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A REVIEW OF METHODS USED IN PLANNING THE DISTRIBUTION OF PERSONAL HEALTH SERVICES.

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Chapter in Survey of Health Planning, edited by W. Reinke, Ph.D. Baltimore: School of Hygiene and Public Health, The Johns Hopkins University, 1968.

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INTRODUCTION

Planning for personal health services involves four steps, closely related but conceptually different: the elaboration of the plan, its acceptance by those affected, its implementation, and its evaluation. These four steps, united in a cyclical time sequence, are differently emphasized, depending on the social, political and economic environment in which the planning takes place. In environments unfamiliar with or unreceptive to the concept of planning, discussions among planners tend to focus on acceptance and implementation, while in environments with a clear commitment to planning, the focus is primarily on the elaboration of the plan and its evaluation. Differences in the importance accorded to each of the four steps motivate much of the lively discussion on the purpose and value of planning.[1]

This chapter reviews the methods used in the first step, the elaboration of the plan. It deals with planning for adequate and appropriate distribution of health resources. The methods described have been developed in a variety of situations that differ in time, location and territory.

I. METHODS BASED ON MORBIDITY

Although the level and structure of morbidity are believed to be important determinants of health resources utilization, planning of health services has not often been based upon morbidity data.

The sequential steps to be followed in planning health services in relation to morbidity are two: first, to survey the extent and character of so-

called "need" for medical care as determined by the morbidity of the chosen population; this morbidity can be either "perceived" by the individual or "defined" by the health professional; second, to translate this "need" defined by morbidity into health resources.

The use of data from morbidity surveys of general populations for planning purposes has been described elsewhere.[2] The conversion of morbidity data into measurement of health resources needed usually has relied on subjective judgment - "expert professional opinion."

Several investigators in different countries - Lee and Jones,[3] Falk et al.[4] in the United States: Kalimo and Sievers[5] in Finland, Forsyth and Logan,[6] and Barr[7] in the United Kingdom among others - have surveyed morbidity patterns in either general populations or specific ones, e.g., hospital populations, and have calculated needed health resources to cope with the morbidity reported.

Among the most detailed studies is that reported by Popov from the Soviet Union.[8] This study involved several cities and rural districts in which "experts" on delivery of medical care considered that demand for personal health services was met, e.g., there were no-waiting lists for hospitalization. The extent of satisfied demand was indicated by the amount of utilization of the personal health resources. For the survey every member of the community was provided with a card, on which all utilization of medical and hospital facilities was recorded for an undetermined period of time. Following this utilization survey, a health examination survey was carried out by medical specialists on the whole population. The return rate for this survey, accord-

La fórmula 1 es:

resumen:

camas requeridas corregidas por norma de grado de utilización

(enfermos x % demanda x días hospitalización / 365)

Jaime
27/III/69

¡Qué Novedad JA JA!

Among the limitations commonly attributed to this method of estimating potential demand for health services, based on measures of "need" determined by morbidity surveys and defined by "expert standards," are the following.

First, it uses as the basis for planning, the highly subjective concept of "need," instead of the more objective one of "demand." The fact that need exists does not imply that it will be expressed as demand for services.

Second, adequate morbidity data are scarce.[9,10] In a recent review of morbidity statistics said to be available in ninety-eight countries, A. Smith comments that "administration and planning of services in most countries lack this kind of bases [morbidity and utilization statistics] to an extremely serious extent."[11] The present reality is that "health administrators faced at first with the virtual necessity of doing without an adequate numerical basis for their decisions have now come to feel that they can dispense with statistical information. The results of this may be seen in many countries today where the available services bear very little relation to the health needs of the communities they are supposed to serve."[12] The main reason for this scarcity is the high cost of obtaining reliable morbidity information. This cost, however, should be weighed against the benefits obtained from the data. The increasing pressure for morbidity and utilization data is the result of their demonstrated value, not only for planning health services but also for epidemiologic surveillance and for studies of the effects of medical and social intervention.[13]

Third, this method requires a consensus of medical opinion on how best to care for each condition. This consensus is difficult, if not impossible,

to reach in some cultural environments.[14,15,16]

II. METHODS BASED ON MORTALITY

In their calculation of required health resources, some authors have preferred to plan on the basis of mortality data rather than morbidity data.[17,18] The reasons given for this preference are: first, mortality statistics are more reliable than morbidity statistics; second, mortality data are available annually for most localities, whereas morbidity data are not similarly obtainable; and third, when they are available, translation into health resources required to meet "need" and/or "demand" involves the difficult process of establishing criteria for services.

