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# International Comparative Aspects of Health Delivery Systems

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In accordance with the title of this paper I should like first to describe a health delivery system, identifying all of its components and allocating them neatly to their proper places. Further, I should like to explain how the many inter-related elements of the system are amalgamated into a unified whole which is greater than the sum of its parts. Finally, it would be useful to compare the structure, operation, and results achieved from existing systems in several countries.

Much as I should like to do these things, the ignorance which I share with others in this field forces me to establish much more limited sights. Circumstances in this country have been described as a 'non-system', and we hardly stand out as a glaring exception.

Superficial comparisons (the only kind presently available on a broad scale) of health inputs (services) and outputs (indices of health status) are confusing in that they supply more questions than answers about the underlying nature of the various health delivery systems. To illustrate, the crude death rate in France is nearly twice that of Israel in spite of the fact that *per capita* national income and health expenditures *per capita* are similar in the two countries. Is the difference in death rate due to the fact that Israel has more than twice as many physicians per thousand population as France, whereas the latter has put more of its resources into hospital beds? This is obviously too simple an answer, for Cyprus, with a reported death rate lower than either France or Israel, also has fewer physicians and fewer hospital beds per thousand population than either of them.

## How Should Health Delivery Systems be Viewed?

Being unable to provide either straightforward descriptions of health systems or entirely rational comparisons between them, we are naturally led to a more questioning analytic approach in which we investigate in depth the nature and role of particular aspects of the system. This approach is necessarily more piecemeal and less global than we might desire, but is necessary and productive, given the current state of the art.

To be more specific, in this analytic approach we seek to learn the extent to which observed national dissimilarities stem from genuine differences in the functional relationships that in turn produce different optimal combinations of resources. At the other extreme is the possibility that the empirical data have been generated by a single equation of universal relationships with 'noise' superimposed. The biological point of view would tend to support the latter view, whereas the behavioral scientists and others would no doubt put forth the first one. The difficulty is that we are so hard pressed to discover functional relationships in any case.

## Conceptual Framework

Even if our primary intent is to analyze the system components, we must start with a general conceptualization of their relationship to the whole. Broadly we take the view portrayed in figure 1, where we note that health services draw upon resources in response to certain health problems for the purpose of producing an output or result in the form of improved health status. Such a broad conceptualization is, of course, of little practical value in coming to grips with real conditions. Therefore, we must look more carefully at each of the system components in turn.

### *The Population and Its Problems*

In figure 2 health problems are identified in relation to the population groups at risk in the health services area. Effectively, then, the problems have epidemiologic numerators and demographic denominators. Demographic considerations are based upon the fact that different segments of the population vary in the type and magnitude of their health needs, as well as in their utilization of health services. As a minimum the population breakdown should include age, sex, and place of residence. Frequently it is advisable in addition to include social class and/or educational attainment, race,

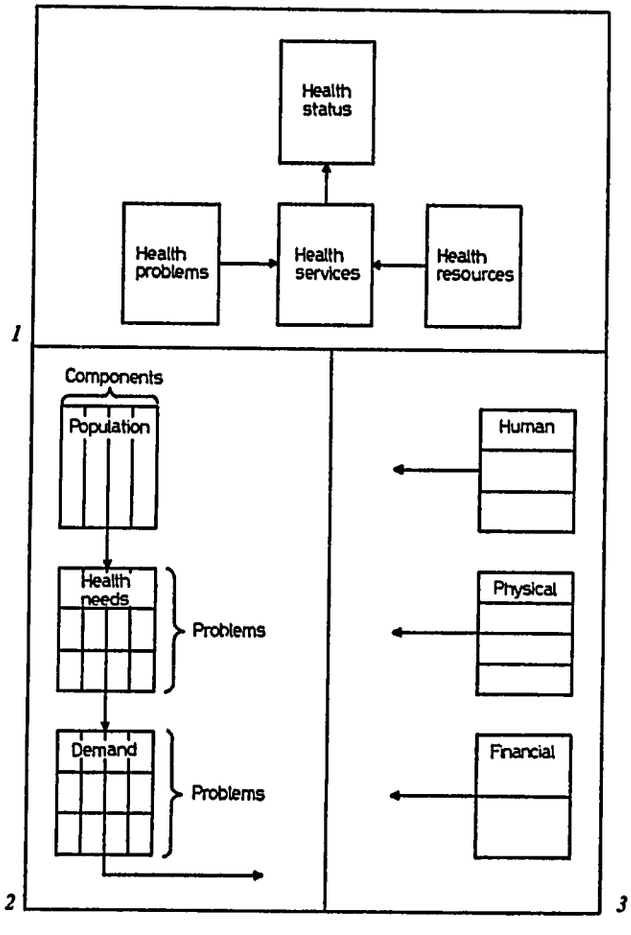


*Fig. 1.* Health care system overview.

*Fig. 2.* Detailed view of health problems.

*Fig. 3.* Detailed view of health resources.

and participation in health insurance programs.

