FUNCTIONAL ANALYSIS OF HEALTH NEEDS AND SERVICES

William A. Reinke, Ph.D.
Carl E. Taylor, M.D., Dr.P.H.
Robert L. Parker, M.D., M.P.H.

From the Department of International Health, The Johns Hopkins University, School of Hygiene and Public Health, Baltimore, Maryland, U.S.A.

Research Supported by USAID Contract No. CSD-832.

FUNCTIONAL ANALYSIS OF HEALTH NEEDS AND SERVICES

Health planning is becoming an objective and quantifiable science rather than an intuitive and subjective art acquired from years of administrative experience. This rationalization of the planning process requires new methods of data collection and analysis. Field work in response to this need forms the subject of this paper.

General Overview

Background of Concern

Ten years ago our Johns Hopkins research teams initiated national health manpower studies in Taiwan, Turkey, Peru and Nigeria. These macro-planning exercises included efforts to measure and project demand, which led to increasing concern with the specification of appropriate manpower mixes for local situations. Simultaneously, we started research in India, Iran, Turkey and Nigeria on preparation for rural service of physicians and other members of the health team. Innovation in educational planning for rural personnel was limited because job descriptions of members of the health center team were based on traditional patterns of hospital or private consulting room experience. Again we faced the need for better job analysis methods to determine local manpower mix.

Efforts to develop an innovative planning methodology were not productive when we approached the problem directly. As research workers we found ourselves handicapped by the tendency to hold to personalized stereotypes of health manpower categories which led to presuppositions that a nurse could be assumed to be a nurse and a doctor a doctor. Mention of any manpower category conjured up a nimbus of associated attributes and functional capacities that set our minds in a rut of traditional thinking and hampered new job definitions. In addition to imposing rigidities in thinking, these stereotypes caused constant communication problems because people's ideas differ. We decided, therefore, that a job analysis should logically start with the functions to be performed. These functions would cut across traditional personnel stereotypes and permit more rational allocation of appropriate manpower categories according to functional capability.

Our varied research interests converged, then, five years ago in a series of projects to develop a functional analysis methodology. We started by developing and testing a wide range

of systems analysis, operations research, epidemiological and survey research tools. Now having shown that a relatively complex and sophisticated methodology produces useful information, we are moving to streamlining and simplifying field methods for local adaptation in routine planning and evaluation. This presentation summarizes some research findings and a proposal for a streamlined functional analysis methodology.

The Model

The conceptual framework underlying this methodology uses health functions as a bridge between a community's health needs and available health resources. In Figure 1, an hour-glass-shaped model illustrates the interrelationships between a multiplicity of needs with associated health objectives and a diverse range of activities and procedures. The narrow neck of the model represents a limited number of functions defined so as to focus the overall systems analysis on a manageable number of variables. Data on both needs and resources are gathered to fit in with functional categories. The number, definitions and scope of the functions are somewhat arbitrary with the main consideration being that they represent semi-independent areas of health concern without regard for traditional administrative divisions. For community health services we have defined eleven such functions.

Measurement of health needs requires a representative sampling of households in the population for which the health service unit has responsibility. Household interviews provide a two-week recall history of: (1) health problems as recognized by the people; (2) sources and costs of care for these illnesses; (3) hazards to health as recognized by professionals in the service unit; and (4) the extent and nature of contact families have had with the service unit apart from medical care.

Quantification of health resources, activities, and services comes from surveys as well as existing records. Overall measurements of effort are usually available from service records. We place major reliance, however, on two forms of health center survey: (1) work sampling by randomly distributed intermittent observations provides information on all personnel activities within the health center and in the field; (2) to get the patient's view of what happens, we use a patient flow analysis of services received from specific providers.

From this health center information we can proceed to the basic analytic model of a function/manpower grid (Table 1). Summarization of effort by function and by source of activity, including the family itself, allows us to derive totals and distributions: (1) of effort within a given function, and (2) of functions performed by a given category of personnel. Costs can be similarly ascertained and allocated.

