

Pan American Health Organization

PAHO/ACMR 17/9  
Original: English

SEVENTEENTH MEETING OF THE  
PAHO ADVISORY COMMITTEE ON MEDICAL RESEARCH

Lima, Peru  
2-6 May 1978

INDEXED

OPERATIONS RESEARCH AS A COMPONENT OF  
HEALTH SERVICES RESEARCH

The issue of this document does not constitute formal publication. It should not be reviewed, abstracted, or quoted without the consent of the Pan American Health Organization. The authors alone are responsible for statements expressed in signed papers.

## OPERATIONS RESEARCH AS A COMPONENT OF HEALTH SERVICES RESEARCH\*

### Introduction

From the outset, in the 1950's, operations research has played a dual role in the health field. On one hand, it has been concerned with the efficiency and effectiveness of clinical operations - essentially as an adjunct of management in staff or consulting relationships. On the other hand, it has been a part of the broadly based set of studies of health in communities known as health services research.

An examination of the literature beginning two or three decades ago identifies O.R. with studies of design and staffing of hospital nursing units and the scheduling of patients and staff in ambulatory medical services (Bailey, 1952). These were problem solving efforts arising from scarcity of resources - doctors, nurses, hospital beds. Extending the effective use of skilled persons through technology or auxiliary personnel has been a characteristic not only of operations research, but of medical care management in our lifetime. It was natural that these studies of activities in clinical settings should lead to an inquiry into the processes of decision making by physicians. A body of studies on medical decision making began, emphasizing the use of data banks and computers for estimating the probabilities of disease in the presence of combination of symptoms.

There has been another side to O.R. in health, paralleling in time and extending in subject matter the original operational and managerial studies. This has been the association with health service administrators in a research and planning function at regional and national levels. While early operations analysts focused attention on clinical problems, another set of colleagues examined health services from the point of view of communities and populations.

---

\*Presented by Dr. Charles D. Flagle, Professor and Head, Division of Operations Research, The Johns Hopkins University School of Hygiene and Public Health, Baltimore, Maryland, USA.

It happened that the agencies funding all these studies - the Nuffield Provincial Hospital Trust in England, the U.S. Public Health Service - for historical reasons, were concerned with both the clinical and community aspects of health services. In their grants programs, they allocated money both to researchers working directly to improve clinical services and to those conducting surveys to increase knowledge about the delivery of health services in communities. They, the sponsors of research, brought the researchers together (the statisticians, physicians, engineers and behavioral scientists) creating the broad field now known as health services research.

#### The Resultant Form of Operational Research Studies

With the dual legacy of problem solving and knowledge seeking, operational studies have taken two forms usually in sequence. First, there are evaluations of a particular activity - say the flow of patients through a clinic - as it is actually experienced, designed in such a way that variables affecting the experience can be isolated and assessed. - say as annual rate, service rates or length of stay. An operational evaluation answers the question, "What is happening?", and perhaps a well designed set of operational evaluations can answer the question, "How is some outcome variable of interest affected by changes in a controllable variable?". (For example, how is waiting time of patients in a clinic related to arrival rates?) The knowledge of functional relationship between outcome variables and both controllable and uncontrollable variables places the researcher in a position to answer another type of question, "What would happen if . . . " if we increase clinic capacity, if we introduce a new technology, if we allocate tasks differently. " But the answers to these questions do not come through direct experience, but by a process of predictive evaluation of models of projected systems, using what we can of empirically learned relationships in operational evaluation.

There is still another possible stage in the operational research process, another question. "Of all the alternative solutions to a problem, which is best?" In the specific terms of our previous clinic example, "What operating system will minimize patient delays? Which will minimize productivity of scarce resources?"

We have seen our questions evolve from ones of simple inquiry, surveys and descriptive statistics to ones of decision and choice. In operations research we recognize two major types of endeavor. First is research which is knowledge seeking and descriptive in nature, and for this we have an array of tools of analysis of the behavior of systems. Most of the studies of flow of patients through clinics, the applications of work study and queuing theory, the evaluation of services through clinical trials are of this nature.