Within each of the relevant population groups the nature and importance of individual health needs must be established, as well as the extent to which these needs are currently translated into demands for health services. Often the problems are simply stated in terms of mortality levels. The six measures proposed for Latin America by MOLINA and NOORN [9] include the crude death rate per one thousand inhabitants, the infant death rate per one thousand live births, the death rate from tuberculosis per 100,000 inhabitants, and others.

While such indices are useful in depicting historical trends in a developing country and in making broad comparisons between countries, they are of less value in directing attention to the health needs of a developed country, where mortality levels are not as sensitive to health inputs. The fact remains, however, that regional, racial, or other group differences in these broad mortality levels can be quite informative anywhere. Observe, for example, that at ages one to five months the white and nonwhite mortality rates in the U.S. are 4.2 and 12.0 per thousand live births respectively, whereas at one to five days the rates are much more similar, being 6.0 and 8.6 [10]. This information is quite helpful in pointing to the problem as community- rather than hospital-based.

Be that as it may, the systems analyst at some point will need to become more specific. He will probably find it necessary to classify health problems in some manner such as that provided by the international classification of diseases. Furthermore, within this classification system he will be concerned with morbidity or loss in productive capacity as well as mortality. For example, the Division of Indian Health has developed a health problem index (Q) that encompasses lost time for inpatient and outpatient care in addition to productivity losses due to premature death [6].

The classification of health problems by disease will not only provide information on effects in terms of mortality and morbidity, but will also suggest specific disease agents as causal factors. In addition though, there are more general environmental sources of health problems which should be identified. These include water supply sources, sewerage and waste collection systems, food protection mechanisms, housing conditions, air pollution, recreational sanitation, and vector control.

### *Health Resources*

In turning the coin to consider health resources the analyst must separate the human, physical, and financial components. He must determine the available quantities and locations of different kinds of health manpower; he must inventory existing facilities of various kinds, including their administrative configurations and capabilities; and he must identify the individual source and sizes of health funds, including the insurance schemes, government support of health programs, and private contributions of various kinds. This breakdown of the health resources box of figure 1 is shown in figure 3.

In some respects an inventory of health resources lacks meaning apart from the services developed from those resources. Knowledge of the number of physicians in a country is of limited value without corresponding information about the number and types of patients seen by these doctors. Still, the fact that there is an average of one physician per 3,000 population does convey something about the health potential of the country. More detailed information about the maldistribution of practitioners between the urban and rural areas is likely to be even more relevant for analytical purposes.

Both manpower and physical facilities fit into a number of categories that must be separately identified and inventoried. In addition, attention must be given to coordination and interactions among categories. Existing referral patterns must be recognized, along with the impact that such things as increased dependence upon extended care facilities would have upon the need for beds in short-term general hospitals.

### *Health Services*

Figure 4 depicts schematically the structure of health services that develops from the organization of resources to satisfy health demands. The figure also shows the impact of these services upon health status. Although in a systems sense the health services 'process' is distinct from the health status 'output', in practice in the health field these two elements are not so easily separated. Indeed, the generally fuzzy relationship between the process and the result causes health administrators at times to measure service units, such as annual physician visits *per capita*, as if they were end points or outputs.

In any event, figure 4 shows health services to include diagnostic, treatment, and rehabilitative components. From the standpoint of planning and evaluation, these services should be viewed in functional rather than organizational terms. Thus,

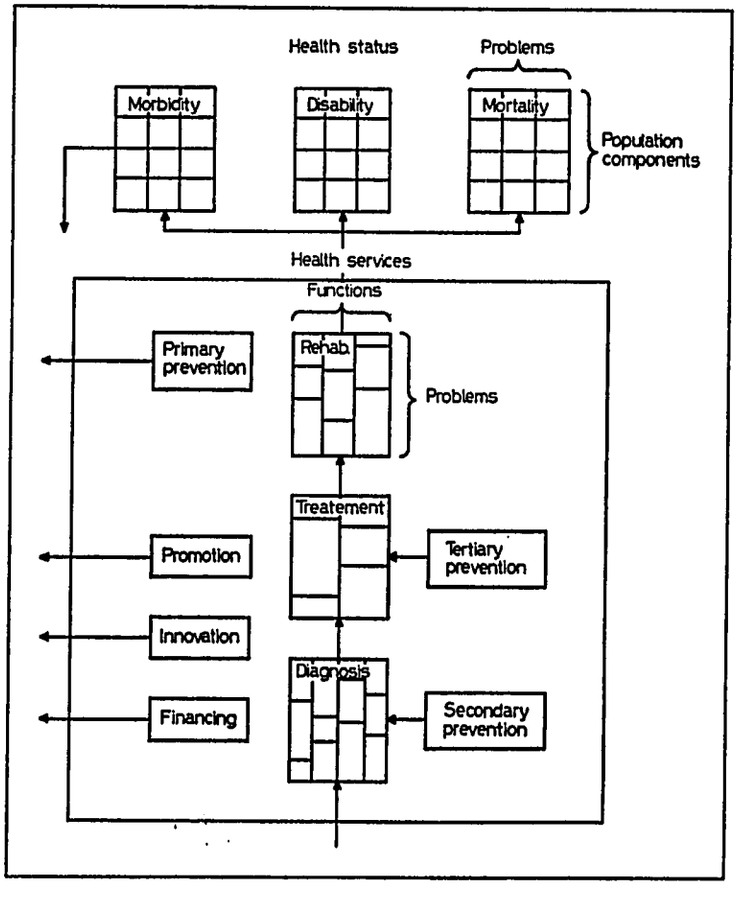


*Fig. 4.* Detailed view of health services and health status.