Figure 1

ANALYTICAL FRAMEWORK

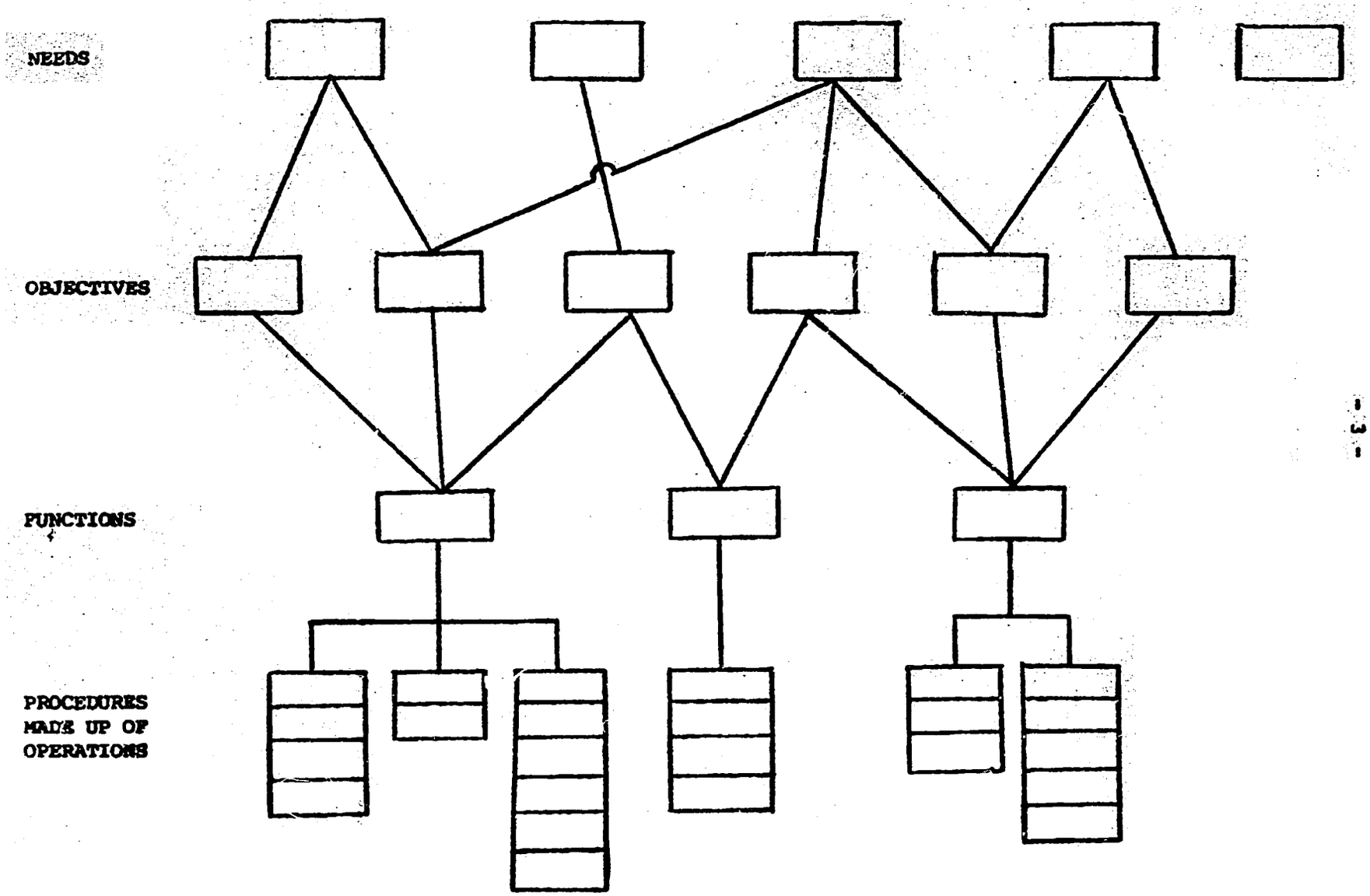

Table 1

IDEALIZED MODEL OF THE MEASUREMENT OF EFFORT BY FUNCTIONS

Functions	Individual Effort					Existing Functional Balance	Functional Balance Based on Need
	Family and Friends	Indigenous Practitioners	Auxiliary Sub-Professionals	Nursing	Physician		
Medical Relief							
Preventive Care							
Family Planning							
Environmental Sanitation							
etc.							
Effort by Individual Type							
Manpower Available							

Applications

At present we see two practical applications of this methodology for health planning and a further application for health services research. First, as a descriptive exercise functional analysis reveals gross inefficiencies and anachronisms which can be adjusted in accordance with needs and priorities. Most evident are imbalances such as the observation that less than 1 percent of health effort in the Indian villages studied went for environmental programs. Second, by obtaining repeated measurements over time within this functional framework it may be possible to establish an evaluative process that will facilitate continuing adjustment of health services to changing health status by concentrating on the bridge between these two areas. From the research point of view such periodic functional analyses carry the potential of permitting assessment of the effectiveness of alternative service program packages in field trials.

Functional Information Generating System (FIGS)

Potential applications of the functional analysis approach can be illustrated by a review of the major findings of our recently concluded field research in India. (Although related projects were also conducted in Turkey and Taiwan, their findings will not be discussed here.) The research had six main objectives: (1) to measure COMMUNITY HEALTH NEEDS with particular attention to developing a better basis for setting priorities among them; (2) to measure the QUANTITY AND QUALITY OF HEALTH RESOURCES currently available for health programs; (3) to identify WAYS IN WHICH HEALTH RESOURCES ARE CURRENTLY UTILIZED to satisfy effective demand for care; (4) to quantify specific ACTIVITIES OF HEALTH CENTERS both in the center and in the community; (5) to define desirable and practical ALTERNATIVES FOR THE REORGANIZATION OF HEALTH CENTERS in terms of both program priorities and job descriptions; and (6) to identify the IMPLICATIONS of modified health center personnel job descriptions FOR PROFESSIONAL AND AUXILIARY TRAINING.

The first four objectives concern the systematic collection and organization of information in order to make decisions in accordance with the last two objectives. A major product of our research, therefore, is the streamlined Functional Information Generating System (FIGS) portrayed in Table 2. This represents what we consider to be the minimum array of health needs and services information necessary for meaningful comprehensive appraisal.

Functions

The System accommodates our eleven functions. The first four--medical relief, personal preventive services, maternity services, and family planning--are personal services stimulated by the felt

Table 2

FUNCTIONAL INFORMATION GENERATING SYSTEM (FIGS)

Needs*			Functions	Services										
						Numbers of Contacts		Time				Cost		
Data Collection	Categories	Numbers		Type of Service Units	Client Characteristics	System Under Study	Other Practitioners	Lay.	Aux.	Mid.	Upper	Personnel	Other Recurring	Capital
Diagnostic Complaint Duration	Grade 1 Grade 2 etc.	Patients	Med. Relief	Diagnosis-Advice Injection Dispensing Other Treatment	Age Sex Socio-Econ. Status									
Birth Rate Morbidity Inf. Mort. Rate Age 1-4 Mort. Rate Immuniz. Status Nutritional Status	Growth and Develop. Maint. and Promotion Protection	Persons	Personal Prev.	Routine Exam. Immun. Non-spec. Nutrition	Age Socio-Econ. Status									
Birth Rate Complication Rate	Antenatal Natal Postnatal	Deliveries	Maternity	Antenatal Delivery Postpartum	Risk Level Complications									
Marital Status Living Children & Sons Knowledge, Attitudes, Practices	Spacing Limitation	Eligible Couples	Family Planning	Motivation Acceptance by Contraceptive Method Follow-up	Living Children & Sons Educational & Socio-Econ. Status									

*Needs have been defined according to a data flow through three stages: first, the form in which data were most readily collected; second, grouping into categories providing a logical transition to service programs; and third, the numbers in each category requiring service with units being variously people, deaths, households or special facilities such as pumps.

