

MAPPING THE PREDICTED NEED FOR HOSPITAL BEDS

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I. Introduction

There is a long history of approaches for predicting the need for hospital beds at specific locations. Past methods have tended to regard as key variables the service area population, hospital use rate per population unit, average length of stay, and occupancy rates. The usual client for a bed-need study is an individual hospital. There is no constraint on the forecasting methodology to ensure that if the approach used for one hospital were to be applied to many hospitals, the summation of the forecasts for a region would yield results that are consistent with macro-regional forecasts of bed need. The methods used in this study are designed to produce such consistent system-wide forecasts when aggregated from individual-level forecasts. That is, a system of allocations of patients to hospitals in individual places is made with a sufficient accounting of flows of patients from each area to all hospitals that hospital-use rates for individual areas prevail irrespective of the particular hospitals patronized. Such a system-wide simulation model corrects for the major flaw in most existing procedures in which the system-wide effects of adapting

a methodology that has been applied to an individual hospital are rarely known. Given traditional client orientations to justify proposed hospital expansions, it is small wonder that a recent study by Griffith and Wellman reviewing six studies in Michigan which, between 1967 and 1971 forecasted acute bed supply and service needs, concluded that the studies overestimated bed needs and that, furthermore, the client hospitals frequently acted to exceed these high estimates, (Griffith and Wellman, 1979). These findings point to the need for a system-wide simulation model that forecasts bed need for all places in a region so that the forecasts of any one place may be placed in the context of forecasted changes in other places in the region. Such a system-wide model has the further advantage that it can be used to conduct sensitivity analyses of impacts on various places in the system of simulated changes in any of the variables or in the expected relationship between them.

Methods Used

Data were available on the choice of hospitals by patients in each county in Oklahoma in 1976. Population estimates and forecasts were also available for the three years of 1978, 1985 and 1990. For each acute general care hospital, data were available on current bed size and occupancy rate. Expected number of beds needed was forecast for each hospital as:

$$B_j = (\sum_i v_{ij} \cdot u_i \cdot w_j) / 365 \cdot 1/s_j \quad (1)$$

where:

v_{ij} is the population in the i th area served by the j th hospital;

u_i is the rate of hospitalization of people in the i th area;

w_j is the average length of stay of patients in the j th hospital;

s_j is the proportion of beds that should be occupied for full occupancy levels.

$$v_{ij} = \frac{x_{ij}}{\sum_j x_{ij}} \cdot P_i$$

where:

P_i is the population of the i th area;

x_{ij} is the number of patients from the i th area who use the j th hospital;

$$u_i = \sum_j x_{ij} / P_i$$

Equation (1) is an identity for current data values. Its use as a forecasting model stems from the ability to insert into it forecasted data values. If, for example, forecasted population data for counties are inserted in it, changes in bed need will reflect the influence of population change under the assumption that all other influences remain unchanged. The interest in the model as a forecasting model should, therefore, focus on the rationale for changing the various elements in it. Each is considered in turn.

Rates of use of hospitals by populations (u_i) are now known to vary markedly between localities. It has recently been shown, for example, that "in 1974 there was five to eight-fold variation in the frequency with which tonsillectomy, colectomy, hysterectomy, cholecystectomy, and appendectomy were performed in Ontario's 49 counties," (Stockwell and Vayda, 1979). Studies in the U.S. confirm such small area differences, (Wennberg and Gittelsohn, 1973). Our model computed existing use rates from the patient flow data and assumed that these rates would prevail in the future. We considered, but did not implement in the current programmed version, an algorithm which would anticipate a reduction of use in those areas shown to have unusually high use rates. This would have been useful if only to show the different degrees of dependence of particular hospitals on providing service to patients in the high use areas. The algorithm would identify hospitals with high dependence and their characteristics could then be studied.

Studies of average length of hospital stay (w_j) have concluded that modest declines have occurred in recent years. A recent study in California which compared statewide one-week discharge surveys carried out in

1968 and 1970 concluded that the decline in hospital utilization in the period was due entirely to decreases in length of stay in Medicare and Medicaid classes rather than to a decline in admission rates, (Shonick et al. 1976, p. 678). A study of Chicago hospital discharge data showed that Medicaid patients had slightly shorter average length of stays than other patients, (Davidson, 1977, p. 522). In our model, observed average lengths of stay in each hospital were used in the analyses performed although provision was made in the program to substitute normative average length of stay rates.