the three boxes are each subdivided vertically into the various categories of activity of which these services are comprised. These activities are directed in varying degrees toward particular health needs which are separated schematically by the horizontal lines. In other words the systems analyst must understand the present health services structure in terms of the performance of certain functions, each of which is a specific combination of human, physical, and financial resources organized to attack, to some extent, one or more of the particular health demands that exist.

In viewing the health services structure explicit recognition should be given to the preventive aspects. As a result, we note primary prevention, such as immunization, which has an impact that extends beyond the health services box to the basic needs box of figure 2. Secondary prevention as a category of service, such as early detection of cervical cancer, has its major effect at the diagnostic stage. Tertiary prevention occurs largely at the treatment stage, as in the case where stroke patients are treated in a manner which minimizes muscular deformities and subsequent problems of rehabilitation.

The health field is rather unique in the extent to which supply and demand interact. This is exemplified by contentions that physicians largely create a demand for their own services and that the utilization of hospital beds is in large measure determined by their availability. A complete and realistic appraisal of the health services structure must therefore include factors that influence demand for services. Three such factors are shown in figure 4. First we include the various forms of health education and professional influence that come under the general heading of 'promotion'. Secondly, since the demand for health services depends in large part upon the extent to which health problems are vulnerable to attack, we must include medical research and other innovative activities that affect the state of the art of medicine. Finally, we must recognize the role of the health services structure in extending effective demand beyond what it would be with private financing alone. For example, we must take cognizance of the free services offered by training institutions to the medically indigent in the interests of medical education. The actual measurement of services rendered should include a compilation of resource utilization data such as the annual numbers of physician visits and hospital discharges as well as average durations of hospital stay. These figures must be related, of course, to the demographic and epidemiologic characteristics of the population served. Likewise, recognizing the important role of financial mechanisms in determining the nature of services actually provided, we must know a good deal about the costs and sources of funding of these services.

### *Health Levels*

We view health status in figure 4 in terms of mortality, disability, and morbidity. From the morbidity box there is a link back to the population, indicating that the entire health system is dynamic. We are interested in observing the ability of the health services to modify and improve health status over time and to return healthy individuals to the population. This further suggests that each of the health status components should have the same subdivisions by population groups and health problems as figure 2. As a result, we identify not only the major sources of health need, but also those areas in which these needs are not being met satisfactorily at present.

Finally, all of the health system components are brought together in figure 5. This is a restatement of figure 1 which incorporates the detail of figures 2–4. Furthermore, it recognizes that the resources may be