Table 1 (Continued)

Needs			Functions	Services										
						Numbers of Contacts			Time			Cost		
Data Collected	Categories	Numbers		Type of Service Units	Client Characteristics	System Under Study	Other Practitioners	Lay.	Aux.	Mid.	Upper	Personnel	Other Recurring	Capital
Clinical Morbidity Disease Prevalence Vectors Environmental Conditions	Surveillance Primary Prevention Immunization Vector Control Mass or Local Treatment	Population of Households	Comm. Disease Control	Surveillance Visits Surveys Immunization Treatments Environmental Control	Persons Households Community									
Morbidity Water Sources and Uses Sanitation Practices and Facilities Crowding and Housing	Availability and Purity of Water Waste Disposal Food Preparation Clean Air Adequate Housing	Specific Facilities	Env. San.	Provision of Facilities Motivation & Education in Use Maintenance	Household Composition Community Characteristics Socio-Econ. Status									
Rate of Population Growth Relation to Economic Development Relation to Social Service	Community Develop. Population Education Economic Factors	Population Units	Mass. Pop. Control	Economic Incentives Educational Measures Social Change Legal Support Administrative Facilities	Cultural Characteristics Social Organization Economic Status Educational Status									

Table 2 Continued

Needs			Functions	Services										
						Numbers of Contacts			Time			Cost		
Data Collected	Categories	Numbers		Type of Service Units	Client Characteristics	System Under Study	Other Practitioners	Lay.	Aux.	Mid.	Upper	Personnel	Other Recurring	Capital
Morbidity for Mental Illness Institutional Admissions Cultural Patterns Specific Situational Pressures	Stress Characteristics Mental Develop. Protection from Drug Depend. Protection from Alcohol Depend.	Persons	Mental Health	Diagnosis (Community & Personal) Prevention and Treatment	Age Sex Cultural Characteristics									
All of Above Community Structure Existing Belief and Knowledge Cultural Pattern	Knowledge of Health Hazards Favorable Disposition to Action Understanding Appropriate Action	Persons Households Schools Communities	General Health Education	School, Mass Media, Grp. Meetings Organization of Individual Contacts Community Organizations	Age Sex Cultural Characteristics									
Data System Info. Requirements Staff (Size, Config.) Physical Resources (Size, Configuration)	Supervision Org. and Coord. of Services Manpower Maint. & Development Financial Accountability Evaluation	Manpower Facilities Budget Reports	Internal Admin.	Planning, Supervision, Training Info., Control -Personnel -Inventory -Financial -Operations Evaluation	Personnel Characteristics Political Patterns									

Table 2 Continued

Needs			Functions	Services										
						Numbers of Contacts			Time			Cost		
Data Collected	Categories	Numbers		Type of Service Units	Client Characteristics	System Under Study	Other Practitioners	Lay.	Aux.	Mid.	Upper	Personnel	Other Recurring	Capital
Channels of Authority and Administrative Relationships Program Responsibilities Consumer Knowledge, Satisfaction Referral Patterns	Coord. with Other Administrative Units Pgm. Coord. and Role Ident. with Other Providers Facilitation: Consumer Rapport	Administrative Units	Liaison	Referral Meetings Administrative Contacts Reports	Other Health Services Non-Health Agencies Consumers									

needs of the consumers of the services. A second set of five functions--communicable disease control, environmental sanitation, mass population control, mental health, and general health education--includes services stimulated through provider initiative: (1) in response to health needs not recognized by consumers; (2) in order to meet felt needs more efficiently or effectively; or (3) in order to alter priority patterns among felt needs. A third set consists of two functions which are non-specific with respect to particular services but which facilitate the conduct of all operational responsibilities. The first is internal administration, and the second--liaison--includes coordinative and educational relationships with consumers, other health agencies, and various political, administrative and social groups outside the health field.

Needs

Table 2 is organized so that individual needs are classified and quantified on the left side. Then they are channeled through the functional grid running down the center of the figure, and are related to the services as indicated on the right. In order to specify magnitudes of need one must collect information regarding related factors. For example, the need for maternity care is dependent upon the birth rate. Moreover, the maternity function may be of such importance in a local situation that an administrator will want to record maternal and neonatal death rates, history of complications in pregnancy, or other factors which over time might reflect changing levels and qualities of need.

Services

The analysis of services requires at least three types of measurement: (1) number of client contacts or other service units; (2) time spent in rendering the service; and (3) cost. Individual service categories to be analyzed in this manner depend upon technical considerations relating to the provider and upon relevant characteristics of the client. Technically, for example, it is useful to analyze medical relief services in terms of patient consultations (diagnosis and advice), injections, dispensing of drugs, and other forms of treatment. Service contacts are enumerated separately for the particular services system being studied, for other health professional providers, and for lay sources of service such as family and friends. Time and cost allocations are usually of interest only for the system being studied. Within the system being studied the allocation of time among auxiliaries, middle level workers, and upper level workers will be of great interest. In allocating costs a distinction should be made between personnel costs, other recurring costs of operation, and capital costs.

Summary of Findings

Data for the study were collected over a 12-month period in the states of Punjab and Mysore. In each state we surveyed three villages within each of two health center areas (community development blocks) of 57,000-87,000 population each. The community survey was divided into two parts. The first included panels of about 25 households in each village which were interviewed at fortnightly intervals throughout a full year. These interviews provided information about health problems and action patterns extending over the full course of a given illness. Data were obtained from 297 households composed of 2,358 individuals, who provided over 50,000 person-fortnights* of health and morbidity experience. The second phase of the survey involved single interviews with ten different households in each village each month. Over the 12-month study period we contacted 1,501 single-visit households with 9,500 members.

Demographic Features

Simple demographic information obtained from the single-visit households provides the basis for estimating the population characteristics of a typical community development block (CDB) in a particular state.** Assembled as in Table 3, this information provides a basis for a first approximation of the CDB needs in separate functional categories. For example, if it were decided that each child should have bi-monthly checkups during infancy and semi-annual visits thereafter until he reaches the age of five, we note that 37,000 contacts would be needed annually in Punjab and 41,040 in Mysore. Similarly, information on household characteristics can be used to determine needs for family planning, health education, and other contacts.

Morbidity

To assess needs for personal preventive and medical relief services, basic demographic data can be supplemented with information regarding immunization status and morbidity levels. For example, the panel households produced estimates of the annual number of illness

---

*The presence of a person in a household during the two-week period prior to interview constitutes a person-fortnight. If any symptoms or complaints were reported for the person during the two-week period, this was termed a problem-fortnight.

**Our sample design did not guarantee random selection of CDBs. For illustrative purposes in this paper, however, data for each state are shown as averages of the two blocks studied. Each block is standardized to 100,000 population for ease of comparison between states and with other populations.