The assumption made in all planning based upon mortality data is that there is a constant ratio of health resources utilization to mortality. However, technological, demographic, and socio-economic changes, among others, condition changes in utilization as well as changes in mortality, and hence the validity of the hospital bed utilization/mortality ratio may be questioned.

III. METHODS BASED ON UTILIZATION

In this approach, the present use of personal health resources is taken as a reliable indicator of future use, and the objectively quantifiable concept of "demand" is preferred to the subjective notion of "need."

Within this approach, two concepts, closely related to each other, have to be considered. The first is, "adequacy of resources," i.e., the availability of sufficient facilities to meet the demand for them. The second is "distribution and coordination of resources," i.e., the geographical and

functional relationships between resources and population.

a. Methods Based on Demand

Among the methods designed to calculate the health resources required to meet future demands, the most frequently used has been extrapolation of the present ratio of health resources to population (conditioned by current demand) to the future projection of the population.[19,20,21] This method takes into account only increased demand due to demographic growth. It assumes that the work loads carried in the past are the best and most objective guide to the requirements of the future.[22] Sometimes this demand is "corrected" to exclude "overuse" and include "underuse," according to "expert" judgment. The main reservation, however, to this correction is that definitions of "overuse" or "underuse" are matters of opinion and depend on the criteria selected; they may reflect value judgments regarding the purposes to which the health resource should be put.

Bailey[23] introduced the concept of the "critical number of beds," which has been widely used in England.[24] This is the number of beds that will just keep pace with current demand. It is calculated by noting the change in the length of the waiting list for hospital admissions over a given period of time, and adding this change to the satisfied demand, that is, the patients actually admitted to the hospital during the same period. The method is illustrated in Table 1.[25]

To determine the desired occupancy rate (total available hospital beds/total occupied hospital beds), Bailey[23] and McPhee[24] divide hospital

TABLE I

Hypothetical annual utilization experience for a general hospital by a population of 10,000.

Time Period	Satisfied Demand (Actual Admissions) (1)	Discharges (2)	Total Demand for Hospitalization (Actual Admissions + Waiting List) (3)	Desired Change in the Waiting List to Meet All Unsatisfied Demand (4)=(3)-(1)	Average Length of Stay in Days (5)	Bed Patient Days (6)=(5)x(2)
	1,070	1,047	1,094	+24	16.3	17,066

Critical number of hospital beds per a population of 10,000 is calculated from the formula:

[2] $$C = D \times S$$

where

C is the critical number of hospital beds,

D is the daily demand for hospitalization,

S is the average length of stay in the hospital

e.g., $C = D \times S = \frac{1{,}094 \text{ total annual hospital admissions}}{365 \text{ days}} \times 16.3 \text{ days} = 47.2 \text{ beds}$

admissions into elective and non-elective (emergencies). They observed that elective admissions tend to follow a normal distribution. They defined the occupancy rate by choosing a desired turnover interval, i.e., the average number of days a bed lies vacant between successive hospital admissions. They consider non-elective admissions to follow a Poisson distribution and accordingly they chose the occupancy rate from prepared tables on "Variation of Beds Required Based on a Poisson Distribution."[26]

Recently, Drosness et al. published one of the first studies in the United States on variations in daily hospital bed census in an entire municipality (Santa Clara County, California).[27] They concluded that for all hospital bed units studied (medical, surgical, obstetrical, and pediatric) a normal distribution gives a more accurate description of variation in daily census than does a Poisson.

Planning based on these methods of extrapolating into the future past and present demand can be criticized because it is not only maintaining the "status quo" but also is magnifying the size of its defects. Another shortcoming of such methods is that they usually do not take account of shifts in demand related to socio-economic changes in the population or to scientific and technologic developments in medicine.