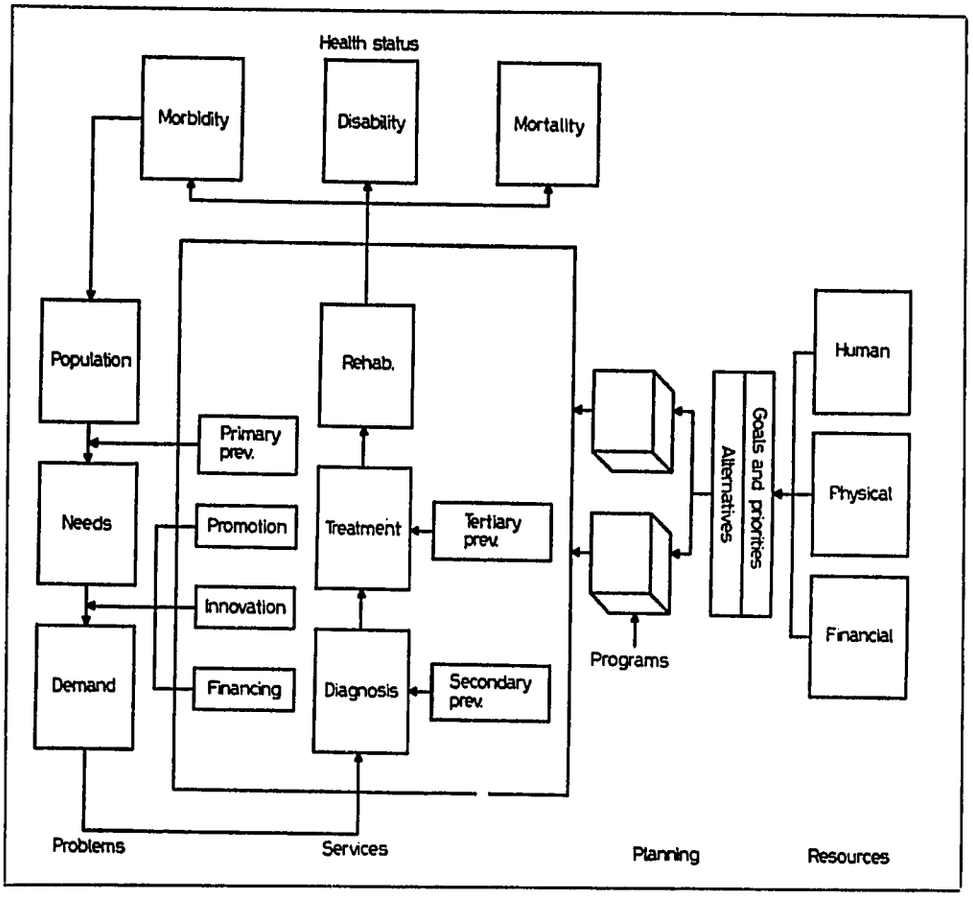


*Fig. 5.* Detailed view of health system.

organized into planned program packages to deliver services aimed at the alleviation of specific health problems.

### Comparative Review of Health Data

While the system that we have just described is largely schematic and leaves the specific functional relationships undefined, it may be of interest, even at this early stage of the analysis, to pause for a look at some concrete data that fit into this model. BRIAN ABEL-SMITH has provided us this opportunity from 'An International Study of Health Expenditure' [1] conducted for the World Health Organization. He obtained at least some information from 33 different countries, of which I have selected ten for inclusion in table I. These ten were chosen on the basis of the completeness of available information and the broad representation they provide with respect to location, accumulation of national wealth, and form of political and social structure.

#### *Measurements*

The national population figures included in the table are admittedly an insufficient reflection of demographic patterns within

*Table I.* Circumstances with respect to health delivery systems – Selected countries (based upon 1961 data)

| Country | *Demographic* | *Problems* | | | | | *Human resources* | | *Phys. res.* | *Financial resources* | | | *Services* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Population (millions) | Live birth rate per thousand | Infant mortality rate per thousand | % of deaths at age 50 and over | Deaths from infectious parasitic disease as % of total deaths | Doctors per 10,000 pop. | Nurses and midwives per 10,000 pop. | Hospital beds per 10,000 pop. | *Per capita* national income ($) | Health expenditure *per capita* ($) | Health expenditure as % of national income | Area per doctor (km²) | % health expenditure on capital | % Distribution of current health expenditure | | |
| | | | | | | | | | | | | | | Personal | Non-pers. public health | Teaching and research |
| Canada | 18.3 | 26 | 27 | 77 | 1.1 | 12 | 77 | 110 | 1,475 | 107 | 7.3 | 468 | 8.3 | 97.2 | 1.0 | 1.8 |
| Chile | 7.9 | 36 | 111 | 39 | 8.4 | 6 | 17 | 46 | 541 | 37 | 6.8 | 160 | 0.9 | – | – | – |
| Czechoslovakia | 13.8 | 16 | 23 | 85 | 3.1 | 18 | 38 | 124 | 920 | 37 | 4.0 | 5 | 6.4 | 91.3 | 2.4 | 6.3 |
| Federation of Rhodesia and Nyasaland | 10.0 | 48 | 100 | – | – | 1 | 4 | 32 | 130 | 6 | 4.6 | 1,429 | 3.2 | 98.6 | 1.4 | 0.0 |
| France | 46.2 | 18 | 26 | 86 | 2.6 | 11 | 20 | 134 | 1,079 | 72 | 5.5 | 11 | 4.2 | 96.7 | 1.7 | 1.6 |
| Israel | 2.2 | 25 | 29 | 71 | 1.7 | 26 | 24 | 74 | 1,042 | 81 | 7.4 | 4 | 6.5 | 95.7 | 1.6 | 2.7 |
| Tanganyika | 9.4 | 47 | 190 | – | – | 1 | 1 | 19 | 54 | 2 | 2.8 | 1,673 | 8.5 | 95.0 | 4.3 | 0.8 |
| USA | 183.8 | 23 | 25 | 80 | 1.2 | 13 | 42 | 91 | 2,306 | 162 | 6.8 | 39 | 4.5 | 95.1 | 0.3 | 4.6 |
| Venezuela | 7.6 | 45 | 53 | 37 | 7.0 | 7 | 4 | 36 | 547 | – | – | 169 | – | – | – | – |
| Yugoslavia | 18.6 | 23 | 82 | 63 | 7.6 | 7 | 2 | 50 | 233 | 12 | 5.2 | 20 | 11.9 | 93.1 | 3.9 | 3.0 |

*Source:* Adapted from ABEL-SMITH [1].

each of the countries, but more meaningful measures are provided to depict the nature and extent of health needs, along with general levels of health resources and services. Needs are represented by the live birth rate, the infant mortality rate, the percentage of deaths at age 50 and over, and deaths from infectious parasitic disease as a percentage of total deaths. On the resources side levels of health manpower are indicated in terms of the numbers of doctors, nurses, and midwives per 10,000 population. The availability of facilities is measured as the number of hospital beds per 10,000 population. Then the general financial picture is roughed in according to *per capita* national income, *per capita* expenditures on health, and health expenditures as a percentage of national income. Comparison of the relative levels of human, physical, and monetary resources provide in themselves some indication of the health services offered. Additional indications are obtained from the data on area served per doctor, the percentage of health expenditures going to capital improvements, and the breakdown of current health expenditures.