Table 3

POPULATION DISTRIBUTION AS BASIS FOR NEED DETERMINATION

	Survey Results		CDB Estimates	
	Punjab	Mysore	Punjab	Mysore
Persons				
Under 1	146	150	3,120	3,110
1 - 4 years	427	540	9,140	11,190
5 - 14 years	1,172	1,370	25,070	28,360
15 - 49 male	1,145	1,149	24,490	23,770
15 - 49 female	1,004	1,044	21,560	21,610
50 and above	777	576	16,620	11,960
Total	4,671	4,829	100,000	100,000
Eligible Women*	655	753	14,090	15,600
Households				
Total	721	780	15,440	16,150
With Eligible Women	514	611	11,010	12,650
With Children 0-4	364	459	7,800	9,500
With Children 5-15	520	604	11,140	12,510

*Eligible women is a term generally used in India's family planning program. We have defined it to include all currently married women between the ages of 15 to 49.

episodes occurring among various age groups. This sample information, extended to the entire CDB population as in Table 4, yields some insight into the magnitude and distribution of medical relief needs. Not all episodes result in health service demands, of course. The study revealed, however, that on the average each episode costs nearly two rupees for payments to practitioners, apart from travel and other expenses. This amounts to more than Rs. 490,000 ($65,000) per CDB in the Punjab annually.

Table 4

ESTIMATED ANNUAL EPISODES OF ILLNESS

Age	Avg. Episodes Per Person		Episodes in CDB Population (from CDB Estimates, Table 3)	
	Punjab	Mysore	Punjab	Mysore
Under 1	2.70	2.91	8,400	9,100
1-4	3.85	3.15	35,200	35,200
5-14	2.26	1.84	56,700	52,200
15-49	2.05	1.87	94,400	84,900
50+	3.20	2.37	53,200	28,300
Total	2.48	2.12	247,900	209,700
Avg. Payment to Pract. per Episode (Rs.)	1.99	1.90		
Estimated Total Annual Out-of-Pocket Payment for Practitioner Services (Rs.)	4.94	4.03	493,000	398,000

Need for Medical Relief Services

One of the most difficult parts of an analysis of medical care is attempting to distinguish between need and demand. Furthermore, in a functional analysis, which is designed to facilitate shifting of activities among multiple functions, ways must be found to relate medical relief activity to needs that might be prevented by allocations

to other functions. The criteria for classifying morbidity according to specific needs and preventability are bound to be arbitrary and subject to controversy, as well as subsequent refinement. We have tentatively established such criteria for episodes divided into two-week segments corresponding to the period of recall in household interviews.

For purposes of this classification the important items of information are: the diagnostic category, the duration of illness, and the amount of time lost from normal activity. Diagnoses in the International Classification of Diseases System were grouped into thirty broad categories. Any illness resulting in at least three days of lost time from usual activities was considered evidence of a need for medical relief, regardless of diagnostic category. Two categories, inflammatory ear and lower respiratory disease, were classified as representing need regardless of duration and generally not preventable. Several diagnostic categories were classified as needing care only if the condition persisted for a specified period. In this group diarrhea was considered probably preventable, while non-infectious abdominal and gastro-intestinal illness was deemed non-preventable. Finally, some diagnostic categories were separated out for "special" consideration. These included minor complaints and non-medical relief services such as antenatal care.

In the course of the study 14,613 problems were classified according to the above criteria with results as shown in Table 5. The pattern in the two states is remarkably similar, with only about one-fourth of the health problems leading to practitioner consultation. The consultation rate tends to be somewhat higher in cases of "need" according to our criteria. For the present, however, we must emphasize that these criteria are only illustrative rather than definitive.

Reasons for Non-Use of Medical Relief Services

Two-fifths or more of those failing to seek consultation were classified as having no need for care. In some cases the problem was considered too trivial to require professional attention, while in others a consultation was intended, though not yet undertaken. For those with evidence of unmet need, the reason (Table 6) most often was the low priority consultation had in relation to other demands on time. Although financial constraints and unavailability of services were of some consequence, accessibility apparently was not.

Table 5

RESULTS OF HEALTH PROBLEMS CLASSIFICATION
BY NEED FOR MEDICAL RELIEF AND PREVENTABILITY--
STUDY POPULATION ONLY

Category	No.		% of Total		No. Seeking Care		% in Category Seeking Care	
	Punjab	Mysore	Punjab	Mysore	Punjab	Mysore	Punjab	Mysore
Need, Not Preventable	1947	1262	24	20	564	373	29	30
Need, Preventable	2571	1703	31	27	751	520	29	31
No Need, Not Preventable	1399	1047	17	16	333	199	24	19
No Need, Preventable	1082	1181	13	19	206	245	19	21
Special	1274	1147	15	18	203	177	16	15
Total	8273	6340	100	100	2057	1514	25	24

Table 6

REASONS FOR FAILURE TO SEEK CONSULTATION

	Punjab		Mysore	
	No.	Percent	No.	Percent
Total Cases with No Consultation	6,216		4,826	
Cases in Which Evidence Was Given of Unmet Desire for Treatment	3,442	100.0	1,646	100.0
Reasons for No Consultation--				
Neglect, Busy with Other Matters	2,306	67.0	743	45.1
Financial	476	13.8	473	28.7
Tried, Failed to Attain Help	615	17.9	358	21.7
No Transport, No Service Nearby	45	1.3	72	4.4

Table 7

ESTIMATED VOLUME OF MEDICAL RELIEF NEEDS AND SERVICES PER CDB

PUNJAB

Problem Category	Need (Thous. Problems)	Visits Made (Thousands)					Additional Visits Needed (Thous.
		IMP	Allopath	Other Govt.	PHC	Total	
Grade 1-Need, Not Prev.	149	85	18	15	18	136	333*
Grade 2-Need, Preventable	192	110	24	27	26	187	458
Grade 3-No Need, Not Prev.	105	54	8	6	10	78	0
Grade 4-No Need, Preventable	81	34	5	6	6	51	0
Grade 5-Special	93	30	5	14	8	57	0
Total	620	313	60	68	68	509	791

MYSORE

Problem Category	Need (Thous. Problems)	Visits Made (Thousands)					Additional Visits Needed (Thous.
		IMP	Allopath	Other Govt.	PHC	Total	
Grade 1-Need, Not Prev.	92	25	4	21	16	66	154
Grade 2-Need, Preventable	125	34	9	27	22	92	205
Grade 3-No Need, Not Prev.	74	13	2	8	10	33	0
Grade 4-No Need, Preventable	88	17	5	6	10	38	0
Grade 5-Special	83	11	4	9	8	32	0
Total	462	100	24	71	66	261	359

*To illustrate the calculations:

$$333 = \left(136 \times \frac{100}{29}\right) - 136 ,$$

where 29 is the percent seeking care from Table 5.

evidence of particular types of contacts with health center personnel during the preceding two weeks. From the household interviews we were also able to get reported levels of smallpox and BCG immunization. This information is assembled in Table 8, along with summaries of effort going into each operating function (as determined from the work sampling observations discussed below in greater detail).

