PN-ABP-348

isn 82856

QUANTITATIVE ANALYSIS OF HEALTH SECTOR POLICY ALTERNATIVES FOR RURAL BOLIVIA

Dolores Barbeau M.D.
Marijo A. Wunderlich

August 1981

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Introduction

The use of cost-effectiveness models to aid policy makers in the allocation of scarce resources has particular value for countries of the developing world. The need to allocate scarce resources in an effective and efficient manner is paramount, especially given the competition among governmental sectors for these extremely scarce resources. The health sector is an area in which alternative programs can be evaluated quantitatively to give planners the relative cost-effectiveness of potential health programs. In this manner, substantiated arguments can be made for or against the implementation of specific health programs beyond that of intuition and/or precedent.

A model developed at the University of Michigan School of Public Health simulates the effects of various alternative programs based on specified program components and their estimated impact.[1] The health programs can include generally accepted public health interventions such as immunizations, nutrition, and sanitation, alone or in concert with various medical organizational structures of facilities or personnel, e.g. village health workers, rural health posts. By quantifying the exact health program with specific effect and cost, various public health interventions and medical organization alternatives can be simulated for cost-effectiveness ranking.

In this analysis, relevant data for the model concerning health effects of present and postulated programs are from the Chapare area of Bolivia. The data used are organized according to the following underlined components as described within the original model study of rural Java developed at the University of Michigan.

> A population, with a particular age and sex distribution, experiences a certain set of diseases, which can be defined through 'attack rates'. Given whatever health care services are available, an estimable proportion of the population (by age and sex) utilizes the services. Deaths and days of disability (incapacity for performing normal functions) can be established for each disease identified, and these can be shown both for those who utilize health services and those who do not. Where death, disability, and attack rates are known to be affected by levels of nutrition, sanitation, immunization, promotion and organization of health services, these can be entered into the model in varied combinations. It is from the combination of these several indicators and conditions that the expected effects of various health service interventions can be explored through the computer model. These effectiveness levels can then be used for comparisons of programs carrying particular costs. (Emphasis in original)[2]

There is a validity check on the estimates for the various components by reviewing the credibility of aggregate numbers produced by the model. For example, if the total mortality rate is indicated to be ten per thousand from the model and various published mortality data are significantly higher, one knows the specific mortalty rates for individual diseases should be reviewed and revised.

Background to Region of Study

The Chapare region of Bolivia covers roughly 50,000 square kilometers and is a settlement region with a burgeoning, migrant, Quechua-speaking population. Due to recent completion of a highway linking the altiplano to this tropical lowland area, the migrants from the Andean highlands settling in the region constitute 80% of the 80,000 population and are seeking relief from the crowded and marginal agricultural areas of the Cochabamba highland and valley region.[3] Historically, tropical lowlands of Bolivia have not been settled---a major reason being the increased threat of endemic diseases. This fear is being realized with the influx of highland migrants to the lowland areas.

The health picture for Bolivia as a whole is a dire one, and that for the Chapare region is equally poor or worse, particularly for the less than five population.[4] The conventional health indicators of infant mortality rate (147/1000), crude death rate (19/1000), and life expectancy (47 yrs.) rank Bolivia at the bottom or second worse in Latin America in terms of general health status.[5] The morbidity and mortality pattern for the Chapare region of Bolivia is similar to that of rural areas of other developing countries, and like other LDCs, mechanisms for gathering precise disease/death data are non-existant or minimally operational. Gross estimates are obtained from the eleven provincial health centers, Unidades Sanitarias, which represent the public sector only. The private sector does not report any health statistics. Preventable, infectious diseases that are respiratory or gastrointestinal in nature represent the primary health problems, especially for the less than five population.[6] Concomitant with infectious disease is the pervasive incidence of malnutri-

tion that is present in varying degrees of severity.

The general impression from the literature for the Chapare area is an overall health status that is slightly worse than the Bolivian average in terms of conventional health indicators.*(see Weil study) Possible reasons for this situation include; exposure of the highland Indian population to new disease agents in the tropical lowlands, and, perhaps more importantly, the health consequences in the hot, humid lowlands of sanitation practices brought from the dry, cooler highlands.[7]

A general ranking of disease categories follows which illustrates the ambiguity of mortality classification.

Ten Leading Causes of Mortality Ages 1-4 Bolivia
(from M.O.H. Five Year Health Plan, 1973-78)

1.) poorly defined illness
2.) respiratory illness
3.) gastrointestinal illness
4.) pertussis
5.) diseases classified as infectious or parasitic
6.) scarlet fever
7.) measles
8.) perinatal illness, illness of infancy and nonclassified illness related to pregnancy
9.) allergies, nutrition, anemia and metabolic diseases
10.) accidents

Many of the disease areas represent challenges as public health programs---immunization, sanitation, and nutrition. Others might be affected more by a change in agricultural practices, levels of literacy or family economics than by modern medicine. In keeping with the scope of this analysis, however, solely health and related programs will be addressed to im-

*This impression is corroborated by the experience of Dr. Dolores Barbeau, a co-author of this study who has practiced in this area for over 10 years.

pact positively on the morbidity/mortality pattern for the region. A description of the present health system with its few strengths and many weaknesses follows.

Health System

The medical care system in Bolivia is fragmented with contrasts and inequities. The Bolivian Ministry of Health (Ministro de Prevención Social y Salud Pública) had a per capita expenditure of $0.40 U.S. in 1972.[8] This has increased somewhat since then but given the allocation of the total budget---78% urban and 22% rural---the rural majority of the population (70%) does not receive even this low per capita amount.[9] As long as most of the health budget goes to the urban areas, the rural health sector will lack the financial resources necessary to provide for equipment, drugs, maintenance, supervision and transportation, all of which are sorely needed to improve health care delivery.

Another indication of urban bias in the Bolivian health care system is the maldistribution of physicians, dentists and registered nurses with nearly 90% of these health professionals practicing in cities larger than 25,000 population. The work conditions for rural health providers are disincentives for long-term commitment. Initial training does not prepare them for the morbidity/mortality pattern of rural areas and their curative focus is ill-equipped to deal cost-effectively with such a disease environment. The low pay, poor working conditions and socio-economic and racial differences between provider and patient produce a rural health system that is shunned by health workers and patients alike. The general rural population prefers to use the traditional healers and empirical midwives (curanderos, parteras empíricas) who do not present the cultural, geographic and socio-economic barriers to access that government health workers present. Moreover, a feeling of confidence and mutual motivation pervades the relationship between curandero and Indian campesino which is

lacking for the most part in treatment situations involving government health workers and rural peasants.

Utilization data reflect the results of the above situation in that sanitary posts report 20-40 patient visits/mo., an average of one per day, and medical posts report 110 patient visits/mo. or an average of 4 per day.[10] Rural bed utilization rates average around 12%.[11] This gross underutilization is grimly ironic when contrasted to actual need for health services by the rural population.

