AN ACUTE BED NEED SIMULATION MODEL

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The cost to maintain an acute care hospital bed can be over $100,000 per year and there is usually a lead time of 1 to 4 years before additional facilities can be constructed and staff hired. It is therefore necessary to accurately predict the demand for acute care beds several years in advance.

Currently, long range planning (in Connecticut) is done utilizing formulas developed in the Hill Burton Legislation. In order to determine an area's future acute bed requirements, the "average daily census" (ADC) is determined by the formula:

$$\text{Projected ADC} = \frac{\text{PROJECTED GROSS TARGET POPULATION}}{\text{CURRENT GROSS TARGET POPULATION}} \times \text{CURRENT ADC}$$

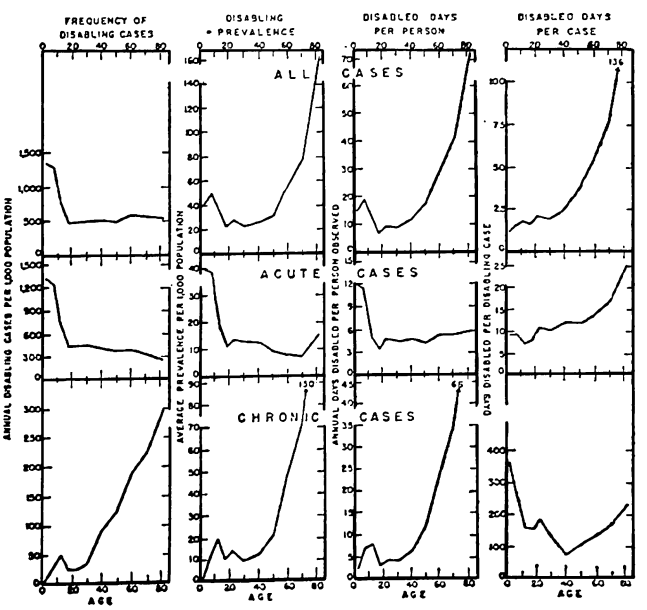
The acute care beds required, by service, is then calculated using the prescribed occupancy rates;

SERVICE	TARGET POPULATION	OCCUPANCY RATE	FORMULA
General Medical-Surgical	Age 15 and over	.85	$\frac{ADC+10}{.85}$
Maternity	Female, 15-44	.75	$\frac{ADC}{.75}$
Pediatric	Age 14 and under	.75	$\frac{ADC}{.75}$

This method would be adequate if everyone, that is all age groups for all categories of acute bed requirements utillized hospitals equally and hence required the same number of patient days per time period. However, the admission rate and lenghts of stay vary among patients and treatments (see Figures 1 and 2). The Hill Burton formulae are therefore accurate for estimating bed needs at a gross level of aggregation.

FIGURE 1

Age-Dependent Health Parameters(1)



Incidence, prevalence, and days of disability from acute and chronic illnesses disabling for 1 day or more, by age:

FIGURE 2

Average Length of Stay by Age(2)

It has been observed that by classifying individuals into certain cohorts (groups of people with similar characteristics; age, sex, race, etc.) relatively accurate projections may then be made based on the average values for the individuals within the cohort. Using U.S. Government census data, population segment projections can be made by first stratifing the total population into cohorts and then projecting the size of each cohort using previous birth, death, immigration, and emigration rates. The total population projection is determined by then aggregating the cohorts. Health and life insurance companies do the same thing to determine the probable risk (and resulting policy cost) for each policy class. (See Figure 3, for instance.)