Table 8

SUMMARY OF RELATIVE EFFORT AND SELECTED SERVICES PROVIDED BY FUNCTION

Functions	Service Indicators	Services		% Time	
		Punjab	Mysore	Punjab	Mysore
Medical Relief	Practitioner Visits	See Table 7		23	23
	Contacts for Education About Illness	1,000	4,000		
MCH	Deliveries	600	400	10	18
	MCH Contacts	14,000	76,000		
	Health Education Contacts	3,000	9,000		
Family Planning	IUCD Insertions	400	200	20	19
	Vasectomies	100	60		
	Tubectomies	70	80		
	Condoms Distributed	18,000	4,000		
	Family Planning Contacts	21,000	24,000		
	Contacts for Family Planning Education	6,000	41,000		
Communicable Disease Control	Primary Smallpox Vaccinations	3,000	5,000	46	39
	Smallpox Revaccinations	15,000	17,000		
	Immunization Contacts	58,000	80,000		
	Percent of Population Immunized within 3 Years	49	30		
	Percent of Population with BCG Immunization	10	7		
	Malaria Blood Smears	14,000	8,000		
	Malaria Contacts	290,000	120,000		
	Trachoma-Plague Contacts	13,000	41,000		
Environmental Sanitation	Wells Chlorinated	200	400	1	1
	Latrines Constructed	0	40		
	Housing and Water Contacts	1,000	1,000		

Table 8 provides a general overview from which judgments can be made about the extent and nature of activities and services in each functional area. In both states communicable disease control absorbed more effort than any other function. The level of activity was especially high in Punjab, where much more malaria control activities were observed than in Mysore. In the latter state, on the other hand, more time and many more contacts were reported for MCH activities. In this connection we recall from Table 3 that Mysore has relatively more young children in its population, presumably a direct measure of the effect of differences in birth rates.

Worker Distribution of Effort

We next direct attention to the efforts of certain categories of workers. Table 9 indicates the balance of effort devoted to direct service, supportive or administrative activities, travel time, and personal time. Perhaps the most striking finding reported is the large amount of time which Mysore field staff devoted to travel, reflecting primarily the greater number of villages and larger distances that they covered, especially since the Mysore women did not use bicycles. Compared to Punjab, however, the extra travel is compensated for by less personal time rather than productive time.

In addition, differences in time allocation of individual categories of workers have practical significance. The dresser, for example, appears to be the most underutilized worker. The health inspector spends the most time in travel in both states. The Punjab health center doctor engages in administrative support activities far more than his Mysore counterpart. The latter spends more time in direct service than any other worker except the Mysore auxiliary nurse midwife. By comparison the Punjab ANM has less time in productive activities. In fact, the differences suggest that a desirable combination would be an ANM whose travel is limited as in Punjab, but who upon arrival at her destination achieves the service level of the Mysore worker.

Service Activity Analysis - PHC Outpatient Visits

Of the four broad categories of activity the most important is direct service. Detailed analysis of the component activities and numbers of encounters with the population is summarized in Table 10 for health center medical relief visits and in Table 11 for the field work of health center personnel. Before turning to the tabulated details we should note that overall analysis of patient flow data showed that of the 87 patients typically visiting a Punjab health center daily, 83 came for medical care purposes. They were detained 24 minutes on the average, but only 4 minutes were required for direct services. Similarly, in Mysore, 93 medical care visits per day typically required 3 minutes of service time and 9 minutes of waiting time.

Table 9

PERCENTAGE TIME DISTRIBUTION AMONG VARIOUS FORMS OF ACTIVITY BY SELECTED WORKERS

Worker	Punjab				Mysore			
	Dir. Serv.	Support.	Travel	Personal	Dir. Serv.	Support.	Travel	Personal
Health Center								
Doctor	27	43	4	26	32	20	10	38
Pharmacist	29	33	9	29	19	24	19	38
Dresser	22	26	6	46	15	31	12	42
Field								
Lady Health Visitor	17	32	19	32	15	32	39	14
Aux. Nurse Midwife	15	28	22	35	32	11	42	15
Fam. Plan. Worker	8	38	27	27	15	13	48	24
Hlth. Insp.	9	37	35	19	11	31	51	7

Table 10

SUMMARY OF HEALTH CENTER MEDICAL RELIEF OUTPATIENT SERVICES

Punjab

Medical Relief Outpatient Activities	Minutes Per Day			Patient Contacts Per Day				% Pts. Seen (N=83)
	Dr.	Pharm.	Dresser	Dr.	Pharm.	Dresser	Other	
Consultation	56	30	1	49	21	0	5	90
Injection	1	19	0	0	8	0	3	14
Dispensing	4	31	5	3	47	1	15	79
Dressing, Other Treatment	1	7	62	0	4	17	3	29
Total	62	87	68	52	80	18	26	

Mysore

Medical Relief Outpatient Activities	Minutes Per Day			Patient Contacts Per Day				% Pts. Seen (N=93)
	Dr.	Pharm.	Dresser	Dr.	Pharm.	Dresser	Other	
Consultation	69	8	4	57	6	3	7	78
Injection	7	0	0	6	0	0	0	7
Dispensing	2	52	5	1	56	2	2	66
Dressing, Other Treatment	2	6	45	0	3	27	1	33
Total	80	66	54	64	65	32	10	