### *Relation of Health Expenditures and Status*

As might be expected, increasing *per capita* expenditures on health correlate well with reduced infant mortality rate as a prime measure of health status. The correlation is at least as good, however, between *per capita* national income and the infant mortality rate. When we rank each of the nations (excluding Venezuela which did not provide information on health expenditures) with respect to each of these indices, we obtain a rank correlation coefficient of 0.68 for the relationship between health expenditures and infant mortality and a coefficient of 0.77 in relating *per capita* national income to infant mortality. Moreover, we find that with increasing national income there is a strong tendency for the relative as well as the absolute level of health expenditures to rise; the rank correlation between *per capita* national income and health expenditures as a percentage of national income is 0.70. If the health component of total national expenditures is the principal contributor to improved health status, then the correlation should be high between the percentage of national income going to health and the infant mortality rate. In fact, however, it is only 0.20. Circumstances in Czechoslovakia were most responsible for this poor correlation. Although that country leads all the others in its success with the infant mortality rate, it ranks second lowest in the relative contribution of health services to the national income.

It could be argued, of course, that general mortality rates should be used in place of the infant mortality rate. Among the nine countries in our list (excluding Venezuela) Czechoslovakia continues its good showing when we turn to the crude death rate. Its rate of 9.2 is bettered by only three countries, Israel, Canada, and Yugoslavia. We should note, however, that variations in the population age distributions from one country to another make comparisons of general death rates rather tenuous in the absence of adjustments for age, which were not provided in the ABEL-SMITH study.

### *Composition of Expenditures*

As we turn to the factors which contribute to the health expenditures, we find evidence of great variation in the types of services provided. Although health expenditures *per capita* in the United States far outstrip the level of any other country[1], the United States does not rank first in the

[1] We must note that comparisons of health expenditures are affected by the currency exchange rates used.

number of doctors, nurses, or hospital beds relative to population. It is true that substantial resources are devoted to teaching and research in this country, but even in this respect Czechoslovakia surpasses us by a wide margin percentagewise. Canada, which ranks second in health expenditures *per capita*, has the largest supply of nurses relative to population. Israel, the third ranking country in *per capita* health expenditures, is notable for its very large supply of doctors, whereas France, the fourth ranking country expenditurewise, heads the list with respect to the relative number of hospital beds. Thus we see that nations not only differ in the amounts spent in the health sector, but also with respect to the allocation of resources within the sector.

Perhaps it is not surprising that countries at differing levels of economic development should exhibit dissimilar patterns of expenditure on health. On the other hand, PETERSON *et al.* [12] have likewise found ambiguities in a more detailed study of health resources and services in three of the developed countries: the United States, England and Wales, and Sweden. Their findings, some of which are summarized in table II, cause them to raise the still unanswered question: 'What is value for money in medical care?'

Since Sweden ranks first in both life expectancy and infant mortality rates, we naturally look for the unique characteristics of its health services statistics. We discover relatively few doctor – patient contacts annually, barely half the U.S. level, but a rather liberal utilization of inpatient services. England and Wales, which have achieved an intermediate level of health status, exhibit a pattern of services which is neither like that of the United States nor of Sweden. While there is nearly as much

*Table II.* Comparison of health services and health levels

| | *Health levels* | | | |
|---|---|---|---|---|
| | Life expectancy at birth | | Infant mortality per 1,000 live births | |
| Country | Males | Females | Males | Females |
| USA | 66.6 | 73.4 | 28.4 | 21.9 |
| England and Wales | 68.0 | 73.9 | 23.7 | 18.4 |
| Sweden | 71.3 | 75.4 | 17.4 | 13.2 |

Health resources and services

| | | | *Short-term hospital statistics* | | | | | |
|---|---|---|---|---|---|---|---|---|
| Health expenditures as % of GNP | Physicians per 100,000 population | *Per capita* Dr. – patient contacts annually | Admissions per 1,000 population | Mean length of stay (days) | Beds per 1,000 population | Bed days per 1,000 population | Bed utilization rate (%) | Non-medical staff per 1,000 patient days |
| 5.2 | 137 | 5.3 | 134 | 7.7 | 3.7 | 1,032 | 76.4 | 241 |
| 4.7 | 127 | 4.7 | 82 | 14.8 | 4.4 | 1,217 | 76.6 | ? |
| 4.7 | 106 | 2.7 | 127 | 12.5 | 6.0 | 1,588 | 72.5 | 138 |

Source: PETERSON *et al.* [12].

reliance placed upon ambulatory care as in the U.S., the rate of hospital admissions is far lower. Once patients are admitted, however, their duration of stay tends to be even greater than it is in Sweden. It is quite clear that such gross comparisons of utilization patterns are not very productive. It is obviously necessary, in addition, to distinguish among types of patients, the nature of the treatments provided, and the outcomes. Even then we have no assurance that the findings will be definitive in the absence of clear relationships between treatment and outcome and general agreement as to what constitutes high quality care.