FIGURE 3

Approximate 1975 Average Monthly Insurance Cost by Age and Sex(3)

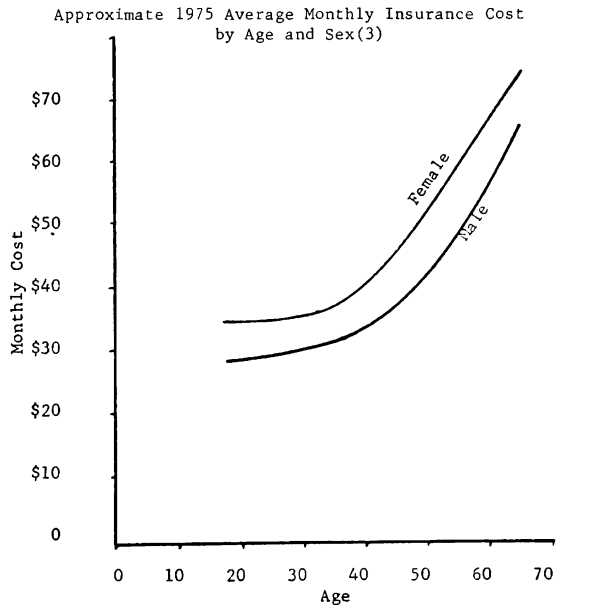


FIGURE 4

Stratified Non - Maternity

Predicted ADC and Beds

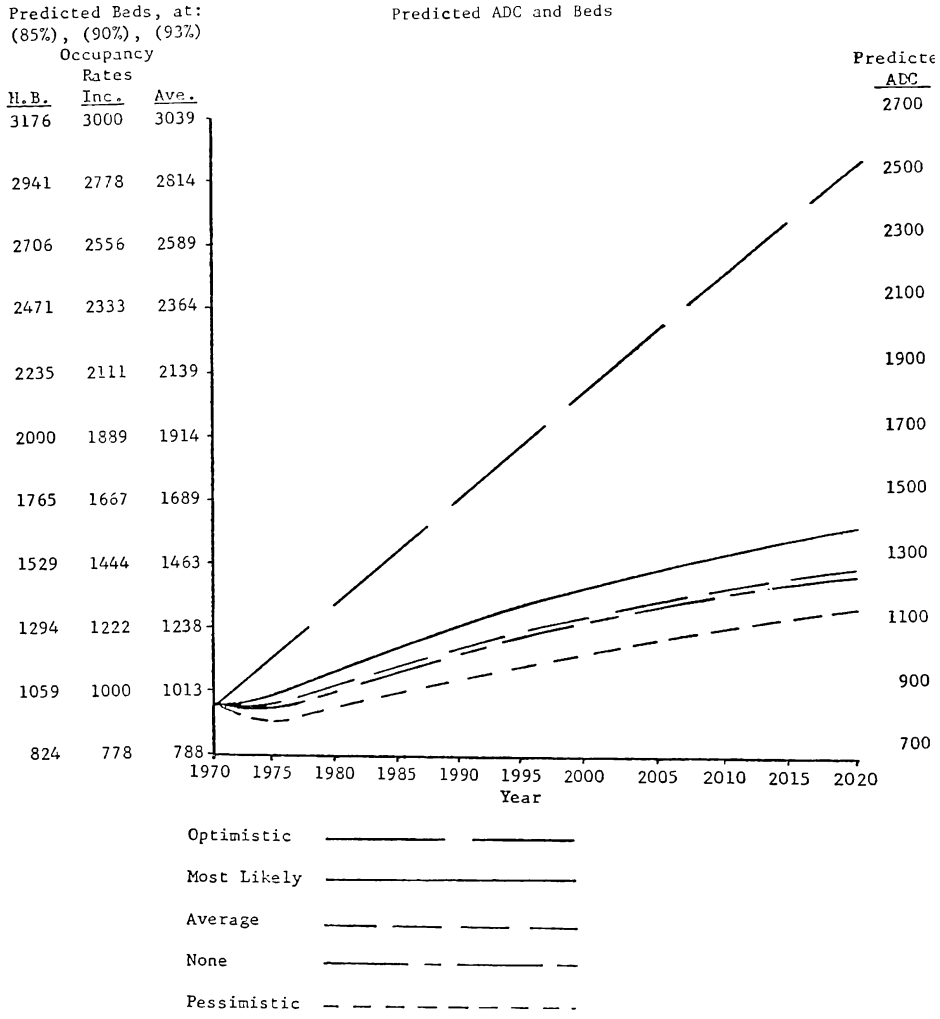


FIGURE 5
Non - Maternity
Admissions per 1000 Pop

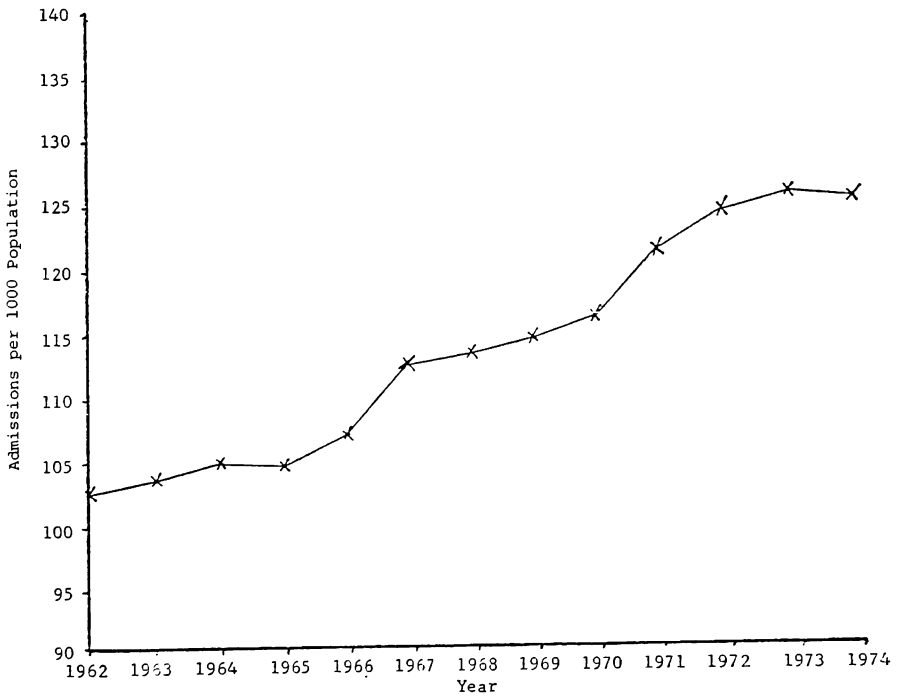


FIGURE 6
A PREDICTION MODEL FOR ACUTE CARE HOSPITAL BED REQUIREMENTS

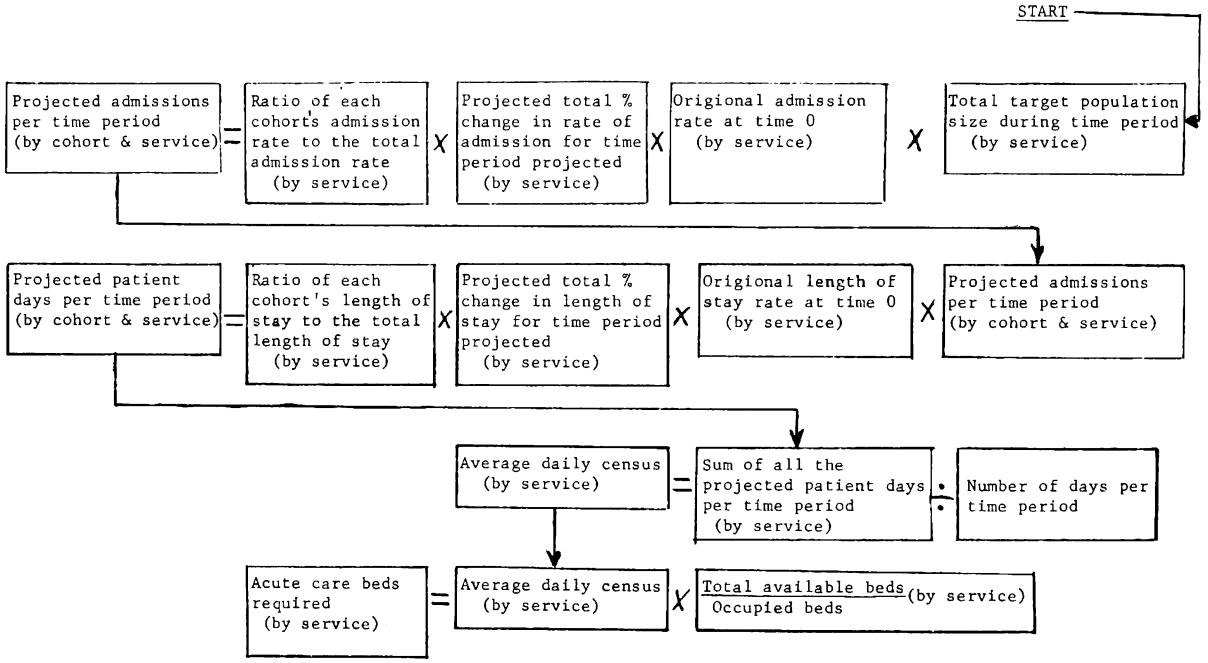