Table 11

SUMMARY OF HEALTH CENTER FIELD ACTIVITIES

Punjab

Functions	Service Min./Day				Contacts Per Day							
	LHV	ANM	FPW	HI	LHV		ANM		FPW		HI	
					Dir.	Ind.	Dir.	Ind.	Dir.	Ind.	Dir.	Ind.
Medical Relief	9	16	1	2	4	0	7	1	0	0	1	0
MCH	16	18	0	1	5	1	4	1	0	0	0	0
Family Planning	27	13	24	2	4	3	4	2	14	6	0	1
Comm. Dis. Cont.	4	3	1	22	6	1	3	1	0	0	14	5
Env. San.	0	0	0	5	0	0	0	0	0	0	1	2
Total	56	50	26	32	19	5	18	5	14	6	16	8

Mysore

Functions	Service Min./Day				Contacts Per Day							
	LHV	ANM	FPW	HI	LHV		ANM		FPW		HI	
					Dir.	Ind.	Dir.	Ind.	Dir.	Ind.	Dir.	Ind.
Medical Relief	11	14	2	2	6	7	8	3	1	0	2	1
MCH	11	40	1	3	11	0	19	0	1	0	4	1
Family Planning	22	29	47	10	5	1	6	0	14	3	2	2
Comm. Dis. Cont.	3	12	0	19	2	0	8	0	0	0	21	3
Env. San.	2	0	0	3	0	0	0	0	0	0	0	1
Total	49	95	50	37	24	8	41	3	16	3	29	8

It is clear from Table 10 that the service pattern in Mysore is relatively specialized; the doctor personally performs most consultations and injections, the pharmacist does the dispensing of drugs, and the dresser takes care of most other treatment. The doctor spends more time in direct services than other categories of personnel. In contrast to this, the pharmacist in Punjab spends nearly 1 1/2 hours per day providing direct service, as well as carrying out a wide range of services. He devotes about as much time to patient consultations as to dispensing, and in the course of a day he sees nearly every patient that comes to the health center. Depending upon whether official policy accepts the Punjab or Mysore pharmacist's role as more appropriate, the implications for training are considerable.

Service Activity Analysis - Field Work

Field services, of course, cover a wider range of functional categories than health center work, as indicated by Table 11; family planning activities are especially important. However, environmental sanitation is almost ignored. As noted earlier, the Mysore workers, especially ANMs, tend to spend more time in direct service than those in the Punjab, and they have more service contacts as well. Direct contacts with persons and families are more frequent than indirect, general community or staff contacts.

Distribution of Worker Contributions within Functions

Another view of service delivery patterns is provided by Table 12, which shows the proportionate time contribution of each member of the health center team to the total effort expended on each function. This contribution is affected by the number of workers in a given category, so that in Punjab, for example, the ANMs as a group devote more time to medical relief than do physicians. In both states medical relief is, in fact, provided by several workers, notably doctors, pharmacists, dressers, ANMs, and, in Punjab, trained dais (indigenous midwives).

In contrast, other functions tend to be associated with single categories of personnel. The ANM is mainly responsible for the provision of MCH services, while basic health workers do most of the communicable disease control. The ANMs are especially active in providing family planning services, but in the Punjab they share this effort with family planning workers. As already indicated, environmental sanitation receives little attention from anyone.

Table 12

DISTRIBUTION OF SERVICE EFFORT WITHIN FUNCTIONS

Worker	Percent of Service Contribution to Given Function									
	Punjab					Mysore				
	Med. Rel.	MCH	Fam. Plan.	CDC	Env. San.	Med. Rel.	MCH	Fam. Plan.	CDC	Env. San.
Doctor	16	2	3	1	0	33	6	3	0	0
Nurse	4	1	1	0	0	5	1	0	0	0
Pharmacist	25	0	1	0	0	17	0	0	0	0
Dresser	14	0	0	0	0	13	0	0	0	0
Lab Technician	1	0	4	11	0	1	0	0	13	0
Lady Health Visitor	4	16	13	1	0	3	4	7	0	2
Aux. Nurse Midwife	24	61	22	2	0	17	63	45	9	21
Trained Dai	10	18	7	0	0	-	-	-	-	-
Family Plan. Worker	1	1	26	0	0	0	0	12	0	0
Health Inspector	0	0	1	3	40	1	1	3	3	40
Block Level Ext. Educ.	0	1	14	0	6	1	0	15	0	0
Basic Health Worker	1	0	3	82	54	8	12	13	72	34
Other	0	0	5	0	0	1	13	2	3	3
Total	100	100	100	100	100	100	100	100	100	100

Content of Direct Services

A mere tally of the numbers of service contacts and time relationships is admittedly incomplete since it does not provide for measures of content and effectiveness. We know of no way to assess the latter simply. We have, however, developed checklists to discover the content of services. Table 13 summarizes for illustrative purposes selected findings from the checklist for medical consultations for patients with fevers of undetermined origin. Non-physician consultants tend to perform more superficial examinations than doctors, but in other respects this measure of the content of consultation differs only slightly according to the category of worker seeing patients. For example, not more than one-fifth to one-third of patients had their treatment and prescribed medicines explained to them, regardless of consultant.

Table 13

PERFORMANCE OF SELECTED ITEMS RELATED TO CARE OF PATIENTS WITH FEVERS OF UNDETERMINED ORIGIN-- BASED UPON PATIENT FLOW OBSERVATIONS IN BOTH PUNJAB AND MYSORE

	Percent of Patients for Whom Action Performed		
Checklist Action	Doctors (N=101)	Pharmacists (N=41)	Nurs. Staff (N=10)
History Elicited	47	39	40
Temperature Taken	26	51	30
Auscultation with Stethoscope	44	7	0
General Exam of One or More Body Areas	34	15	0
Blood Test Ordered	45	32	40
Drugs Dispensed	97	95	80
Treatment Explained to Patient	32	34	20

Further Analysis of Findings

The illustrative findings reported so far represent some of the possibilities of the Functional Information Generating System. The value of these findings can be further enhanced by creating various indices and applying other analytic methods. Without reviewing all possible analytical techniques, a few examples will be presented.

Morbidity Indices

Morbidity indices provide a direct means of estimating disease load. By relating the average number of illness episodes per year by groups (Table 4) to the age composition of survey households in a given CDB we can determine the number of episodes expected for the whole block. In one of the Punjab blocks studied, for example, the panel households (interviewed fortnightly for an entire year) would be expected to yield 1,543 episodes of illness, compared with 1,370 cases actually recorded. An index, then, can be constructed:

$$\frac{\text{Actual Cases (A)}}{\text{Expected Cases (E)}} \times 100 = \frac{1,370}{1,543} \times 100 = 89$$

This can be used to indicate the relative disease load of a CDB. In contrast, the other Punjab CDB studied achieved an index of 112.

