THE IMPACT OF MEDICAL ASSISTANTS ON THE HEALTH STATUS OF RURAL SIERRA LEONEANS – A STUDY DESIGN

BY

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ABSTRACT

The issues relating to planning for health care delivery in developing countries, the current health care delivery system in rural Sierra Leone and the health care problem of this rural population particularly infant and children, have been examined. The research literature was reviewed and the various options for health care delivery systems to rural communities were discussed.

A design for a randomized controlled study to evaluate the effectiveness of health care teams led by medical assistants working in pairs in reducing infant and childhood mortality and malnutrition and improving sanitation and safe water supplies of communities will be compared with effectiveness of health care teams led by nurse dispensers working in pairs and individually, has been presented. The proposed study is intended to be carried out in nine chiefdoms in rural Sierra Leone and it is expected to last for 52 months.

It is anticipated that the result of the study will provide information useful to the Ministry of Health in Sierra Leone to plan for a future health care delivery system in rural Sierra Leone.

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CHAPTER I

INTRODUCTION

1:1 Health Conditions in Developing Countries in General

Health conditions vary greatly from country to country and within countries. However the developing countries have in common that their health conditions are substantially inferior to those in the developed countries.

Consider one measure of health conditions, namely life expectancy. Low life expectancy may reflect very high infant and childhood mortality. Life expectancy in the developed countries has been shown to have improved over the past three decades[20] but in the developing countries the rate of improvement is declining;[20] and for those who survive beyond age five, life expectancy is six to eight years less than in developed countries.[20]

1:2 Disease Pattern in Developing Countries

Assessment of the health situation requires knowledge not only of mortality rates and life expectancy, but also the distribution and causes of mortality and morbidity. Unfortunately reliable information on disease patterns is unavailable on a country wide basis. This is not a problem only in Sierra Leone, it is a problem in most developing countries. Tables I and II, show the pattern of disease in the western

area of Sierra Leone where better health facilities are available, and a rural community with limited facilities. Although these are based only on partial returns, they do reflect the pattern of disease in the country as a whole.[50,51]

From the tables I and II, it is clear that three major disease groups (gastrointestinal and respiratory infections and malnutrition) are major problems in Sierra Leone. The research literature shows that inexpensive effective prevention and/or treatment are available for most of the diseases in these groups.[76]

1:3 Improving Health Conditions in the Developing Countries

Despite the large expenditures on health in some of the developing countries and the technical feasibility of dealing with many of the most common health problems, efforts to improve health have had only modest impact on health for the vast majority of the population. This is commonly attributed to two main reasons.[76] First, health activities may have typically overemphasized sophisticated, hospital-based care, while neglecting preventive public health programmes and simple primary care provided at conveniently located facilities. Secondly, where health facilities have been geographically and economically accessible to the rural communities, deficiencies in logistics, inadequate training of staff, poor supervision, inappropriate services and lack of social acceptability have often compromized the quality of care they offer and limited their usefulness.

The Ministry of Health in Sierra Leone has recognized these

problems and is in the process of shifting its policy from expansion of hospital based care facilities towards extension of rudimentary health services to the underserved populations. This new commitment led to the development of a para-Medical School in Bo (Sierra Leone) to train medical assistants for the rural health units.

1:4 Sierra Leone in Brief

1:4:1 The Country

Sierra Leone lies just at the bulge of the west coast of Africa between Liberia and the Guinea with a long coast line on the Atlantic Ocean. It has an area of 28,000 sq miles with an estimated population of 3 million of which about 75 - 80% live in the rural areas with subsistance farming as their main occupation. Table III shows the main demographic features of the country. The climate is tropical with two seasons: the rainy season from May through October and the dry season from November to April.

1:4:2 Administration

The country is divided into 3 provinces (Northern, Southern and Eastern) and the western area where the capital city is located is the seat of government.

The provinces are subdivided into 12 districts and each district is further divided into chiefdoms. Finally, chiefdoms are divided into villages. The average size of a district is about 2,500 sq miles with an average population of about 200,000 people, whilst the typical

population of a chiefdom is about 6,000 to 15,000 people.

1:4:3 Health Facilities in Sierra Leone

The government, missions, and mining companies, together operate a total of 44 hospitals. In addition the Ministry of Health operates a total of about 150 rural health centres, treatment centres and dispensaries throughout the country. There is a government hospital in each provincial and district headquarter town, and health treatment centres or dispensaries in most chiefdoms. However, 30 out of 145 chiefdoms are still without any medical units whatsoever.