### In-depth Studies of Systems Elements

Unfortunately, comprehensive studies of entire health delivery systems have not been attempted in any genuinely thoroughgoing manner. What has been done in any particular geographical area, therefore, is unlikely to be sufficiently similar to attempts made elsewhere to make comparisons as useful as we would like. As a result, it appears more fruitful to review stepwise some of the work that has been done in an effort to gain understanding of specific aspects of the delivery systems. While the breakdown is somewhat arbitrary, and the illustrations cited are by no means intended to exhaust the literature, the following five points form a logical sequence for such a review.

1. The relationship between changing demographic and epidemiologic factors on the one hand, and projected health resource inputs on the other.
2. Modification of the resource projections to reflect a more balanced distribution of health inputs.
3. Association of specific health inputs to services provided.
4. Orientation of specific services to one another.
5. The contribution to health status of the individual services provided.

#### *Relation of Health Problems and Resource Inputs*

The first item in the list is the most elementary and the easiest to accomplish; yet even it represents an advance over the time-honored procedure of translating the health requirements of a growing population into constant doctor to population ratios. In a recent study of future health manpower requirements in Taiwan [3] the population of the island was divided into 288 sub-groups representing the various combinations of age, sex, economic status, educational attainment, and area of residence. The health survey based upon interviews in over 10,000 households yielded among other things estimates of the number of physician visits *per capita* in each of the 288 population sub-groups. A statistical analysis using the specially developed multi-sort technique then revealed the factors which contributed significantly to differences in the utilization rates. Since neither education nor sex were of consequence to these differences, the population was reassembled into a smaller number of sub-groups from which projections were made of the aggregate number of physician visits to be anticipated. The number of physicians required to provide this level of services was in turn computed and translated into the number of additional physicians needed to be trained. While the calculations admittedly made no provision for possible productivity changes, they did recognize the uneven rates of growth among various population sub-groups that exhibit different levels of demand for physician services.

At the present time this procedure is being applied with further refinements in the development of a national health plan for Chile. Consideration is also being given

to its possible use elsewhere, notably in certain African countries.

The medical care group of the World Health Organization has a continuing interest in comparative studies of the utilization of health services in relation to socio-economic development [4]. One model being studied, for example, concerns relative differences in the utilization of health services among various age groups. It is postulated that nations with the most rudimentary form of health delivery systems are characterized mainly by a utilization peak at intermediate age levels reflecting demands for maternal care, the needs of workers in the productive age groups, and low life expectancy. As socio-economic development proceeds, child care services are among the first to be added and this produces a second peak in the graph of utilization. Finally, the developed nations are characterized not only by a substantial flattening of the utilization curve, but also by a definite upswing at the higher age groups, indicative of aging population with a considerable degree of chronic illness.

### *Distribution of Resources*

Having analyzed existing differentials in the effective demand for medical care among various population segments, we are naturally led to consider the possibility of modifying the relationships. It is not difficult to visualize changes in the system of providing services that would succeed in bringing effective demand into closer alignment with health needs; nor is it hard to imagine the potential effects of a more even distribution of services geographically. In spite of these possibilities, however, a frighteningly uniform characteristic of all forms of health delivery systems seems to be the consistent gravitation of health professionals, particularly physicians, to urban areas. As one humble illustration, the eight geographical regions of Turkey range from 13 practicing physicians per 10,000 population in the area around Istanbul to 1 per 10,000 in the provinces of Eastern Anatolia [16]. Indeed, two-thirds of Turkey's physicians are located in three metropolitan areas: Istanbul, Ankara, and Izmir. Admittedly, in a nation like the Soviet Union, which has large numbers of physicians and a high degree of centralized control, the extremes are not as great; but even there the ratios among the 15 republics range from 35 down to 15 physicians per 10,000 population [17].

A number of means have been proposed, of course, for obtaining a more balanced distribution of health input. In Iran, for example, the decision has been made to reduce the size of medical school classes in Teheran and to increase them in the medical schools of certain less populous provinces. This has been done under the assumption that doctors tend to remain in the region in which they have been trained. In one of the Indian states which trains more than its proportionate share of physicians I have heard the huge educational costs justified in part by the reasoning that the heavy stream of doctors being turned out will soon overflow the urban areas into the remote villages where they are needed.

The point is that in spite of the universality of the problem I know of no attack that has been made upon it on the basis of the systematic analysis of costs and benefits of well-conceived alternatives. One model is perhaps worthy of our attention for purposes of illustration, even though it is unrealistically simple and has not yet been put into practice [13].