In the Chapare area under study there are 3 small government hospitals, 2 medical posts (puestos médicos) and 5 sanitary posts (postas sanitarias) all under the jurisdiction of the provincial health entity, the Unidad Sanitaria. This is one of 11 provincial Unidad Sanitarias in the country. The medical posts and sanitary posts are differentiated by an M.D. on staff in the former and a practical nurse in charge in the latter. The staffing pattern, however, varies with each facility and is characterized by high turnover and inefficient use of auxiliary personnel. The obligatory one year rural service for medical students is partial cause for this turnover and also precludes physician involvement with the community for any length of time.

As indicated above the source of health care relied on by the Indian campesino population and estimated to provide nearly 95% of all patient encounters is the curandero and empirical midwife. These traditional health workers usually have learned their craft via an apprenticeship and vary in their skills (bone setting, minor surgery) and use of herbs or patent medicines. The traditional healer knows the patient and family and provides psychological support within a cultural context. Most

traditional healers are held in high regard and are the first source of health care when help is sought. Given this reliance on traditional health workers there is an urgent need to develop a health system that integrates both government and traditional sources of care to effectively reduce the preventable illnesses that comprise the disease profile for the Chapare area.

Disease Profile

A disease profile was developed for the approximately 80,000 population of Chapare, Bolivia, a predominantly rural area with pueblo concentrations no larger than 3000 persons. The basis for the disease profile data include a number of sources; Unidad Sanitaria data from the province of Cochabamba (includes Chapare), World Health Statistics Annual, United Nations Statistical Yearbook and empirical estimations made by Dr. Dolores Barbeau, co-author and practicing physician in the area under study. The profile encompasses 20 of the major diseases responsible for the bulk of morbidity and mortality of Chapare. Because of the major reliance on traditional health workers (curanderos, empirical midwives), this source of health care was included in the generation of the disease profile. However, the data used for the traditional source of health care in the disease profile is less accurate than the government health worker sector because of the lack of published information of this kind. Another caveat regarding data on the traditional source of health care is the mutually exclusive character of health care utilization, i.e. according to the disease profile people use either the government health posts, or, traditional workers but not both for a specific disease episode. This either/or situation probably does not reflect reality and ill persons might consult curanderos initially and then go to a government health worker or vice versa. This is assuming they seek any type of care at all outside of selfcare or no treatment. Also, choice of type of health source is disease-specific which is reflected in the profile.

The attached appendices are the disease profiles generated by the com-

puter for the current health system and the four proposed health programs. There are five tables for each disease profile which are the following:

Table 1 = Traditional Health Sector, Age-Specific Morbidity and Mortality Relative to Health Care Utilization and Effectiveness

Table 2 = Government Health Sector, Age-Specific Morbidity and Mortality Relative to Health Care Utilization and Effectiveness

Table 3 = No Health Care Sought, Age-Specific Morbidity and Mortality Relative to Health Care Utilization and Effectiveness

Table 4 = Summary of Total Disability by Age Group and Disease

Table 5 = Summary of Total Mortality by Age Group and Disease

The code terms used for each disease category of the computer printout are the following:

rate = annual rate or incidence of disease
cases = cases per year
XPSC = proportion seeking care
NUSC = number seeking care (XPSC x rate)
VC = visits per case or per illness episode
TOVT = total number of visits (XPSC x VC)
DLRX = days lost (disability days) with treatment per specified source
X = total days lost for each age group
CFRX = case fatality rate with treatment per specified source of care
S = deaths for each age group

The age-specific and disease-specific morbidity and mortality for the first disease profile (all 5 tables) gives an indication of the health status of the population with the present health system. See appendix 1. This basesline information can be used to check the effectiveness in terms of age specific morbidity and mortality of the alternative health programs. The age specific morbidity and mortality rate determined from the input data and listed in more detail in tables 4 & 5 of appendix 1 of the computer print-

out of the disease profile are summarized below:

Table 1

Age Group	Disability Days	Mortality Rate
0 - 1	27.6 per capita/yr.	168.3/1000 population
1 - 4	21.3 "	115 "
5 - 14	13.8 "	6.5 "
15 - 44 m	6.4 "	11.2 "
15 - 44 f	4.9 "	9.9 "
45+	5.0 "	23.6 "

As illustrated by these numbers, a major area of concern is the very high rate of infant and less than 5 yr. old morbidity and mortality. Deaths in the 0 - 5 year old range account for 77% of the total deaths. Age is a significant variable in relation to disease incidence and type of disease. Additional analysis of the profile in Appendix 1 indicates the principal causes of death by age group are the following:

Table 2

Age Group	Diseases
0 - 1	tetanus, measles, LRI (lower respiratory infection) gastroenteritis/ severe diarrhea, complications of pregnancy (birth)
1 - 4	menigitis, measles, LRI, gastroenteritis/severe diarrhea
5 - 14	accidents/trauma, menigitis, LRI, gastroenteritis/severe diarrhea
15 - 44m	accidents/trauma, tuberculosis, cholecystitis /pancreatitis, skin infections, silicosis, skin infections
15 - 44f	accidents/trauma, tuberculosis, cholecystitis/pancreatitis, skin infections, complications of pregnancy
45 +	accidents/trauma, silicosis, tuberculosis, LRI, cholecystitis/ pancreatitis, skin infections

Infectious and parasitic diseases have the highest incidence and case fatality rate among the young population. The focus of the health program alternatives is the less than 5 yr. population because of this high mortality

and preventable nature of the diseases. All of the data in the disease profile are subject to revision as more reliable statistics become available.

Resource Allocation - the inputs to decision making

In developing new health programs, decisionmakers must utilize the best available data to determine potential effectiveness of the respective programs. This effecteveness can then be assessed in relation to costs to enable a cost-effectiveness analysis of the alternative programs. This process requires the specific information outlined below as delineated by the developers of the U of Michigan/School of Public Health model used in this paper.

1.) population per age cohort
2.) attack rates of identified diseases (given no new programs of health promotion)
3.) public health promotional programs: specifications & expected benefits
4.) medical care, nontreatment or utilization of varied sources of care and clinical prognosis of disability days and case fatality rates for each
5.) cost estimates for each program component[12]

The population breakdown according to age is given in the table below:

Table 3

Age distribution Estimated for 80,000 Persons of the Chapare Region

Age Group	Number	% of Population
0 - 1	4500	5.6 %
1 - 4	13,500	16.8 %
5 - 14	20,400	25.5 %
15 - 44 m	16,800	21 %
15 - 44 f	16,800	21 %
45 +	8,000	10 %

The attack rates given no new programs are displayed in Appendix 1 along with medical care utilization,disability days and case fatality rate according to source of care. These are age and disease specific and are important

when discussing alternative strategies for health programs.

Essential to the development of alternative health programs are the characteristics of the target population, e.g. dependence on traditional healers, geographic remoteness of the population distribution and extremely low M.O.H. per capita expenditure characteristic of the Chapare region.

Four health promotional programs and their respective costs and effectiveness are reviewed in the following pages. The original disease profile is altered by estimating the impact each individual program alternative will have on the current attack rate, utilization rate, disability days, and mortality rate. These new disease profiles (Appendices 2 - 5) are then contrasted in view of effectiveness and alternate budget levels.