A further reservation about the use of these methods has been created by Roemer's[54] and Newell's[52] findings that supply appears to promote demand, although Rosenthal[55] and Sigmond[56] questioned these findings. This divergence of opinion seems to indicate that there is as yet no clear understanding of the effect that supply has upon demand for hospital beds.

b. Comparative Methods

The comparative methods is similar. It takes the ratios of resources to population from an area or region where health resources are considered adequate to satisfy demand, and applies these ratios to another population.[28] This method suffers from the same defects as the previous one, as well as two others; there are few areas or regions that are truly comparable, and even fewer where the demands, to say nothing of the needs, of the population are satisfied.

c. Methods based on Analysis of Demand

A more sophisticated approach than simple extrapolation to the future either of present demand or of ratios of resources to population is that based on analysis of present demand.[51] This method represents, in fact, market analysis of consumer use. Brooks, et al.[29] predict future demand by multiple regression analysis of 117 variables, such as demographic data, mean life expectancy, mean effective buying income, average length of stay in hospital, average occupancy rate, ratio of physicians to population and others. Monthly figures are collected for each of these variables for five years, and then multiple regression techniques are applied to establish the relation between the number of patients in each hospital department and the 15 to 20 most important factors. The number of patients expected per month in each department can be predicted by estimating the value of the factors for that month. The number of beds needed by departments or by the whole hospital is estimated by multiplying the number of patients per month by the average length of stay and dividing by the average number of days in a month.

Feldstein and German use two methods; first, extrapolation of present supply and demand and second, in relation to estimates of population growth, analysis of selected socio-economic factors that affect utilization.[30] By predicting the future level of these factors they derive estimates of future hospital utilization.

Reinke and Baker have developed a new analytical method, the multi-sort technique, that improves the analysis of the effects of multiple demographic variables on utilization.[31] Multiple regression techniques can analyze effects of demographic variables but interactions may be overlooked entirely or inadequately identified. Analysis of variance has proved useful in handling interactions, but uneven distribution of observations among cells creates orthogonality problems. The multi-sort technique is an approximation procedure that simplifies computations while maintaining the analysis of variance approach. The procedure assigns to cells weights for all factors according to the rules for evaluating main effects; thus, the assessment of interactions is approximate but not tedious.[31]

Swedish workers base their estimates of required medical and hospital resources upon a demographic analysis of hospital utilization. Because of the polarized age distribution of the country they are particularly interested in differences in utilization by different age groups.[32,33] Swedish health planners therefore use an index, the "consumption unit" which reflects differences in utilization by different age groups rather than by the number of persons, for estimating future demand.

An example of this approach is presented in the "Goteborg plan."[34] The mean annual number of physician visits for each age group is related to the mean annual number of physician visits for all age groups (231.6 visits per 100 persons), and thus the consumption unit is obtained, which is said to measure the proportional consumption per age group (Table 2, right hand column).

By multiplying the consumption unit for each age group by the number of people in "Goteborg" in each age group in 1963, 1970, 1975 and 1980, the total number of consumption units for the region may be estimated.

By taking into account differences in the consumption of medical and hospital services by different age groups, the method gives more detailed estimates of future consumption than those estimates based on the growth of the entire population.

IV. METHODS BASED ON DISTRIBUTION

The concepts of distribution and coordination refer to the geographical and functional relationships between resources and the population served. To study these characteristics two methods have been used: the "facilities-centered"[35,36,37,39] and the "population-centered"[38] approaches.

In the "facilities-centered" approach, a group of facilities, usually hospitals, is surveyed to define the population served by these hospitals. This method involves collecting information about hospital discharges according to patient's places of residence for each of the hospitals serving the community or region being studied. For each hospital within the region, the pro-

TABLE 2

Annual number of Consumption Units per person in the city of Göteborg (1967).