It is based upon three health input measures: the ratios of doctors, nurses, and hospital beds to the populations of prescribed areas. First, each of the ratios $R_{ij}$ is compared to a norm $N_i$, where the subscript $i$ takes on the values from 1 to 3 and refers to the indices of health input; the

subscript *j* relates to the particular geographical areas of concern, of which there are *a* in all. Secondly, since increasing discrepancies between a given ratio and its corresponding norm are presumably associated with more than proportionate increases in undesirability (disutility), the model proposes to square these discrepancies. Third, it is assumed that a given magnitude of departure from, for example, the doctor to population ratio is valued differently from a similar deviation in the nurse to population ratio. Hence, values $V_i$ must be inserted into the model. Suggestions for their numerical estimation are included in the paper in which the model was originally developed. Finally, conditions in one geographical area are not necessarily assigned the same weight as those in another area. It seems reasonable to assign weights according to the size of the population, $P_j$, in each region. The model then describes the total disutility

$$D = \sum_{j=1}^{a} P_j \sum_{i=1}^{3} V_i(R_{ij} - N_i)^2$$

associated with a given set of conditions. This disutility is to be minimized, subject perhaps to monetary, cultural, or other constraints to induced change.

### *Association of Health Resources and Services*

Many considerations of health delivery systems focus upon the inputs and give relatively little attention to the services rendered as a result of these inputs. Such approaches leave the impression that the presence of a given number of registered nurses in a hospital ward or of a given number of physicians in a geographical area more or less automatically dictates the level and kinds of services provided. The current local dissatisfaction with health care systems stems largely from the increasing recognition that these assumptions are patently false. As a result health professionals these days are giving a great deal of attention to the benefits gained from industrial and military applications of industrial engineering and operations research methodology. Although this open-minded search for the optimal relationships between health resources and services is refreshing, there is still distressingly little to report in the way of concrete findings. Moreover, much of what has been done relates to the relatively simple and confined hospital setting. In that setting there have been studies of nursing activity patterns, the inventory control of such things as supplies, pharmaceuticals, and blood, and the stochastic nature of hospital admissions and patient flows [7, 8, 15].

### *Orientation of Services*

As we move on to a consideration of the individual service areas themselves, we enter an even more rarified atmosphere. Here the work of NAVARRO [11] is perhaps as representative and fruitful as any for purposes of discussion. His concern has been the acquisition of data appropriate for the development of Markovian models of transition probabilities. The health service states in this model include ambulatory, inpatient, and extended care, as well as the healthy state and death. From these models one could predict, for example, the transitional and ultimate effects of the present shift in emphasis from hospital inpatient to nursing home care. Morevover, one could determine the path to increased use of ambulatory facilities that would be least disruptive to current modes of operation. This form of systems review was proposed but not implemented during the early development of the community mental health center approach [14]. At the present time, however, there is a real likelihood

that it will be tried in the mental health field in the U.S. and on a more general basis in one area of the U.K.

*Relation of Health Services and Status*

Finally we come to the impact which particular health services have upon indices of health status. In this connection we face the dual problems of measuring levels of health and of establishing their functional relationship to the services provided. As indicated earlier, the Division of Indian Health in the U.S. has been active in the creation and application of the so-called Q index of health problems. This is a composite of the mortality rate, the extent of hospitalization, and the lost time outside hospitals associated with a given disease or health problem. The magnitudes of the various Q indices thus establish problem priorities, which are then analyzed in terms of the resources required to alleviate the problems. Together, the two considerations form the basis for the development of program packages to be implemented.

Health planning in much of Latin America is based upon another index which is couched solely in mortality terms [2]. For a given problem the components include the mortality level rated according to the age at which death typically occurs; the vulnerability of the problem, i.e., a quantitative judgment of current ability to affect mortality levels; and the cost of avoiding a death.

A third index being developed by Dr. BRIDGMAN [5] of the World Health Organization relates the cost of disease to the productivity level of the country or region in question. Thus the numerator incorporates the various factors that contribute to the annual loss due to disease per 1,000 population, while the denominator measures the potential annual productivity per 1,000 population minus the productivity loss due to disease in this population. The index relies upon admittedly crude data in order that it may be readily applied broadly to countries that encompass a wide range of economic development. Although it is still in the process of refinement, it is presently being tried out in Poland.

**Ongoing Systems Research**

Among other things, the preceding review of the bits and pieces of health delivery systems should have made abundantly clear, if it was not so earlier, the pressing need for a comprehensive yet reasonably simple methodology by which total systems could be analyzed and compared. This is a difficult assignment under any circumstances, so that it should be pursued under carefully selected circumstances. It seems that the most favorable conditions are likely to be found within the framework of a micro-analysis in a relatively self-contained area of a developing country where the health services system is relatively uncomplicated. Fortuitously such circumstances are precisely those in which the optimal allocation of extremely scarce resources is most important. Rather superficial studies along these lines have been conducted under the auspices of the World Health Organization in Taiwan and are going on in Malaysia and Tunisia. Somewhat more ambitious, though still quite elementary, efforts are currently underway under the direction of the Department of International Health, Johns Hopkins University, in two districts of India and three provinces of Turkey. The remainder of this paper will briefly outline the conceptual and analytical framework of that study.