Program Alternatives

Four different health programs are posited and discussed below. They are not additive nor viewed in combination, although this is possible. Two of the programs are changes in the delivery of health care while the sanitation and nutrition interventions are preventive public health programs that utilize the existing medical care delivery structure. The objective of the four programs is to reduce the high morbidity and mortality of the under five population.

I. Training of Empirical Midwives and Traditional Healers

As indicated earlier, there is greater accessibility to and use of traditional health workers because of fewer cultural, financial and geographic barriers as compared to formally educated, government health workers. Because of this, integration of the two health systems offers great potential. In this program, a portion of the two major groups of informally trained health workers - the empirical midwives and the traditional healers (curanderos) - would receive additional formal training and equipment to improve their effectiveness.

Eighty traditional midwives would receive 2 weeks of initial training and on-site refresher courses from their supervisors throughout their service. This allows one midwife per 55 live births in the region under study. The midwives would be supervised by four graduate or registered nurses and receive midwifery kits to aid them in their tasks. These tasks would be mainly preventive oriented and include:

1.) pre and post natal well baby care (referral if high risk)

2.) delivery of normal births
3.) weighing and measuring children to detect growth deficiencies
4.) oral rehydration therapy (non intervenous)
5.) informal education of mothers regarding home oral rehydration therapy, nutrition hygiene, food preparation
6.) dispensing simple drugs
7.) referral of complex cases
8.) birth and death record-keeping

Formal training would stress key areas such as sanitary techniques in delivery, review of traditional practices to identify those which are beneficial, innocuous or harmful, and early recognition of complex cases for referral to a clinic or hospital. Because of their position of influence in the community, the empirical midwives are a potential source of quality health care which could reach many women and children.

The traditional midwives would receive a stipend of $100 US per year and allowance would be made for bag/equipment maintenance and updating. They could charge for their services or be paid in kind as is now the custom. The stipend would cover opportunity cost for the midwife and also drug supply costs.

The second part of the program addresses the curanderos. Twenty-five traditional healers would receive 3 weeks initial training and on-site refresher training from their supervisors throughout their service. Supervision would be provided by 2 graduate nurses (R.N.s), preferably of the same sex as the majority of the curanderos. First aid kits would be provided with aspirin, vitamins, analgesics, antiparasitics, simple antibiotics, basic antitubercular medication, oral rehydration packets and simple primary care instruments. Treatment of symptoms would be stressed along with

referrals of more serious cases or those cases that are not improving. In like manner, government health workers could refer those patients they feel have health problems more appropriate to treatment by traditional healers. Similar to the midwives, the curanderos would be paid monetarily or in kind and receive a $100US stipend per year to offset drug costs. It is assumed that both groups would work on a part-time basis and maintain some farming and domestic activities.

II. Auxiliary Nurses

This proposal calls for the training and employment of fifty auxiliary nurses in addition to present government health personnel in the Chapare region. These nurses would have a minimum eighth grade education and receive 6 months training in preventive and curative health at the local government hospital. They would be employed by the government full-time and supervised by 4 graduate nurses who would provide on-site refresher training. The auxiliary nurses would be curative oriented and work out of their homes with much outreach activity. Duties would include:

1.) simple diagnosis, treatment and/or referral to medical post or hospital when necessary
2.) participation in immunization programs and immunization maintenance
3.) dispense drugs
4.) pre and post natal well baby care
5.) delivery of normal births
6.) oral rehydration therapy
7.) informal education of mothers on hygiene, food preparation, gardens etc.
8.) record keeping of all cases, along with births and deaths

Auxiliary nurses would receive a salary of $80US per month and would not charge for their services. However, there would be a slight charge for drugs via a voucher system which the government would use to replenish the drug supply.

III. Sanitation Program

The sanitation intervention includes the development of a potable water supply, hygiene education and pit latrine construction. Data from a research community in the Chapare region indicated no potable water supply, and water for drinking, cooking and washing was taken directly from streams and ponds. In addition, the few latrines in existence were open shallow pits.[13] Data from the National Water Supply Plan attributes 45% of the mortality rate to unsanitary conditions. When causes of morbidity are broken down by age and department, dysentery and gastroenteritis rank second only to undefined causes for morbidity among children in both the less than one year age group and the one to four year age group in Cochabamba.[14] As mentioned earlier, it is postulated that the sanitation habits brought from the highlands have deleterious health effects when practiced in the lowland areas. Water supply is a case in point in that mountainous streams are less likely to be contaminated as compared to lower altitude water sources.

The sanitation proposal would provide one gravity system potable water supply per 200 population with house connections for each family. Studies done indicate the advantages of house connections over public taps in terms of health benefits (greater use, less chance of transport contamination) are overwhelming and the former should be chosen when there is less than a $5US per capita differential in price.[15] Data from an AID project indicate a $36 per capita cost for a house connection and $34 per capita cost for a public tap per 200 population.[16] House connections would then be recommended for the Chapare region with a total of 400 systems. (80,000 ÷ 200 = 400)

Pit latrines would be constructed for each family (average size of six members) at a cost of $25 US each which includes hole excavation, adobe walls and roof, concrete slab and commode.[17] The family will contribute to its construction and maintenance.

A review of the literature indicates a key component of any sanitation program is education concerning hygiene practices and proper use of potable water sources, sewage and excreta disposal systems. One hundred (1 per 4 systems or 800 pop.) sanitarians would be responsible for this educational aspect of the sanitation intervention in addition to co-ordinating latrine and gravity system construction and maintenance. This education component would include the transmission of diseases by water and sewage, personal/family hygiene, food preparation and storage and safeguards against flooding. Sanitarians would work on a one-to-one or group basis, depending on how they perceived their effectiveness. Supervision and continuing education for sanitarians would be provided by 4 individuals with advanced training and supervisory skills. The sanitarians and their supervisors would be government employees on a salary.

The use of primary school teachers would be encouraged to emphasize the importance of good hygiene to school children in the classroom and their parents in the community-at-large. Given their status within the community and short working days, they are ideal change agents to promote a sanitation program. This could be easily facilitated by the involvement of the Rural Teachers Training School in Chapare and the Ministry of Education.

IV. Nutrition Program

The rationale for a nutrition program lies in the fact that Bolivia ranks lowest in food/nutrient intakes in Latin America and the rural magnitude of malnutrition corroborates this fact. Actual PCM incidence is calculated to range from 60-65% with approximately 40% I degree, 15-20% II degree and 5% III degree. In addition, the per capita income of $235 US can afford only 52% of an average family's recommended calorie levels and an estimated 66% of families live far below income levels capable of purchasing minimum nutrition requirements.[18] Height/weight data from research in the Chapare region revealed nearly 75% of the 1-4 population were moderately or severely stunted - low height for age and evidence of past undernutrition. This was especially noted in the female toddler population.[19]

The nutrition intervention would provide forty agricultural extensionists and forty nutrition extensionists to upgrade farming and diet practices, respectively. In addition, fortified food packets for high risk*, pregnant or nursing women and high risk children less than five years would be distributed by the nutrition extensionists.