Age Group	Number of Visits per 100 Persons (V)*	Number of Consumption Units (C.U.)** per Person
0 - 15	125.0	0.540
16 - 19	154.0	0.665
20 - 29	196.9	0.850
30 - 39	236.0	1.019
40 - 49	274.9	1.187
50 - 59	311.1	1.343
60 - 66	345.2	1.491
67 and over	308.9	1.334
Mean Number of Visits ($\bar{V}$)	231.6	

* Data taken from National Insurance Board Study, 1963.

** C.U. = $\frac{V}{\bar{V}}$; For example: C.U. for Age Group 0 - 15 = $\frac{125.0}{231.6}$ = 0.540.

portion of its total patients coming from each small area (e.g., county, commune, municipality) can be calculated and the percentage of the area's total population that this proportion represents can be estimated. By applying these percentages for each hospital to the total population of each small area and adding them, the population served by each hospital in the region may be estimated. By estimating projected changes in the populations of these areas, one can predict future hospital utilization and thus future requirements for the whole region. This method suffers from the defect that it does not take into account the influence of selective bias in choosing a hospital on the part of residents in the same small areas.

Schneider[40] in the United States has described a conceptual model for evaluating the locational efficiency of health resources - physicians' offices and hospitals - using a "facilities-centered" approach in his analysis. The locational efficiency measures the costs of operating a hospital which may be attributed to its location.

The "population-centered" method is based on the analysis of the current patterns of hospital utilization by a defined population. The initial step is to define the survey population as the residents of a particular geographical area. The pattern of bed utilization for this specified population is then determined. This involves analyses of bed utilization data from hospitals both inside and adjacent to the defined area. This method measures current use of hospital beds rather than demand for beds.

This method has been used more often for planning hospital beds than for manpower planning. It has the advantage of fostering the idea of community care with the hospitals as an essential but not the only component.

Forsyth and Logan[41] have used both "facilities-centered" and "population-centered" methods in Barrow-in-Furness, in the North of England. A factor facilitating the use of both approaches was Barrow's peninsular geography and consequent clear regional boundaries.

The study in the Soviet Union mentioned above, which was based on estimates of morbidity and utilization, also used both these methods. Engel and Godland used a modification of both approaches in their plan for regionalization of the health services of Sweden.[42,43] A similar approach was used more recently in Göteborg.[57] It was decided to centralize the super-specialities, e.g., neurosurgery, in one teaching hospital, which would be the principal medical center of a region. Using hospital utilization experiences of different surveyed populations, as well as experts' opinions, the authors defined the desired ratio of super-specialist beds to population. By defining the minimal desirable size for the super-specialists units in regional hospitals, they were able to define the optimal size of a region. For example, if the "experts" defined the minimal size of a plastic surgery unit as 60 beds and the suggested number of beds for plastic surgery patients per 100,000 persons as 5.5, then the minimal size of a region that could generate enough patients to support a plastic surgery unit would be $(60 \times 100{,}000)/5.5 \cong 1$ million persons.

With respect to geographic distribution of regional centers and their size, these authors gave primary importance to the accessibility of the regional hospital center for the population living in the region. The constraints chosen as the basis for selection were travel times and costs. No

person within a region should have to travel more than four hours round trip by car or public transport. The travel times for alternative locations of regional centers were represented graphically on isochrone maps. (Isochrones are lines joining points situated at similar travelling times from a given center.) If travel cost instead of time is used, isochrone maps also perform the role of travel cost maps (isodapan maps), since travel cost is proportional to travel time. The isochrone maps for each alternative location were placed over the population projection maps for each future year. The population living within each travel time zone was then estimated. The location chosen was that which minimized aggregate travel times and costs.

V. METHODS BASED ON SYSTEM PERFORMANCE

According to this method, planning of personal health services is based upon analysis of the performance of the system. In this method the required resources are determined by the amount and type needed to achieve a defined output, measured in terms of performance such as reduction or control of death, disease, disability, discomfort, etc. Effectiveness is the relationship between input and output in the system performance method.

Unfortunately, little is known about the effectiveness of different health services systems. Most analytical studies of health services have been concerned with productivity, expressed in terms of efficiency, but not with effectiveness.