Conceptually we begin with an enumeration of the many existing health problems. These lead to a specification of certain broad goals and a large number of specific objectives that one would like to see ful-

filled. Such fulfillment is potentially centered in a more limited number of functional areas of activity in which there are many types of functionaries carrying out a wide range of tasks and utilizing various tangible resources. The conceptual model, then, takes on the form of an hour glass with a broad upper layer of objectives and a broad lower tier of specific activities separated by a limited number of functions. It is this manageable number of functions that provides the focus for our analysis. These are not necessarily the traditional organizational categories such as pediatrics, health education, and surgery, but rather the functionally distinguished classifications such as medical care, environmental sanitation, personal preventive services, and family planning.

For analytical purposes a broad data base has been established. Principal attention is centered at two points, however. In the community, especially the household, we can learn most about the nature and magnitude of existing health problems. At the primary health center, which serves several communities, we can become acquainted with the manner and extent to which these problems are being serviced.

In the community we recognize complaints, such as disability resulting from respiratory illness, and unfelt needs, such as that for potable water. These must be translated into illness or other health problem categories. From this point we work backward toward the description of individual differences in susceptibility to illness characterized by such things as immunization status and nutritional levels and to the identification of more general circumstances, such as housing conditions and educational levels. Concurrently we move forward to a study of the pattern of health actions taken and their outcome in terms of duration of illness and costs incurred.

Variations in the sequence of health actions taken are reported broadly from the community and are observed in considerable detail at the health center with the aid of work sampling and patient flow analyses. These will provide us with two-dimensional function – functionary matrices from which we can ascertain the functional load of the health center as well as the roles of the various health workers in carrying out these functions.

In the analysis the observed functional load can be compared with norms determined in relation to the identified health problems of the community. Moreover, we expect to develop more appropriate allocations of activities among the functionaries. In particular, given the severe limitations on the availability of skilled manpower, our goal is to shift activities toward those with the lowest level of skills commensurate with adequate quality of care.

The study is relatively unsophisticated in that many of the conclusions will be judgmental based upon descriptive methods of analysis. Nevertheless, we feel that the framework of analysis is sufficiently structured to permit a view of the interrelated components of the entire system. Hopefully, in addition, we shall be able to make a start toward the prescriptive assessment of certain problem areas. For example, it is possible that infant diarrhea can be functionally related to certain predisposing conditions as well as to certain effective courses of action. From these relationships we hope to be able to predict the impact of certain system interventions upon the magnitude of certain problems, the distribution of functions, and the requirements for training of various health workers.

## References

1. Abel-Smith, B.: An international study of health expenditure. WHO Publ. Hlth Papers 32 (1967).
2. Ahumada, J. *et al.*: Health planning: Problems of concept and method. Pan Amer. Hlth Organ., Scientific Publ. No. 111 (1965).

3. BAKER, T. D. and PERLMAN, M.: Health manpower in a developing economy (The Johns Hopkins Press, Baltimore 1967).
4. BRIDGMAN, R. F.: Private communication (WHO, 1968).
5. BRIDGMAN, R. F.: Unpublished memorandum (WHO, 1968).
6. Bureau of Medical Services: The principles of program packaging in the Division of Indian Health (U.S. Public Health Service, 1966).
7. FLAGLE, C. D. and YOUNG, J. P.: Application of operations research and industrial engineering to problems of health services, hospitals and public health. J. industr. Engineer. *17:* 609–614 (1966).
8. HORVATH, W. J.: British experience with OR in the health services. J. chron. Dis. *17:* 779–788 (1964).
9. MOLINA, G. and NOORN, I. F.: Indicators of health, economy, culture in Puerto Rico and Latin America. Amer. J. publ. Hlth *54:* 1191–1206 (1964).
10. National Center for Health Statistics: Infant and perinatal mortality in the United States. Vital and Health Statistics, Series 3, No. 4, pp. 64–65 (U.S. Public Health Service).
11. NAVARRO, V.: Planning personal health service: A Markovian model. Med. Care *7:* 3 (1969).
12. PETERSON, O. L. *et al.:* What is value for money in medical care. Lancet *ii:* 771–776 (1967).
13. REINKE, W. A.: Criteria for measuring the effectiveness of health services. Operations Research Society of Spain, Madrid 1967.
14. REINKE, W. A.: Unpublished work.
15. ROCKWELL, T. H. *et al.:* Inventory analysis as applied to hospital whole blood supply and demand. J. industr. Engineer. *13:* 109–114 (1962).
16. TAYLOR, C. E. *et al.:* Health manpower planning in Turkey (The Johns Hopkins Press, Baltimore 1968).
17. The System of Public-Health Services in the USSR, p. 118 (Ministry of Health of the USSR, 1967).

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