The second, and more difficult, is normative or prescriptive in nature, an effort that aims at making an optimal decision. The fields of mathematical programming, game theory, decision theory, are all examples of a methodology that seeks to maximize some measure of effectiveness within certain constraints or probabilities.

This formal distinction between descriptive and normative approaches has not been as sharp for operations researchers as the words may imply. It is rare that operations researchers in health services have sought knowledge for its own sake. Even in studies that may appear to be descriptive, the variables under study are often figures of merit and the study reveals how these variables may be improved. Thus the intent of a study is normative even if the models employed are not. If anything has distinguished operations research from other techniques within the armamentarium of health services research, it is the normative character of the work, the intent to bring about change.

## The Evolution of Operations Research in Health

All the foregoing has been abstract. The points may be clarified by exemplification. We have already observed that studies of the 1950's were hospital centered. An early piece of work (Connor et al., 1961) in which direct observation of inpatient care led to a system of patient classification and nursing unit staffing has led, over the past decade, to a standardized commercial procedure, computerized and widely available. While development and diffusion of the original idea have taken place, research still continues to improve the techniques and apply them in other areas.

Similarly, the early work in outpatient scheduling has by now been developed into routines.

Yet if we examine a sample of current operations research in the Americas, we find much of the work continuing at operation or clinical levels. From a survey of studies in progress<sup>(1)</sup>, we see queuing theory and simulation applied to the operation of maternity wards (Monterrey, Mexico, 1976), flow charts and work sampling in emergency rooms (Social Security, Mexico, 1972), work studies in emergency rooms and operating rooms (Costa Rica, 1974), inventory analysis (Peru, 1974) and evaluation of ambulatory services (Brazil).

While the origins of operations research may have been at clinical levels, the findings have implications for communities. Involvement in micro-social studies lead to macro-social involvement. Here it is necessary to integrate the work of demographers, epidemiologists, and survey researchers with the clinical findings of operations analysts and industrial engineers. There are many examples of the extension of O.R. to community problems; for example, the application of inventory theory to estimation of pharmacy needs for a region (Costa Rica, 1975), the estimation of numbers and location of clinics (Monterrey, 1972), and statistical analysis of maternal and child care risks (Columbia, 1976). At both micro and macro levels modern

<sup>1</sup>Prepared by Ing. Jorge Ortiz, PAHO

operations analysis, while continuing its original clinical concerns, has joined forces to study such current problems as the hospital bed needs of a region, the strategies of maintaining adherence of patients to treatment for such chronic diseases as hypertension, and the evaluation of cost and effectiveness of communications technologies in primary care. One finds examples of all three of these projects in the Institute of Social Medicine, State University of Rio de Janeiro.

#### A Generalization of Techniques and Approaches from General Systems Theory

Is it possible to see some goal, some end point of the evolutionary process of health services research? Do these techniques of observation, models of system behavior, building of information, and search for decision rules make any sense? The fact that they are all a rational part in the evolution of complex human organization may be seen if looked at from the point of view of general systems theory (Miller, 1976). General systems theory tells us that for any living system to survive, there must be three processes in effect: information flow, energy transformation, and the flow of matter. This is true throughout the hierarchy of living things, from the cell, organs and organisms to human groups, institutions and PAHO itself. It is evident that health service researchers, as well as administrators, planners and providers of service have concerned themselves in one way or another, with all three of these vital functions. The study of and development of information and communication systems, the study of flow of patients and staff in hospitals and clinics, the analysis of costs and benefits are all reflections of a society's efforts to remain viable and to improve. In health services we are in advanced steps in some of these processes, rudimentary in others.

Operations research has played a special role in the development of information flow processes. At the tenth meeting of the PAHO Advisory Committee, we presented a model of sensing, analysis and decision that characterized human endeavor. While colleagues in statistics and epidemiology have developed the mechanisms for sensing and communicating, i.e., the development of encounter forms, registries and data bases, the decision theorists have sought methods for using information so gathered for decision purposes.