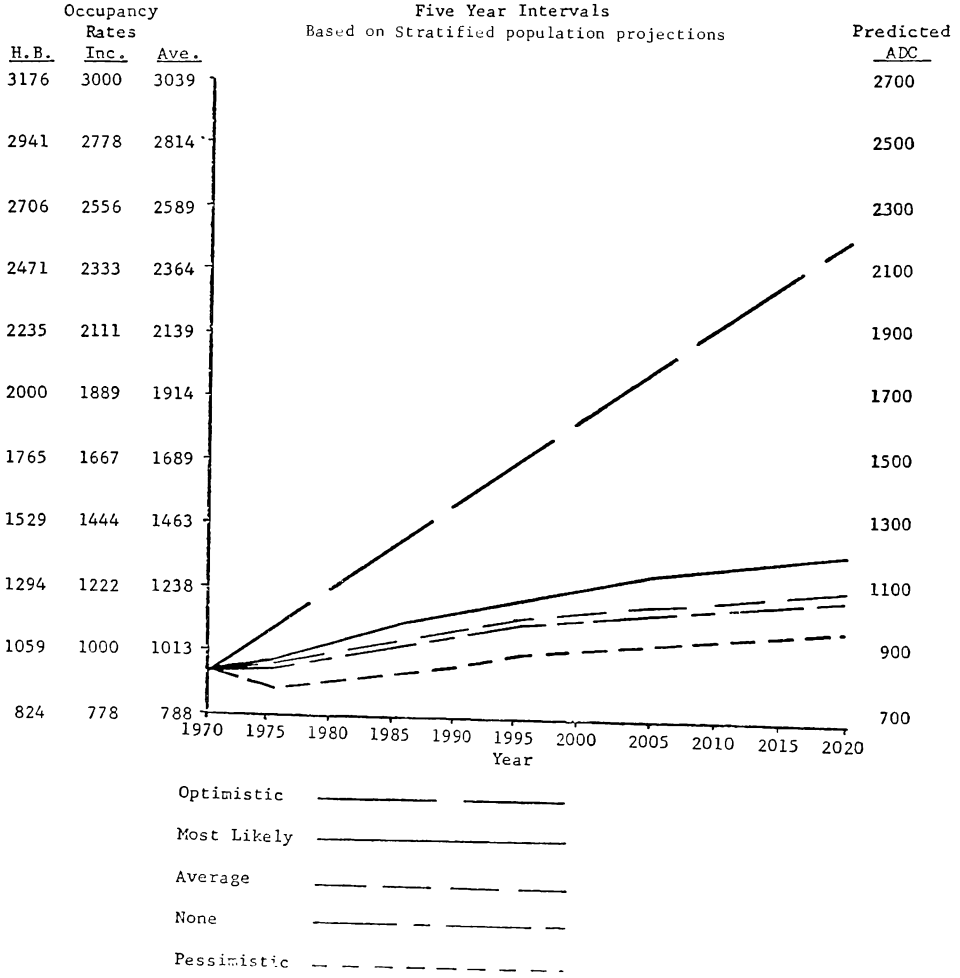


FIGURE 7
Non - Maternity
Average Length of Stay
Based on Gross population forecasts

FIGURE 8
Non - Maternity
Predicted ADC and Beds
Five Year Intervals
Based on Stratified population projections



By stratifing the gross target population into smaller cohorts and making entry rate and ADC projections for each, the demand for acute care hospital beds may be similarily determined. However this method still has some short-comings. First of all, the present use rates (which are reflected in the ADC) will not necessarily remain constant. For example, the decreasing birth rate observed over the past few years has resulted in a dramatic decrease in maternity admissions. Similarily, due to better home care programs the average length of stay in acute hospital services has dropped.