Furthermore, the significance of variations between blocks studied can be ascertained as

$$\text{Sum} \left[\frac{(A-E)^2}{E}\right] = 40.5$$

in the case of Punjab. Comparing this result with tabulated critical values of χ^2 indicates a highly significant lack of uniformity among CDBs. This could lead in turn to an analysis of block differences as related to average economic level and other factors.

Intensity of Services Utilization

For a second illustration of analytical possibilities we turn from needs assessment to services, first with respect to intensity of utilization and then to range of coverage. For a measure of utilization intensity we calculate the rate of visits made to a local practitioner. For every 1,000 residents in Punjab study villages, for example, we found that 739 visits were made to indigenous practitioners (IMPs) within a one mile radius of the patient's residence. Table 14 shows that residents

of the health center village had an even higher rate of PHC utilization (5,438 visits per 1,000) indicating that the health center has considerably greater local attraction than the IMP. The overall utilization of IMPs, however, was greater due to the large number of these practitioners in the CDB. Corresponding rates for private allopaths and government dispensaries are low, but the comparison is not very meaningful because the number of villages sampled was not sufficient to assure that the general distribution of these services was adequately represented.

Table 14

HEALTH SERVICES UTILIZATION INTENSITIES
AND EFFECTIVE SERVICE AREAS - PUNJAB

Service Category	Annual Visits Per 1,000 Population--Travel Under One Mile	Max. Miles Travelled by 75% of Visitors	Effective Service Area (Sq. Mi.)	Service Areas Needed Per CDB	Approx. No. Practitioners or Facilities Available
IMP	739	2.5	19.6	5.1	360
PHC	5,438	2.9	26.4	3.8	1
Pvt. Allopath	7	7.2	162.8	0.6	4
Other Public	3	3.4	36.3	2.8	5

Effective Range of Service Coverage

The effective range of service coverage was calculated from the travel radius which included three-fourths of all patient visits to a given service. For example, 75 percent of the IMP visits in Punjab involved travel of less than 2.5 miles. The effective IMP service area, therefore, is estimated to be a circle with area

$$\pi R^2 = (3.14)(2.5)^2$$

$$= 19.6 \text{ square miles.}$$

Since a typical CDB contains roughly 100 square miles, the relationship between the minimum of five service areas (5=100/19.6) and the number of practicing IMPs (72=360/5) gives an indication of the amount of overlap in service areas.

A similar analysis of PHC coverage indicates a somewhat larger radius of coverage, 2.9 miles, which indicates an effective service area of 26.4 square miles. At this rate complete CDB coverage would require 3 or 4 health centers. An alternative approach would be to develop a more complete subcenter infrastructure. In general, the present clinical coverage of the Punjab PHC is characterized by exceptionally intensive utilization but an effective service area that is only one-fourth of the CDB.

Potential Uses of Functional Analysis

In the section on Applications above we discussed possible uses of the functional analysis methodology. In summary they are:

1. For health planning

   a. As a cross-sectional survey, functional analysis provides a quantitative description of health needs and resources in a population group permitting better priority setting and allocation.

   b. As part of a continuing planning process, repeated functional analysis can measure change in health status and provide evaluation of health services especially as new measures are introduced.

   c. As a comprehensive analytic system which includes cost accounting, functional analysis provides a basis for cost-effectiveness comparisons.

2. For action research the application of functional analysis methodology provides quantitative measures of inputs in experimental field programs. Standard epidemiological and survey tools have provided information on health outputs which can now be related to measures of such input variables as various mixes of manpower, balance of activities, and costs.

Data Required for Streamlined Functional Analysis Approach for Health Planning

Most of our research so far has been methodological. From the relatively complex research procedures of our definitive study we have now evolved a minimum methodology especially adapted to the needs of a planning and evaluation unit in an operating health service. A biopsy approach is to be used to collect specified items of data from a limited area. The techniques proposed are outlined in Table 15 with an estimate of the man-days required for a minimum and an extended design as applied to four CDBs in India.

Table 15

SUMMARY OF DATA COLLECTION PROCEDURES
IN FOUR COMMUNITY DEVELOPMENT BLOCKS
(Streamlined Functional Analysis)

Procedure	Description	Estimated Man-Days Required	
		Basic Design	Extended Design
Regional and Village Assessment	4 CDBs, 300 villages	4	4
Village Leaders' Opinions	36 villages in 4 CDBs	18	18
Health Services Record Review	One year of data from the health facilities	12	20
Household Surveys	400 households in 36 villages of the 4 CDBs	40	60
Health Center Work Sampling	7,200 observations at 4 health centers for 10 days each	40	40
Field Work Sampling	7,200 observations at 4 health centers for 10 days each (doubled in extended design)	40	80
Patient Flow Analysis	1,200 patients at 4 health centers for 5 days each (extended design only)	0	100
TOTAL		154	322
Months Required Using a Team of 5 Investigators at 20 Days per Month		1.5	3.2

The four CDBs, each containing a health center, would be randomly chosen in the state or administrative region of concern. Nine villages in each CDB would be selected with the following geographical requirements: the health center village itself, two subcenter villages, two villages within 1-2 miles of the health center, two within 3-4 miles and two 5 or more miles away. Extrapolations to the total region or state could then be based on the distribution of villages in the various geographical ranges. Data are to be gathered under the following headings.

1. Regional and Village Assessment

The four community development blocks (CDBs) would be selected in collaboration with State officials. Each CDB would be visited to initiate contacts with block officials and health personnel. Initial selection of villages would be made with their participation. General information about health care in the block would be solicited.

2. Village Leaders' Opinions

The cooperation and active assistance of village leaders is essential for all field work. In addition, their judgments and opinions provide a good introduction to data gathering. They can give historical background and presently perceived estimates of local health needs and service patterns. Getting their participation early will pave the way for village cooperation in subsequent household surveys. A senior investigator should spend approximately half a day in each village in these initial contacts.