The forty agricultural extensionists (1 per 2000 pop. or 333 families) would instruct small groups of campesinos on how to improve their efficiency and productivity via erosion control, use of local fertilizer, small scale irrigation, crop rotation, etc. A small volume of seeds and fertilizer would be provided on a one-time basis to each family. One supervisor would oversee the activities of the extensionists and offer on-site refresher training and continuing education.

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*High risk would translate to one or more of the following factors: low income, high birth order, absence of a parent, previous history of PCM.

Forty nutrition extensionists would implement instruction in kitchen gardens, the raising of small animals/ fowl for food, food preparation, family nutrition and weaning foods. Again, a small volume of seeds would be distributed on a one-time basis to facilitate the instruction and learning process. Growth charts and scales would be used in non-formal education settings, such as women's clubs, to illustrate the importance of good nutrition and describe the warning signals of PCM.

Again, the primary school teachers of the area could be utilized in nutrition education for their students and directing animal feeding projects in the classroom.

Assessment of the Alternatives - Effectiveness and Costs

I. Effectiveness

Each alternative is assessed as to how it affects the various categories in the disease profile for each disease. In the first health program posited, it is assumed the training of traditional healers and empirical midwives will increase their effectiveness and utilization. This increases the percent seeking care and decreases the morbidity and mortality for many disease categories in the traditional health sector.* In addition, the incidence rate for tetanus and malnutrition is shown to decrease 50% and 25% respectively, because of more sterile procedures being used by the now formally trained midwives and the nutrition education performed by the midwives. Gastroenteritis also decreases slightly with the activities of the midwives. It is assumed that the government health sector part of the profile will not be affected, except for the changed incidence rates for tetanus, gastroenteritis and malnutrition.

In the case of the second health program posited - the training of auxiliary nurses - there is an increase in the per cent seeking care in the government health care sector for many disease categories. Since these auxiliary nurses will be working in the remote communities which they are from, the change in accessibility will be both cultural and geographic. Malnutrition incidence is postulated to decrease by 25% because of nutrition education and oral rehydration performed by the auxiliary nurses. The incidence of gastroenteritis and complications of pregnancy also decrease

*The estimates for the increase in per cent seeking care, decrease in morbidity/mortality, and decrease in incidence rates for the traditional health worker program and auxiliary nurse program were made with the assistance of Dr. Jan deVries, co-developer of the model from the School of Public Health at the University of Michigan.

with the activities of the auxiliary nurse program. The immunizable diseases of tetanus and pertussis will decrease in incidence by the following amount because of auxiliary nurse participation in immunization outreach programs:[20] (see Appendix 3).

tetanus: 95% efficacy x 60% estimated coverage = 57% reduction or 43% reduction factor

e.g.	age group	current incidence	incidence after immunization
	0-1	.04	.04 x .43 = .017

pertussis: 80% efficacy x 60% estimated coverage = 48% reduction or 52% reduction factor

e.g.	age group	current incidence	incidence after immunization
	0-1	.03	.03 x .52 = .015

The 60% estimated coverage is the per cent of the population that will receive sufficient dosages of the vaccine to allow seroconversion. The efficacy factor is the % that actually do seroconvert of those receiving the vaccine.

In the sanitation program the effectiveness measures focus only on incidence rates for disease because there is no change in the structure of health service delivery or medical care organization. The components of the sanitation program will affect the incidence rates of the following water-borne /transmitted diseases.[21]

typhoid	incidence per person per year without sanitation*	with sanitation**
0-1 yr	.001	.0002 (80% reduction)
1-4	.002	.0004 " "
5-14	.016	.0032 " "
15-44 m	.005	.001 " "
15-44 f	.005	.001 " "
45 +	.001	.0002 " "

*see original disease profile for Chapare, Bolivia - Appendix 1

**see disease profile with sanitation intervention - Appendix 4

amebiasis	incidence per person per year without sanitation	with sanitation
0-1 yr	.001	.0005 (50% reduction)
1-4	.067	.0335 " "
5-14	.1	.05 " "
15-44m	.2	.1 " "
15-44f	.2	.1 " "
45 +	.05	.025 " "
helminthiasis		
0-1 yr	.4	.2 (50% reduction)
1-4	.53	.265 " "
5-14	.7	.35 " "
15-44m	.67	.335 " "
15-44f	.67	.335 " "
45 +	.8	.40 " "
gastroenteritis/ severe diarrhea		
0-1 yr	.40	.2 (50% reduction)
1-4	.50	.25 " "
5-14	.05	.025 " "
15-44m	.01	.005 " "
15-44f	.01	.005 " "
45 +	.01	.005 " "
skin infections		
0-1 yr	.1	.05 (50% reduction)
1-4	.33	.165 " "
5-14	.25	.125 " "
15-44m	.166	.083 " "
15-44f	.166	.083 " "
45 +	.20	.10 " "

In the nutrition program the incidence of malnutrition is assumed to decrease by 60% for the under 5 yr. population.[22] The case fatality rate with and without treatment (for both traditional and government sectors) decreases by 45% for measles with the nutrition program and the incidence of severe diarrhea is reduced by 27% as illustrated:[23]

Table 5

Severe Diarrhea	Incidence per Person per yr with current nutritional level	Incidence per Person per yr with no Malnutrition	Incidence per Person per yr w/ malnutrition reduced 60%
0-1 yr	.40	.220	.292
1-4 yr	.50	.275	.365

Measles	Case Fatality Current Nutritional Level			Case Fatality with Malnutrition reduced 60%		
	with treatment		no treatment	with treatment		no treatment
	govt.	traditional		govt.	traditional	
0-1 yr	3.0	8.0	10.0	1.65	4.4	5.5
1-4 yr	2.0	5.0	6.0	1.1	2.75	3.3

II. Costs of the Programs

The following is a description of the approximate costs of the programs in 1979 dollars. Staff training, equipment and supplies are part of investment or one-time costs, while salaries, maintenance and supplies' update are part of operating or recurrent costs. For the purpose of this analysis cost estimates are evaluated over a five year period. This is done by adding the investment costs and the operating costs and dividing the total by five. In addition, the population size is divided into this figure to obtain the per capita cost.