The use rate employed in projections should therefore incorporate observed trends in the demand sub-systems and not just current levels (see for instance FIGURES 4 and 5).

In addition to trends in acute care bed use, planning and forecasting should take into account future contingencies, that is to say policy and program changes. Examples are; the effects of implementation of a PSRO and the establishment of an HMO in the area, (or other modalities of health delivery that may affect acute bed utilization.

In order to forcast bed requirements under the preceding assumptions the model (shown in FIGURE 6) was developed and programmed for computer simulation.

The Greater Bridgeport Regional Planning Area in southwestern Connecticut, population 310,000, supplied the data used for simulation. Land use studies indicate that this area has a high urban development. Over one-half the people are employed in manufacturing. The median family income is approximately $14,500 per year. The area comprises six towns and includes three general hospitals with a combined capacity of about 1200 beds.

The forecast cohort sizes used in the model were determined using the cohort-survival method of population projection. Future admission rates and length of stay were determined by combining the subjective estimates of several health care practictioners with the historical data and then using least sum of the squares methodology the data was fit to several mathematical functions. This technique provided several possible futures for each service. These were termed the "most likely", the "highest expected", the "lowest expected", the "average" (the average 1970-1974 values with only the population size changing), and the "latest", a projection using the latest observed (1974) values with only the population size changing.

Three different occupancy rates for each service were used to predict the acute care beds required from the previously calculated average daily census. The three rates used were; the recommended Hill Burton, the actually observed average (1970-1974), and an increased occupancy rate which was used to show what a 5% increase in the occupancy rate (over the Hill Burton rate) would mean in terms of acute bed requirements.

This methodology supplied several different simulation options; a comparison of gross vs. stratified population projections, evaluation of the impact of apparent aging of the population on health services, and a comparison of the effect of constant vs. changing admission rates and length of stay rates on acute bed predictions.

FIGURE 7 shows the predicted ADC and acute care Beds required for the five different simulated futures, based on gross population forecasts. The "None" future corrosponds to the Hill Burton formulae prediction. The "Most Likely" future forecasts higher ADC (and corrosponding acute care Beds required) than the "None" future. A look at PIGURE 5 reveals that this is due to the increasing admission rate expected.

FIGURE 8 shows the predicted ADC and acute care Beds required based on stratified population projections. Comparing FIGURES 7 and 8 we find that an increase of approximately 5.6% may be expected as the result of the more sensitive population projection, as follows;

Non-Maternity ADC Predictions
Gross vs. Stratified

Future used	Non-Strat. 1985	Strat. 1985	Percent Difference
Highest	1237	1305	+5.5%
Lowest	842	898	+6.6%
Most Likely	983	1040	+5.8%
Average	934	978	+4.7%
Latest	944	997	+5.6%

The methodology used in the acute care bed requirement model is being extended to include long term bed requirements, home care visits, and amblatory care visits employing an additional subsystem that represents "exchanges" among these services.

A resource by service matrix which gives the quantity and mix of resources - manpower, facilities, and equipment - required to provide a unit of each type of service has been constructed. Thus the total requirements for all types of resources for a given service can be determined. By adding unit costs of the resources to the model optimum allocation of personnel, equipment, and facilities either for a desired level of care or a given funding level can be determined through trade-offs between services. Also the effect of future contigency factors may be predicted for estimates of the impacts of programs such as an HMO of a PSRO. Once the programs effect on the area's admission rate and length of stay has been determined the model's subsystem values may be adjusted and then various futures simulated.

REFERENCES

(1) Perrott, G. St. J., et al., "Illness and Health Services in an Aging Population", Public Health Service Publication No. 170, United States Government Printing Office, Washington, D.C., p. 5, 1952.

(2) "Professional Activity Study", Commission on Professional and Hospital Activities, Vol. 10, No. 11 p.1, December 15, 1972.

(3) From interviews with several area health insurance salesmen.