Operations Research in Public Health

One of the better introductions to operations research in public health is the paper written by Stig Anderson (Operations Research in Public Health, Public Health Reports, April 1954, volume 79, pages 297 to 305). Anderson points out that "there is little likelihood that operations research in public health can reach the stage, for many years to come, where it can utilize directly many of the mathematical programing techniques which have been developed for military and industrial purposes". The basic concept, however, of research into total systems which, in principle, can be translated into mathematical models can and should be adapted to the needs of public health services research.

It is interesting to see that the major phases in operations research as described from Churchman and associates (Churchman, C. W., Ackoff, R. L., and Arnoff, E. L.: Introduction to operations research. John Wiley & Sons, Inc., New Year, 1957.) and Houlden (Houlden, B. T., editor: Some techniques of operational research. Hasell Watson & Viney Ltd., London, 1962.) must have been the basis for most of the approaches to a public health planning. The major phases are described as follows:

1. Formulating the problem, including definition of the objectives.
2. Collection of data relevant to the problem.
3. Analysis of data to produce a hypothesis and a mathematical model to represent the system under study.
4. Deriving solutions from the model.
5. Choosing the optimal solution and forecasting results.
6. Testing the optimal combination of interventions, with controls built into the system to keep continuous check on the hypotheses.
7. Recommending implementation of the solution, including the control system.

It is pointed out that team work is essential since no one single person possesses all the necessary skills and experience to conduct worthwhile operations research.

Anderson discusses the approach to operations research by the above readings.

Formulation of the Problem

One of the greatest challenges is the precise and explicit formulation of the problem. What is the system under study? Does it comprise the entire health field in the nation? It is likely that the administrative and political heads of a public health service would want "the maximum utilization of the given resources towards the promotion of health among the people". The point of operations research is, however, that it needs far more specific objectives and the major obligation of the operations research team in the first stages of its work is to guide the executive towards very specific definitions of objectives.

What is meant by "given resources"? What is meant by "promotion of health"? With regard to promotion of health, one might emphasise one of two entirely different aspects. (1), the state of health itself in a certain distribution in the population, which might be viewed according to (a) absence of illness and (b) presence of positive health. Or (2), the existence in reasonable proximity to the distributed population of a confidence-inspiring health service. Again, "among the people" must be far more sharply defined. Is there to be complete equality, or are we to qualify the principles of equality by emphasising assistance to the more productive groups, for instance.

Collection of Data

One of the most important things in the collection of data is that only data strictly intended for decision making should be collected. On the input side, cost of services, training of personnel, handling medical stores, administrative and technical operations, etc. These data will often be too small for the use of sampling techniques. Major part of data to be collected would be on the system as it now works and the results that are now obtained. What in the PAHO/UCLA methodology is called the "diagnosis".

Analysis & Hypothesis Formulation

Anderson suggests that pioneers in operations research in public health must strive, within a few years, to reach the stage where at least simple models depicting the public health service can be constructed. It may be remembered that an attempt at a mathematical

model for health planning has already been suggested by Hector Correa (Health Planning, Kyklos, Internationale Zeitschrift für Sozial-Wissenschaften , volume XX, 1967, Fasc. Y, pp. 909 - 23.)

Anderson points out that even if it is not possible initially to formulate the model, or the hypothesis, mathematically, an operations research team can think mathematically, that is, logically, in making the formulation under this phase. Such a model is actually a simplified explicit description of the existing services, the elements and factors of which it consists and the relationships between them. Its function is to summarise the input of resources: money, material, personnel training; preventive, curative, and educational services; and administrative, decision-making, and evaluating machinery. At the same time the model outlines the geographic and functional distribution of the above resources. It attempts to summarise output partly with regard to operational achievement, public participation in services, and numbers of relevant health personnel actions, and partly in relation to fulfillment of declared objectives, including disease control, health promotion, demographic change, consumer satisfaction and economic effects.

Anderson suggests as examples of factors which would be part of the model:

Input: The total health budget, its geographic and functional breakdown, inflow and outflow of personnel, quantity and quality of training, inflow, storage, and consumption of durable and nondurable goods, and distribution of all types of health services and institutions.

Output: Operational achievements seen from the side of the services, including participation and attendance, vaccinations performed, number of childbirths assisted, wells constructed, drugs distributed. Otherwise the output part of the model can probably afford to be rather sketchy and give four or five indices, for example, demographic: crude or age-specific death rates and birth rates; epidemiologic: prevalence of two or three major diseases; and educational: at least one index of health educational status.

Derivation of Solutions From the Model

The general idea is to manipulate the model through a continuous series of theoretical input changes and calculation of the probable output changes. Anderson quite rightly points out that a certain amount of common sense is essential so that the field of theoretical study is restricted to sufficiently few combinations to make it possible to derive solutions before the administrators become too impatient about the results.

Choice of Solution and Prognosis

What the team here is actually doing is to provide the executive with a choice of different alternatives. The various intervention combinations are likely to differ from each other, particularly in two major respects (a) the degree of departure from the existing system will vary, and (b) the solutions will differ in the degree to which they are calculated to fulfill each of the three, four, or five major objectives.

As in the PAHO/CENDES approach, prognosis is crucial to the solution. Such a prognosis will partly forecast the change in operational achievements and partly the change in results with respect to the declared objectives.

It is, of course, clear that one of the greatest obstacles for the output forecast is the slow development of health status, health consciousness, health action, or health habits. Even rather radical changes in several aspects are not likely to be observable in less than five or ten years.

Anderson points out that the form of the prognosis will largely be statistical and conditional, with results expressed, for example, as 19 in 20 chances of a value being within certain limits provided the operational achievement attains a given value and within certain other limits if the operational achievement attains such other value.

The Test Run

It is suggested that the test run be in an area of manageable size, but sufficiently large to provide observations for proper statistical inference. Anderson points out that the major difference between the test run and the final national implementation, is that the former can have a more intensive control system. The information on all aspects of the operations and their results is the feed-back, which must continuously be analyzed and compared with the prognosis.

Recommending Implementation

The last link in the chain of operations research is the application of the solution to the whole system and establishment of evaluation machinery with an apparatus for new decision making when the key variables change beyond predetermined limits. It must be remembered that in a public service there may be a number of unforeseeable and unavoidable constraints to a rational solution. The solution may be considered politically unacceptable to special groups or certain political parties, including the party in power. Such possibilities should actually have been taken into consideration by the operations research team, one of the reasons why such a team should, in general, include a behavioural scientist.

Anderson points out that while operations research might be said to be holistic, it must be remembered that whole systems usually consist of many smaller ones, and that a national public health service is itself only a sector of a whole socioeconomic system. The public health service comprises numerous large and small sectors and units and it is quite possible to utilize the above approach on a smaller system, as, for instance, the medical stores system. This was actually done in Trinidad where the whole entry into national health planning by the Government came originally from the systems analysis of the medical supply system.