Costs - Health Program I - Training of Empirical Midwives and Curanderos

A.)80 Midwives - 1 per 55 live births;* 2 wks training, 4 supervisors

one-time costs

training i. payment for attending @ $45/midwife	$3600
ii. room, board, materials, instruction @$75/midwife	$6000
iii. 4 supervisors @$900/yr/sup x 3 yr.	$10800
midwife kit[24] @ $19.68/kit	$1574.4
drugs:	
aspirin @ 1.84/midwife	147.2
ferrous sulfate @ 1.27/mw	101.6
multivitamins @ 2.98/mw	238.4
oral rehydration packets @ 7.00/mw	560
antiparasitics @ 8.53/mw	682.4
antihelminthic @ 5.36/mw	428.8
other miscellaneous @ 15.00/mw	1200
bikes for 4 supervisors @ 130.00/bike	520
	$25,853

recurrent costs

stipend @ $100.00/yr/midwife	$ 8000
salary for 4 supervisors @ 150.0/mo/sup	7200
maintenance of kits, bikes & updating supplies (other than drug supply) $500/yr	500
	$15,700 per yr x 5 = $78,500

*assumption of zero attrition rate

B.) 25 Curanderos - 3 wks training with on-site refresher training, 2 supervisors

one-time costs

training i. payment for attending @ $55/curandero	$1375
ii. materials, instructors @ $100/cur	2500
iii. 2 RN supervisors $900/sup/yr x 3 yrs.	5400
1st aid kit @ $15/kit	375
drugs: asprin @ 1.84/cur	46.00
vitamins @ 2.98/cur	74.5
analgesics @ 6.00.cur	150.00
antiparasitics @ 13.89/cur	347.25
zinc oxide @ 2.24/cur	56.00
antitubercular med. @ 2.76/cur	69.00
antibiotics @ 34.04/cur	851.00
O.R. packets @ 3.50/cur	87.5
other misc. @ 15.00/cur	375.0
bikes for 2 supervisors @ $130/bike	260.0
	$11,966

recurrent costs

stipend @ $100/yr/curandero	$2500
salary for 2 supervisors @ $150/mo/sup	3600
maintenance of kits, bikes & supply update $250/yr	250
	$6350 per yr x 5 = $31,750

Average per capita cost over 5 yr. period

	$25,853
	78,500
	11,966
	31,750
	$148,069/5 yr/80,000 pop.
	= $0.37 per capita cost

The training of traditional health workers program has a per capita cost of $0.37 US.

Costs - Health Program II - Training of Auxiliary Nurses

50 Auxiliary Nurses - 6 mos. training, 3 RN supervisors

one-time costs

training of 50 auxiliary nurses @ $300/nurse	$15,000
50 nurses kits @ $42.66/kit	2133
3 yr. training of 3 supervisors @ $900/yr/sup	8100
3 bikes for supervisors @ 130/bike	390
vaccines for 1-4 yr pop.* (60% coverage = .6 x 13500) $1.05[25] x 8100	8505
	$34,128

recurrent costs

salaries:	
50 aux. nurses @ $80/mo/aux.nurse	$48,000
3 supervisors @ 150/mo/sup.	5,400
drugs @ $94.15/aux. nurse	4,707.5
other supplies @ $25/aux. nurse	1,250
maintenance immunizations for less than 1 yr. pop. (.6 x 4500) x cost per child $1.05 x 2700	2,835
transportation @ $50/yr/aux. nurse	2,500
bike, kit maintenance $500/yr	500
	$65,193 per year
	x 5 = $325,965

Average per capita cost over five year period

34,128
325,965
$360,093/5 yr/80,000 pop.
=.90 per capita cost

The training of auxiliary nurses program has a per capita cost of $0.90 US.

*thereafter only maintenance immunizations for under one year old population.

Costs - Health Program III - Sanitation

one pit latrine per family, potable water supply with house connections (one system per 200 pop.), 100 sanitarians with 4 mos. training (one sanitarian per 4 systems), 4 supervisors

one-time costs

training i. 100 sanitarians @ $300/sanitarian	$30,000
ii. 4 supervisors @ $600/sup.	2,400
13,333 pit latrines @ $25/latrine[26]	333,333
4 bikes for supervisors @ $130/bike	520
gravity system @ $36 per capita (80,000 pop.)	2,880,000
	$3,246,253

recurrent costs*

Salaries:	
100 sanitarians @ $80/mo	$96,000
4 supervisors @ $115/mo	5,520
bike and materials' maintenance @ $100/yr	100
	$101,620 per yr x5 = $508,100

Average per capita cost over 5 year period	3,246,253
	508,100
	$3,754,353/5 yr./ 80,000 pop.
	= $9.38 per capita cost

The Sanitation Program has a per capita cost of $9.38

* maintenance costs of latrines and water supplies will be assumed by communities

Costs - Health Program IV - Nutrition

A.) 40 agricultural extentionists
1 supervisor

one-time costs

training i. 40 agricultural extensionists @ $200/agr. ext.	$8000
ii. 1 supervisor @ $600/sup.	600
tools:[27]	
machete @ 1.78/exten	71.2
hoe/cultivator @ 6.10/exten.	244
spade @ 2.26/exten	90.4
seeds and fertilizer per family @ $1.00/family	13,333
bike for supervisor @ $130/bike	130
	$22469

recurrent

salaries: 40 agric. extensionists @ $70/mo/exten.	33,600
1 sup. @ $100/mo/sup	1,200
tool maintenance @ $25/exten.	1,000
	$35,800 per yr
	x 5 = $179,000

B.) 40 nutrition extensionists
1 supervisor

one-time costs

training i.40 nutrition extensionists @ $200/nutr.ext.	$8000
ii. 1 supervisor @ $600/sup.	600
equipment:	
education materials (nutrition, growth charts) @ $100/nutr. exten.	4000
scales @ 32.98/nutr. exten.	1319.2
kitchen garden demonstration materials @ 20.00/nutr. exten.	800
seeds @ 0.25/family	3333
bicycle @ $130/bike for sup.	130
	$18,182

recurrent costs

salaries: 40 nutrition extensionists @ $70/mo/nutr. exten.	$33600
1 supervisor @ $100/mo/sup.	1200
equipment maintenance @ $25/nutr. exten.	1000
monthly food supplements for 1500 women & children @ $2.04 per capita[28]	36800
	$72,600 per yr
	x 5 = $363,000

Average per capita cost over 5 year period	$22,469
	179,000
	18,182
	363,000
	$ 582,651/5 yr/80,000 pop. = $1.45 per capita

The nutrition program has a per capita cost of $1.45 US.

Comparison of Alternatives

Since the reduction of infant and childhood mortality is the major goal of the health programs, comparison of programs will focus on the reduction in mortality rates and days of incapacitation for the 0-1 and 1-4 year age groups. Below is a table with expected outcomes for each of the health programs with full coverage and no set budget, i.e. each program is completely implemented.

Table 6

mortality = rate per 1000 disability days = rate per capita

	total mortality	0-1 mortality	1-4 mortality	total disablity	0-1 disability	1-4 disability
Current Health System	37.2	168.3	115	11.5	27.6	21.3
Alt. I trad.	25.8	112.8	70.2	10.6	25	18.3
Alt. II aux. nur.	26.9	104.7	78.5	9.8	20.5	16.7
Alt. III san.	25.6	120.4	67	9.6	24.2	16.4
Alt. IV nutr.	22	103.7	46.1	9.2	14	12.1

With no set budget one can see that alternative IV, the nutrition program, is better than the other health programs in terms of reduction in the mortality and disability days in all the above categories.

Given the cost range for the various programs earlier - $0.37 per capita for Alt I, $0.90 per capita for Alt.II, $9.38 per capita for Alt. III, and $1.45 for Alt. IV - and the low Ministry of Health per capita expenditure, one must examine the effectiveness of the proposed health programs at budget levels that do not provide for full implementation. In this manner, given a specific budget level the cost effectiveness can be determined for each program.