3. Health Services Record Review

Existing records provide convenient though incomplete sources for data on the volume of specific services and for information useful in estimating costs. Since the direct field observations are limited to short periods of time, records may provide comparative seasonal information. We estimate three to five man-days per health center for the record review. Although records are notoriously inaccurate and incomplete, it is probable that where functional analysis becomes accepted as part of a continuing planning process, the specification of a limited amount of useful data to be reported might be a catalyst to stimulate reform and streamlining of the whole health statistics system.

4. Household Surveys

Household surveys, together with the work sampling procedures described below, form the core of the functional analysis methodology. In the basic design we have recommended a single visit to each of ten randomly selected households in the eight non-health center villages

and to twenty households in the health center village. Data would thus be obtained on twenty households from each of the five geographical zones around a health center.

Interviews would review felt needs for various health functions, episodes of illness, the services received from various practitioners, and costs. As indicated in Table 15, a survey of 400 households, 100 per health center area, would require 40 man-days of effort, based upon about 10 interviews per day. The household surveys in the extended design would generate additional information at each interview. They would also provide for bi-weekly reinterviews of households in which an episode of illness was encountered on the first visit to obtain some longitudinal information on the dynamics of health actions during illnesses.

5. Health Center Work Sampling

Instantaneous observations are made at two-minute intervals on the activities being performed by health center workers. Observations would cover two different rounds of each weekday, Monday through Friday, for six hours per day. Two weeks of data collection would produce 1,800 observations per health center. If five categories of workers were studied, there would be an average of 360 observations per category per health center, or 1,440 units of information per category in all four health centers. Each observation would include a classification of activity and function observed, along with details identifying special features of the service and the client being served.

Health center work sampling provides much of the quantitative data for functional analysis with relatively little cost in time and effort. Therefore, the full 40 man-days of effort (10 days of observation in 4 health centers) are included in both the basic survey and extended designs (Table 15).

6. Field Work Sampling

Field work sampling requires the investigator to accompany health center personnel on field visits to note their activities at two-minute intervals and to log their service contacts continuously. If two working days of six hours each are allowed per worker, 360 units of information would be obtained. In the basic design, five categories of staff would require a total of 40 man-days. Field observations are not likely to vary as much from one observation to the next as in the health center; however, overall work patterns in the field are likely to vary more than in the health center. The extended design, therefore, permits either more observations per worker or more workers to be observed, extending the field work sampling to a total of 80 man-days of observations.

7. Patient Flow Analysis

Patient flow information requires observations of what happens to individual patients as they go through a health center visit. It is a means of relating patient characteristics and needs to the content and quality of health center services as provided by specified workers. Such investigations are, however, a rather costly way of refining information gained more simply from work sampling. Patient flow information is, therefore, only included in the extended survey design. In five days at a health center approximately 300 patients may be observed.

In summary, estimates of effort required total about 150 man-days for the basic design and over 300 man-days for the extended version. A team of 5 investigators working 5 days a week would complete the simpler design in 6 weeks as compared with three months for the extended design.

Future Plans

A. Planning Applications

Although based upon extensive research, the streamlined methodology requires field testing in each locale of application. Moreover, we recognize that continuing implementation by planning and evaluation units will be achieved only after they have received concrete evidence of feasibility and relevance. We therefore propose a four-stage cooperative program of introducing functional analysis into the planning process.

1. Our field research team with delegated staff from state health services would apply the streamlined approach in four health center areas, as specified by the design for data collection described earlier.

2. At the second stage state officials would use their own teams to carry out a field trial in four randomly selected areas. This trial would be under routine administrative conditions with our research staff assuming a consultative role.

3. Next the planning and evaluation unit would incorporate the methods of functional analysis into its routine activities. An ongoing schedule would provide for regular repetitive analysis at selected centers throughout the state to generate a steady stream of planning data and to evaluate the impact of pilot trials of new

procedures instituted as part of the planning process. An important aim at this stage would be to prune the existing record system.

4. The final stage involves the extension of the methods to other states and countries for comparative purposes. Already arrangements are being made to conduct three such studies under international auspices. Interest has also been shown by American agencies concerned with a broad spectrum of settings, including inner city and rural poverty communities in the United States.

B. Action Research Applications

The Rural Health Research Center in Punjab has been the base for two major action research projects in addition to the functional analysis one. In order to carry out this research we have assumed responsibility for providing health care to 23 villages with 28,000 population distributed through three community development blocks. The experimental designs provide for controlled measurement of specified health outputs from carefully defined service inputs.

The largest project is a study of how health and family planning services can be integrated at the village level. To examine this question we have established different combinations of child care, women's services, nutrition programs, and family planning services among five groups of four villages each, with about 5,000 population per group.

The second study examines the interactions between nutrition and common infections in weaning-age children. Child care programs and nutritional supplementation are provided alone or in combination to study their effect on growth, development, morbidity, and mortality.

In all of this action research, primary care, including diagnosis and treatment of illness, is provided by auxiliary nurse midwives and lady health visitors, with doctors and nurses playing only supportive and referral roles. Developing this new pattern of health center role relationships has been, in itself, a major research effort. It follows, therefore, that careful measurement and evaluation of activities are as important to the research findings as measures of program impact. Indeed, any evidence of the effectiveness of specific services will count for little in practice if there is lack of corresponding evidence that manpower and monetary resources will be adequate for widespread replication of services.

The work sampling of activity inputs, the assessment of costs, and the measurement of levels and changes of health status through household surveys are all features of the functional analysis methodology that can contribute to the resolution of the above issues. In particular, the methodology seems to be proving useful in at least two ways.

1. It provides an internal evaluation mechanism for the continuing evolutionary development of our service programs. This process of internal monitoring within well-controlled community laboratories facilitates the prompt selection of improved service components.

2. In the course of developing these service components we are able to assign price tags to them so that the administrator can review the alternatives and select those that meet his specific program needs. Moreover, in this selection process he is made aware of interaction effects. Synergistic and antagonistic influences on results are well-established phenomena in multifactorial epidemiological studies, but the approach considered here permits the assessment of interactions among inputs as well.

In summary, functional analysis methods added to the present measurement skills of the experimental field epidemiologist provide a useful bridge to health services planning and research. We have adapted basic systems analysis and operations research techniques to measure more precisely the combinations of variables relating to service inputs. The household survey is then used to supplement standard output measurements with morbidity and utilization data. The combined field methodology should have much relevance to the health planner who is trying to develop and implement innovative programs.