In the process, it has become apparent that there is a hierarchy of decision processes, as well as a hierarchy of living things. The operations analyst becomes aware of a constant stream of short term decisions in operating situations, made on the basis of predetermined responses to the range of possible circumstances, with fixed objectives and resources. We call these operational decisions.

Simultaneously in an organization there are a set of decisions of a somewhat more flexible nature, where resources may be expanded or contracted and decision rules changed within the constraints of budgets and set policies. We call these managerial decisions.

Finally there is a part of the information/decision process that questions organizational goals in light of external pressures and change. These are value laden decisions, concerned not only with economy in use of resources but also with the purpose for being of an organization or society. We call these policy decisions.

An inquiry into the sponsorship, the justification, and the motivation behind health services research reveals an incentive to improve decision making processes at all of these levels.

## The Integration of Operations Research and Health Services Research

It may help to understand where we stand in the development of health services to look at a matrix or graph whose dimension on one axis is the level of living system, ranging from human individual, group and institution through levels of society from regional to supra-national. On the other axis is the level of decision. Each point on the graph represents a type of decision at some level of social organization.

If we were to place the operational research projects we know about on such a graph, I believe it would be apparent that our preoccupations have been with operational decisions at group or institutional levels. Our data bases, particularly in primary care, have been designed - and rightfully so --for patient care decisions, with some consolidated reports on utilization and cost to guide managerial decisions. The challenge remains to develop these systems in such a way that long range implications can be drawn - estimates of the long range benefits and costs of preventive strategies or particular modalities of care. It is on the basis of such estimates that policy can be based rationally and it is the long range task of health services research to illuminate the issues confronting policy makers by new knowledge.



SYSTEM/DECISION LEVELS

|  |   |  |  |
|--|---|--|--|
|  | Goals of Care<br>Ethics of Care           | Projections of Service Demands<br>Goal Setting                     | Comprehensive Health Planning<br>Dynamic Modelling<br>Health Surveys |
|  | Capacity of Mix of Services<br>Technology | Facilities Design<br>Health Care Technology<br>Utilization Studies | Manpower Planning<br>Facilities Estimates                            |
|  | Life Style Research<br>Diet<br>Drug Usage | Staffing Patterns<br>Scheduling<br>Inventory<br>Information Flow   | Environmental and Occupational Health Standards                      |

DECISION LEVEL

POLICY (3)

MANAGERIAL (2)

OPERATIONAL (1)

INDIVIDUAL (1)

GROUP (2)

INSTITUTION (3)

SOCIETY (4)

SYSTEM LEVEL

### References

1. Bailey, N.T.J. A Study of Queues and Appointment Systems and Hospital Outpatient Departments, with Special Reference to Waiting Times. *J. Roy Stat. Soc.* 14:185-199 (1952).
2. Connor, R.J., Flagle, C.D., Hsieh, R.K.C., Preston, R.A., and Singer, S. Effective Use of Nursing Resources: A Research Report. *Hospitals* 35:50-59 (1961).
3. Miller, J.G. Second Annual Ludwig Von Bertalanffy Memorial Lecture, in Systems Thinking and the Quality of Life. Washington, D.C., Society for General Systems Research (Proceedings) (1975).

### General References

1. Bailey, N.T.J. Mathematics, Statistics, and Systems for Health. New York, John Wiley and Sons (1977).
2. Bailey, N.T.J. and Thompson, M. (Eds.) Systems Aspects of Health Planning. Amsterdam, North Holland (1975).
3. Flagle, C.D., Huggins, W.H., and Roy, R.A. (Eds.) Operations Research and Systems Engineering. Baltimore, The Johns Hopkins University Press (1961).
4. Shuman, I., Speas, R.D., Jr., and Young, J.P. (Eds.) Operations Research in Health Care: A Critical Analysis. Baltimore, The Johns Hopkins University Press (1961).