The per capita budget levels of $0.50, $0.75, $1.00 and $1.25 will be examined to determine the cost effectiveness ranking of the proposed programs at these budget levels.[29]

Table 7

Expected Effectiveness - $0.50 per capita budget - $40,000 total

	total mortality	0-1 mortality	1-4 mortality	total disability	0-1 disability	1-4 disability	cover-age
Current Health System	37.2	168.3	115	11.5	27.6	21.3	-----
Alt. I trad.	25.8	112.8	70.2	10.6	25	18.3	100%
Alt. II aux. nur.	32.6	139.7	98.6	10.7	24.4	19.2	45%
Alt. III san.	36.6	165.9	112.6	11.4	27.4	21.3	5%
Alt. IV nutr.	32.0	146.3	91.6	10.7	23.0	18.2	34%

At the $0.50 budget level Alt. I, the training of traditional health workers, is the most cost-effective program in terms of total mortality and age-specific mortality reduction. Age-specific disability days are slightly less with Alt. IV, the nutrition program, however, for purposes of this analysis, reduction in mortality will take precedence over disability reduction. The excess budget of $10,400 could be used for other health programs. (Alt. I cost of $0.37 per capita with budget level of $0.50 per capita = $0.13 per capita excess budget or $10,400 total).

At the next budget level of $0.75 per capita, the following are the results in Table 8.

Table 8

Expected Effectiveness - $0.75 per capita budget - $60,000 total

	total mort.	0-1 mort.	1-4 mort.	total disab.	0-1 disab.	1-4 disab.	population coverage	excess budget
Current Health System	37.2	168.3	115	11.5	27.6	21.3	------	------
Alt. I trad.	25.8	112.8	70.2	10.6	25	18.3	100%	0.38 per capita
Alt. II aux. nur.	28.7	115.6	84.7	10.1	21.7	17.5	83%	-------
Alt. III san.	36.3	164.5	111.2	11.3	27.3	20.9	8%	-------
Alt. IV nutr.	29.3	134.7	79.2	10.3	20.5	16.5	52%	--------

Again, Alt.I is the preferred choice with the criterion of mortality reduction. Alt.II & Alt. IV are more effective in disability days reduction even when coverage is less than 100%. However, for the purposes of this analysis, disability reduction will be a secondary criterion. (If one were considering productivity, disability days would take on more importance.) Again there is excess budget for other health programs with Alt. I at this budget level. The following illustrates the $1.00 per capita budget.

Table 9

Expected Effectiveness - $1.00 per capita budget - $80,000 total

	total mort.	0-1 mort.	1-4 mort.	total disab.	0-1 disab.	1-4 disab.	population coverage	excess budget
Current Health System	37.2	168.3	115	11.5	27.6	21.3	------	-----
Alt.I trad.	25.8	112.8	70.2	10.6	25	18.3	100%	0.63 per capita
Alt. II aux. nur.	26.9	104.7	78.5	9.8	20.5	16.7	100%	0.10 per capita

(Table 9 cont.)

	total mort.	0-1 mort.	1-4 mort.	total disab.	0-1 disab.	1-4 disab.	population coverage	excess budget
Alt. III san.	35.9	163.0	109.7	11.3	27.2	20.8	11%	-------
Alt. IV nutr.	26.7	123.7	67.5	9.9	18.2	15.0	69%	-------

At the $1.00 per capita budget level, the ranking of programs is not so clear cut. As is shown above, Alt. I still has the lowest overall total mortality. However, Alt. II has the lowest 0-1 mortality rate and total disability rate, while Alt. IV has the lowest 1-4 mortality rate in addition to the lowest age-specific disability rate. In this situation, using a straight total mortality criterion, Alt. I is preferred. However, a focus on the less than five population mortality might lead to a preference for Alt. II or IV. Table 10 illustrates program effectiveness at the highest budget level used in this discussion.

Table 10

Expected Effectiveness - $1.25 per capita budget - $100,000 total

	total mort.	0-1 mort.	1-4 mort.	total disab.	0-1 disab.	1-4 disab.	population coverage	excess budget
Current Health System	37.2	168.3	115	11.5	27.6	21.3	--------	-------
Alt. I trad.	25.8	112.8	70.2	10.6	25	18.3	100%	0.88 per capita
Alt. II aux. nur.	26.9	104.7	78.5	9.8	20.5	16.7	100%	0.35 per capita
Alt. III san.	35.7	162.1	108.8	11.3	27.2	20.7	13%	-------
Alt. IV nutr.	24.1	112.7	55.7	9.5	15.9	13.4	86%	-------

At the $1.25 per capita budget level Alt. IV has the greatest mortality and disability reductions save for one category - the mortality rate of the 0-1 population. Alt. II has the lowest rate in this age group. In all probability Alt. IV would be the preferred health program at this budget level because of the categories of mortality reduction. See Table 13 also for a complete ranking by individual categories and budget level.

Major areas for further investigation come to mind when observing the various budget levels and/or excess budgets in regard to optimum program mix. What is the most cost-effective manner to allocate excess budgets to other health programs?, and/or, Can programs be mixed and funded at levels that are less than 100% for any one program yet yield mortality/morbidity reductions that are greater than those reductions achieved with 100% funding of any one program? This suggests a synergistic effect among programs and the effectiveness calculations would have to be changed to include various program mixes to begin to address these questions.

Sensitivity Analysis of Inputs

> The ranking of alternative rural health programs is determined by the interaction of numerous inputs (utilization rates, attack rates, cost calculations, and other values) about which there is considerable uncertainty. The stability of the program rankings to variations of the values of inputs within reasonable ranges, helps us to evaluate the relative importance of accuracy in the estimated inputs...When the ranking of the preferred program is sensitive to changes of the assumptions, then research to improve the accuracy of these inputs is indicated. Where ranking is insensitive to changes in assumed input values, within a reasonable range, greater precision is less important.[30]

There are sundry ways to change the various inputs. Combinations of increasing or decreasing one or more inputs within various ranges at varying budget levels may change the health program ranking. In this discussion the highly "undominated" programs of training traditional health workers and nutrition will be changed to test the robustness of their preferred ranking.[31] To do the actual sensitivity analysis the inputs to these two programs are changed in the computer program of the model and compared at a similar budget level.

Major areas of uncertainty in the input calculations are in regard to effectiveness and cost calculations. This is especially true for the training of traditional health workers. Their effectiveness and potential for integration with the government health system are contentious issues. The per cent seeking care (related to perceived effectiveness) and the case fatality rate for the traditional health worker program were halved to determine the effect this would have on program ranking. Table 11 illustrates the results at the $0.75 budget level.