Surprisingly, scientific studies of patient flow patterns, (x_{ij}) , (market penetration) are rare. In their study of bed need forecasts for six hospitals, Griffith and Wellman found marked changes in the market penetration of the hospitals in their local areas. Whether the cause of this was a general shift of patients from patronizing local hospitals to using the larger regional level hospitals, or was caused by a change in the method of measuring patient flows, was not known. Five of the six hospitals, however, registered a decline in the ratio of the hospital's service population to local county population. With the exception of one study which employed questionable methods, studies of temporal changes in patient flow patterns to hospitals do not appear to exist even though errors in the spatial allocation forecasts for patient flows are the most likely source of inaccuracies of forecasts, (Meade, 1976). The assumption of stability of market penetration by hospitals in their service areas, is therefore, questionable on empirical grounds. It is also questionable on the grounds that a recent trend in hospital administration is that of more aggressive promoting of hospital services, (Lublin, 1979). We conclude, therefore, that models of patient flows from small areas to hospitals would be useful in providing a basis for forecasting future patient flow rates. Such models should be tested for parameter stability with time-series data and should be based on variable values that are either time-lagged or which can themselves be forecast with sufficient accuracy for use in a spatial flow model. One previous attempt which used an uncalibrated, unconstrained, spatial interaction model, nevertheless succeeded exceedingly well in replicating the boundaries of hospital dominance between hospitals in Oregon, (Meade, 1974). No data was provided on the

recovery of the proportional flows. In our model, we assumed stability of patient flows in making forecasts with the exception of a provision to allow one new hospital to be introduced with ad hoc forecasts of expected flow patterns to it. Our model then adjusts previous patient flow rates to accommodate the new hospital and then makes bed need forecasts on the "new" patient flows. Provision of this option enabled us to model the possible effects on existing hospitals of constructing a new hospital at a given location.

The forecast of population to be served in any area (v_{ij}) is based on the assumption that the proportion of the population served by a hospital in any area is the same as the proportion of patients from the area who use that hospital. It follows that errors in forecasting the proportional flows of patients from any area to hospitals (x_{ij}), will be translated into errors in forecasting hospital service population. Implicit in the above assumption, however, is the further assumption that hospital use rates within any small area are the same for each segment of the population served by each hospital. But because we know that hospital use rates vary between areas served by different hospitals, we have every reason to believe that they also vary within areas served by different hospitals. In our model, population served in any area was assumed to be proportional to patient flows from that area.

Conclusions

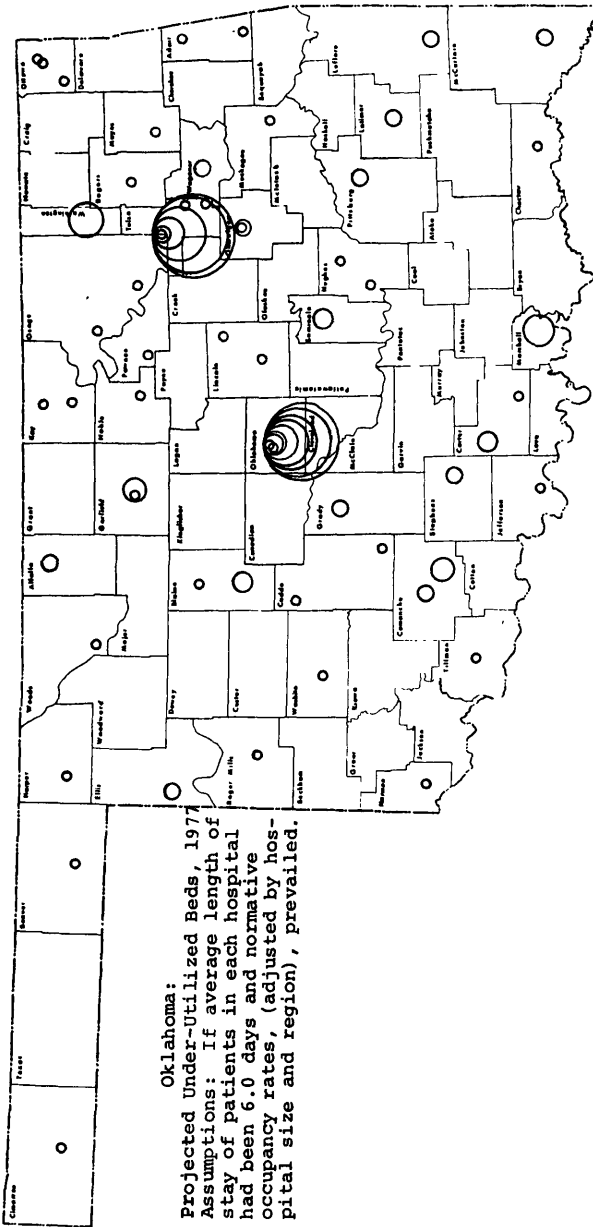
The key characteristics of this model are its ability to keep a complete accounting of patient flows to all hospitals in the state and the flexibility with which the user may modify assumptions about average length of hospital stay, occupancy rates, population forecasts, service area populations and hospital utilization rates. It was constructed according to the philosophy that system flexibility and adaptiveness rather than optimization is the most appropriate orientation for health planning. The model allows sensitivity analyses to be performed, the results of which will indicate the likelihood that a given or proposed system of hospitals will meet the needs of an ever changing region.

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Oklahoma:
Projected Under-Utilized Beds, 1977
Assumptions: If average length of stay of patients in each hospital had been 6.0 days and normative occupancy rates, (adjusted by hospital size and region), prevailed.