it is entirely possible that people may become ill indepently of their location, and utilize hospitals without regard to socioeconomic or locational factors.

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