Table 11

Expected Effectiveness with Changes in Traditional Health Worker Effectiveness

$0.75 budget per capita

	total mort.	0-1 mort.	1-4 mort.	total disab.	0-1 disab.	1-4 disab.	population coverage	excess budget
Current Health System	37.2	168.3	115	11.5	27.6	21.3	-------	-------
Alt. I trad.	34	152.2	102.8	11.2	26.7	20.3	100%	0.38 per capita
Alt. II aux. nur.	28.7	115.6	84.7	10.1	21.7	17.5	83%	-------
Alt. III san.	36.3	164.5	11.2	11.3	27.3	20.9	8%	-------
Alt. IV nutr.	29.3	134.7	79.2	10.3	20.5	16.5	52%	-------

As this illustrates, Alt. I loses its preferred ranking when subject to changes in effectiveness inputs. Alt. II now has the lowest total mortality and age-specific categories of disability days.

A change in the effectiveness of the nutrition program on the key diseases it theoretically affects (measles, gastroenteritis/severe diarrhea) changes the ranking of this program at the $1.25 per capita budget level using a mortality reduction criterion. Changes were made by imposing a 25%-50% decrease in effectiveness for case fatality rates (measles) and the incidence rates, disability rates and case fatality rates for gastroenteritis/severe diarrhea. This translates to an increase for all these values. This is illustrated in Table 12 at the $1.25 budget level per capita.

Table 12

Expected Effectiveness with Changes in Nutrition Program Effectiveness

$1.25 per capita budget

	total mort.	0-1 mort.	1-4 mort.	total disab.	0-1 disab.	1-4 disab.	population coverage	excess budget
Current Health System	37.2	168.3	115	11.5	27.6	21.3	-------	------
Alt. I trad.	25.8	112.8	70.2	10.6	25	18.3	100%	0.88 per capita
Alt. II aux. nur.	26.9	104.7	78.5	9.8	20.5	16.7	100%	0.35 per capita
Alt. III san.	35.7	162.1	108.8	11.3	27.2	20.7	13%	------
Alt.IV nutr.	30.1	139.6	94.1	10.4	20.6	17.1	86%	------

Cost calculation is a major area of uncertainty regarding health program ranking. The cost of sanitation is prohibitive at the cost per capita of $9.38 and even a reduction by 50% in cost does not give it preferred ranking at the highest budget level of $1.25 in this analysis. It is unlikely that a sanitation system could be implemented at a lower cost level with the same morbidity/mortality reductions seen here. However, the other programs are sensitive to changes in their cost which changes their resultant ranking. The following table illustrates the change in ranking with a change in budget level which bears directly with the estimated costs of each program.

Budget Level Per Capita*	Total Mortality	0 - 1 Mortality	1 - 4 Mortality	Total Disability	0 - 1 Disability	1 - 4 Disability
$0.50	Alt.I,25.8 " IV,32.0 " II,32.6 "III,36.6	Alt.I,112.8 " II,139.7 " IV,146.3 "III,165.9	Alt.I,70.2 " IV,91.6 " II,98.6 "III,112.6	Alt.I,10.6 " II,10.7 " IV,10.7 "III,11.4	Alt.IV,23.0 " II,24.4 " I,25.0 " III,27.4	Alt.IV,18.2 " I,18.3 " II,19.2 " III,21.1
$0.75	Alt.I,25.8 " II,28.7 " IV,29.3 "III,36.3	Alt.I,112.8 " II,115.6 IV,134.7 "III,164.5	Alt.I,70.2 " IV,79.2 " II,84.7 "III,111.2	Alt.II,10.1 " IV,10.3 " I,10.6 III,11.3	Alt.IV,20.5 " II,21.7 " I,25.0 " III,27.3	Alt.IV,16.5 " II,17.5 " I,18.3 " III,20.9
$1.00	Alt.I,25.8 " IV,26.7 " II,26.9 "III,35.9	Alt.II,104.7 " I,112.8 " IV,123.7 " III,163.0	Alt.IV,67.5 " I,70.2 " II,78.5 " III,109.7	Alt.II,9.8 " IV,9.9 " I,10.6 " III,11.3	Alt.IV,18.2 " II,20.5 " I,25.0 " III,27.2	Alt.IV,15.0 " II,16.7 " I,18.3 " III,20.8
$1.25	Alt.IV,24.1 " I,25.8 " II,26.9 " III,35.7	Alt.II,104.7 " IV,112.7 " I,112.8 " III,162.1	Alt.IV,55.7 " I,70.2 " II,78.5 " III,108.8	Alt. IV,9.5 " II,9.8 " I,10.6 " III,11.3	Alt.IV,15.9 " II,20.5 " I,25.0 " III,27.2	Alt.IV,13.4 " II,16.7 " I,18.3 " III,20.7

Alt. I = training for traditional health workers

Alt.II = auxiliary nurse program

Alt.III= sanitation program

Alt. IV= nutrition program

*all monetary figures in U.S. dollars

As can be seen from Table 13, Alt. I and Alt. IV change positions for the preferred program at the lowest and highest budget level for both total mortality and disability days reduction. It is assumed the costs for Alt. I are so low because of the minimal training, equipment and stipend required for the traditional worker program. This is subject to revision and should be an area for further investigation. The costs for the nutrition program are related to one type of nutrition intervention and have a high cost food supplementation component that is recurrent. Perhaps there are other nutrition programs that are as effective at a lower cost. Further research is needed in the areas of, 1.) effectiveness and actual success of training traditional health workers, 2.) effectiveness of nutrition programs with and without a food supplementation component, and, 3.) reliable cost figures for programs of the nature described in this analysis.

Conclusion

From the above data, there are clear preferences for programs at the lowest and highest budget levels. The training of traditional workers is preferred at the $0.50 per capita level and the nutrition program at the $1.25 per capita budget level. In between these budget levels there are no clear choices because the ranking varies by mortality or disability category. The ranking then varies by the criterion used, e.g. 0-1 mortality, 1-4 mortality, total disability days. (see Table 13)

Generally speaking, Alt. I is the most cost-effective at the lower budget levels. Alt. IV is the most cost-effective at all budget levels using the age-specific disability days criterion. The sanitation program is the most expensive and least cost-effective in every category at all budget

levels and is completely dominated except when fully implemented.

The criteria used to rank programs are dependent on the policy-makers' values and result in substantial differences in selecting preferred health programs. In addition, the budget level allocated to the health sector (and actually expended in rural areas) will change the preference ranking of cost-effective programs. The budget level for health is a function of a society's resources and the perceived value of health relative to other sectors.[32] A strictly technocratic answer is not possible to questions of optimal resource allocation, but model analysis as the one presented here can postulate policy effects. The manner in which these policy effects are perceived and subsequent programs implemented is dependent on the ideology of a society's decisionmakers.

REFERENCES

1.) Grosse, R., deVries, J., Tilden R., Dieveler, A., Day, S., A Health Development Model Application to Rural Java, Department of Health Planning & Administration, University of Michigan, Ann Arbor, 1979.

2.) Ibid., 7-8.

3.) Weil, Connie, "Morbidity, Mortality and Diet As Indicators of Physical and Economic Adaptation Among Bolivian Migrants" Social Science and Medicine, 1979; vol. 13D; 215-222.

4.) Ibid., 215.