The paucity of effectiveness studies is due to present limitations in knowledge of methods to measure the different variables involved in the

output as well as in the input of the system and their interrelationships. Except in a few instances, relationships between the system and its performance are not known; even less is known about methods of quantifying them. There is no evidence, for example, that by providing X units of prenatal care one will save Y children's lives.

The absence of objective measurement of the relationship between systems and performance explains the use of subjective measurements, such as the opinions of experts or the experiences of other areas or countries, as described in the earlier sections dealing with planning based upon morbidity and mortality.[45] Actually, they may be regarded as variants of the system performance method.

An example of this approach is the method used by the Centro de Estudios de Desarrollo (CENDES) and the Pan American Health Organization (PAHO) in health planning.[46] In this method the main goal is to decrease mortality by disease categories, subject to the constraint of cost. Although it would be possible to take morbidity into account also, only mortality is considered owing to the lack of data on the former. The first step in this method is to establish a priority rating for each cause of death by disease category based on the incidence of death, i.e., the proportion of deaths due to each disease category to total deaths. The relative importance of the disease category is measured by an arbitrary score based on age at death and the degree to which premature deaths caused by this disease could be prevented. This preventability is defined either by experts' opinions or epidemiological studies.

For non-reducible morbidity and related non-reducible mortality, this method defines two alternatives: in the so called "minimum alternative," the future resources required are calculated by extrapolation of current demand determined by these diseases: in the "maximum alternative," the future resources required are defined by experts' opinion of what resources should be provided to care for this present and prospective demand, regardless of cost. For reducible morbidity and mortality, the resources needed are divided into preventive and curative resources. The number of preventive resources required is defined by experts' opinion (vide supra) of standards of prevention needed, according to the "minimum alternative," to keep morbidity and thus mortality at the current ratios, or, according to the "maximum alternative," to reduce morbidity and mortality as much as possible, regardless of the cost.

The number of curative resources required is based in both alternatives on the ratio of utilization to mortality, i.e., "a correlation between the mortality rate for each reducible disease and the hospital and consultation rates for the same disease."[57]

In the United States, the Division of Indian Health Services of the United States Public Health Services has developed a planning method that defines its objectives as quantifiable reduction of morbidity and mortality.[47] The determination of health problem priorities is based on a Health Problem Index, which takes into account morbidity, mortality and utilization for each category of disease. The resources required are estimated by the plan of action chosen, with choices based upon a cost-benefit analysis of the different alternatives. The difficulties in applying similar approaches in open health

services systems, in contrast to the closed system of Indian Health Services, have been discussed by Kissick.[48] Several other studies have used a comparable approach for certain categories of diseases.[49,50]

VI. METHODS BASED ON SYSTEM STRUCTURE

These methods are based upon the knowledge of the internal relations among the system's parts and therefore they require knowledge not only of its static aspects of the system, i.e., the counting of the system's parts and the measuring of their productivity as the number of services per part, but also of its dynamic aspects. They are based on the knowledge and understanding of the referral and transferral system, which gives the dynamic relationship among the system's parts. By considering these dynamics and knowing the population defined according to the desired demographic and/or epidemiological interest, one can then speak of the probability (transitional probability) that a case will be in a particular flow from one part of the system to another.

Navarro and Parker[58] have described a planning model based on these concepts. The model, based on the Markovian process[59,60] is used to predict resource requirements, to calculate change in these requirements in simulated situations, and to estimate the best alternative for reaching a desired goal in the presence of a defined constraint. In Prediction and Simulation the required resources are obtained from the multiplication of the vector representing the utilization of health services by the transitional probability matrices representing the dynamics of the system. In the last application or Goal Seeking the problem solved is to minimize "change" or "cost" subject to

reach the desired goal. This minimizing change or cost is the objective function in a mathematical quadratic program.[61]

Williams et al.[62] have used a Montecarlo technique to simulate present and future situations in a hospital outpatient clinic to improve its efficiency.

The advantage of these mathematical models in planning is that they allow greater clarity and precision than purely intuitive methods. Further, the use of probability models is essential to describe patterns of happenings that could occur with their relative chances of occurrence.[63] This allows the maximum of flexibility to the planner to face the continuously changing health services system. The validity of these models, of course, depends on the validity of their implicit assumptions.

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