5.) U.S. Department of State, A.I.D. Project Paper Bolivia - Rural Sanitation, Proposal and Recommendations for the Review of the Development Loan Committe, Washington D.C. March 1979 p. 1.

6.) Frerichs, Ralph R., Becht, James N., Foxman, Betsy, "Prevalence and Cost of Illness Episodes in Rural Bolivia" International Journal Epidemiology Vol. 9; 3; 233-238.

7.) Op Cit., Weil, C., 215.

8.) WHO/IBRD Cooperative Program Bolivia: Water Supply and Sewerage Sector Study Vol. I; Latin American and the Caribbean Regional Office, April 1975; p. 10.

9.) Le Bow, Robert H., Consultants Report; The Rural Health System in Bolivia, US/AID August 1974.

10.) Ibid., 18.

11.) Ibid., 19.

12.) Op Cit., Grosse et al. 27.

13.) Op Cit., Weil, C., 215.

14.) Op Cit., U.S. Department of State (reference #5) p. 1.

15.) Ibid., p. 61.

16.) Ibid., p. 65b.

17.) Ibid., p. 44.

18.) Grewal, Tina, Report on Nutrition Program Analysis for Bolivia CARE Inc., unpublished report Nov., 1975; 3.

19.) Op Cit., Weil, Connie, p. 218.

20.) World Health Organization, Expanded Program In Immunization, Programming Manual, Geneva, EPI/G/77.1 p.2.I.3.

21.) Saunders, Warford, Village Water Supply; Economics and Policy in the Developing World Johns Hopkins University Press, Baltimore, p. 93. also from White, Bradley and White, Drawers of Water; Domestic Water Use in East Africa University of Chicago Press, Chicago p. 191.

22.) Op Cit., Grosse et al. Estimate from Java study for similar nutrition program. p.30.

23.) Originally cited in Java Study:
Sojogyo, Nutrition Guidance Project for Village Population: Report for Second Year (1976/77), Agricultural Foundation 1976.
Drake, William D., and Farjardo, Luis F., The Promotura Program in Candeloria: A Colombian Attempt to Control Malnutrition and Disease
Morley, David, Pediatric Priorities in the Developing World Butterworth press Boston 1973; 207.

24.) kits, drugs, bicycle cost estimates from UNICEF Guide List RANI A Composite List of Equipment and Supplies for Peripheral Health Facilities U.N. New York and UNIPAC United Nations Childrens's Fund Supply Division, Packing and Assembly Centre 1979/80.

25.) cost per fully immunized child from, Barnum, Howard, N., Cost Effectiveness of Programs to Combat Communicable Childhood Diseases in Kenya Bureau For Africa, AID Washington D.C. January 1980 p. 42.

26.) Estimate includes hole excavation, adobe walls and roof, concrete slab and commode from AID Project Paper p. 44 (see reference 5).

27.) Op Cit., UNICEF see reference # 21; price estimates for tools, seeds, fertilizer, educaion materials etc.

28.) Ibid. price estimate from UNICEF guide for food supplementation packets.

29.) The cost effectiveness figures were arrived at in the following manner:

$$\text{total mortality} = \left(\text{mortality rate for Alt.}\ ___ \times \frac{\text{budget level}}{\text{cost of Alt.}\ ___}\right)\left[+\ \text{mortality rate for current system} \times \left(1 - \frac{\text{budget level}}{\text{cost of Alt.}\ ___}\right)\right].$$

$$0 - 1\ \text{mortality} = \left(\text{0-1 mortality rate for Alt.}\ ___ \times \frac{\text{budget level}}{\text{cost of Alt.}\ ___}\right) + \left[\text{0-1 mortality rate for current system} \times \left(1 - \frac{\text{budget level}}{\text{Cost of Alt.}\ ___}\right)\right].$$

The above was done for each age category.

30.) Op Cit., Grosse et al. p. 61.

31.) As used in the Java study "undominated" refers to an alternative which is equal to or superior to all other alternatives in at least one category such as total mortality or 0-1 year disability. On the other hand "dominated" alternatives are those which are inferior to one or more alternatives in both days of disability and death rate. The sanitation program is always dominated in this analysis except at no set budget level when it can be fully implemented.

32.) Op Cit., Grosse et al. p. 67.

BIBLIOGRAPHY

1.) Barnum, Howard N., Cost-Effectiveness of Programs to Combat Communicable Childhood Diseases in Kenya Bureau for Africa, AID., Washington D.C., January 1980.

2.) Drake, William D., Fajardo, Luis F., The Promotora Program in Candeloria: A Columbian Attempt to Control Malnutrition and Disease, 1968-1974, Cali, Colombia, Community Systems Foundation, 1976.

3.) Frerichs, Ralph R., Becht, James N., Foxman, Betsy, "Prevalence and Cost of Illness Episodes in Rural Bolivia" International Journal of Epidemiology, Vol. 9; 3; 233-238.

4.) Grewal, Tina, Report on Nutrition Program Analysis for Bolivia CARE Inc., unpublished report, Nov., 1975.

5.) Grosse, R., devries, J., Tilden, R., Dievler, A., Day, S., A Health Development Model Application to Rural Java, Dept. of Health Planning and Administration, University of Michigan, Ann Arbor 1979.

6.) LeBow, Robert H., Consultants Report; The Rural Health System in Bolivia US/AID Washington D.C. August 1974.

7.) Morley, David, Pediatric Priorities in the Developing World Butterworth Press Boston 1973.

8.) Pan American Sanitary Bureau, Regional Office of World Health Organization, Report of the Americas Washington D.C. 1976.

9.) St. John, Ronald K., Communicable Disease Problems in Bolivia, Operational Research Branch, Venereal Disease Control Division, Bureau of State Services, Center for Disease Control, Atlanta, 1974.

10.) Saunders, Robert, J., Warford, Jeremy, J., Village Water Supply; Economics and Policy in the Developing World Johns Hopkins University Press Baltimore 1976.

11.) Sojogyo, Nutrition Guidance Project for Village Population: Report for Second Year (1976/77), Agricultural Foundation 1976.

12.) UNICEF, RANI A Composite List of Equipment and Supplies for Peripheral Health Facilities and UNIPAC United Nations Children's Fund Supply Division U.N. New York 1979/80.

13.) U.S. Department of State, A.I.D. Project Paper Bolivia-Rural Sanitation, Proposal and Recommendations for the Review of the Development Loan Committee, Washington D.C. March 1979.

14.) Weil, Connie, "Morbidity, Mortality and Diet as Indicators of Physical and Economic Adaptation Among Bolivian Migrants" Social Science and Medicine Vol. 13D; 1979.

15.) White, Gilbert F., Bradley, David J., White, Anne, Drawers of Water; Domestic Water Use in East Africa , University of Chicago Press, Chicago. 1972.

16.) World Health Organization, Expanded Program in Immunization, Programming Manual, Geneva EPI/G/77.1.

17.) WHO/IBRD Cooperative Program Bolivia: Water Supply and Sewerage Sector Study Vol. I Latin American and the Caribbean Regional Office, April, 1975.