1:4:4 Health Conditions in Rural Sierra Leone

Communicable and parasitic diseases, malnutrition, gastro-intestinal and respiratory infections are some of the major health problems in rural Sierra Leone.[50,51] For these diseases, doctors may not be needed to either treat or prevent them. Medical auxillaries with the necessary training can be utilized to cope with these health problems.

1:4:5 Purpose of the Study

The purpose of this thesis is to design a study to determine the impact of medical assistants activities on the health status of rural Sierra Leoneans and compare this impact with that of nurse dispensers, the health care providers in current use.

Table I

Leading causes of mortality among children of ages 1 – 4 years in the western area of Sierra Leone 1975/1976.

	DISEASE	% MORTALITY
1	Measles	21.0
2	Diarrhoeal Diseases	16.0
3	Avitaminosis and other Nutritional Deficiency	12.4
4	Anaemia	10.0
5	Whooping Cough	9.3
6	Malaria	4.3
7	Others	27.0
	TOTAL	100.0

Source: Ministry of Health Medical Statistics Reports for 1975/1976.

Table II

Diagnosis at Health Centre and Dispensaries in the Bombali District of Sierra Leone (1975/76)

DIAGNOSIS	NEW CASES	%
Respiratory Diseases	10,899	20.9
Diarrhoea	9,939	19.1
Malaria	5,051	9.7
Helminthis	5,019	9.6
Anaemia	5,014	9.6
Measles	3,685	7.0
Others	12,549	24.0
TOTAL	52,156	100.0

NOTE: % relates to total of all new cases seen during the period 1975 and 1976 (2 years). Approximate population of the District in 1976 was 200,000.

Source: Ministry of Health Medical Statistics Reports for 1975/1976.

Table III

Main demographic feature of Sierra Leone

1	Population	3,000,000 estimated 75% Rural and mostly illiterate
2	Life Expectancy at birth	Male 42 years, Female 45 years
3	Crude Birth Rate	47/1000
4	Crude Death Rate	22/1000
5	Infant Mortality Rate	Freetown 130/1000 Rural areas 270/1000
6	Under 5 Mortality	250/1000 live births
7	Growth Rate	2.4%
8	Children Under 5 Years Old	17% of Population
9	Children Under 15 Years Old	40% of Population
10	Per Capita Income	180 US$

Sierra Leone Government Central Statistics Unit 1978.

CHAPTER II

LITERATURE REVIEW

This chapter will review studies and observations done in developing countries or pertaining to developing countries under such broad headings as:

(1) General health programmes evaluation

(2) Various health care delivery patterns

(3) Historical developments of the medical auxillaries

(4) Evaluation of medical auxillaries.

11:1 General Health Programmes Evaluation

There are very few reports of research in the literature that have been carried out to evaluate the improvement of health resulting from a particular programme in the developing countries. The few that have been reported so far have yielded fairly inconclusive results. [30,39,55,64]

The first of these was a study carried out in 1952 in Egypt to detect the benefits of various combinations of health services introduced into 4 villages over a period of 18 months. A fifth village (the control village) was left without services.[64] Here the most outstanding methodological feature was the selection of specific pathological conditions for measurements that were likely to be influenced by these

services. Unfortunately follow-up data on the various physical examinations done and the outcomes of the study are not reported except for conjuntivitis. No further outcome reports of this study appear to be existent in the literature.

In another investigation carried out in Japan from 1956 - 1960;[30] emphasis was placed on determining the impact of health education in reducing mortality and morbidity. Despite a dramatic decrease in certain disorders, notably tuberculosis, Ascariasis and diaharrea, there was no improvement in the crude death rate, infant mortality rate or the estimated nutrition status of the population. These negative findings, the absence of a control area, suggests that the programme as such was not responsible for the improvements noted.

The result of another study carried out in rural India in 1966;[39] with a time series research design was difficult to interpret because many changes occured in the health services of the study area and furthermore, as in the Japanese study, no control area was utilized.

The most carefully designed, executed and consequently the most conclusive study was that undertaken in 6 Ethiopian villages from 1961 - 1967.[55] Before and after changes were used to compare test and control groups. After an 18 month preparatory period during which basic data were collected in all the villages, a health centre with a medical assistant was set up in each of 3 villages the others being left as control. All households were systematically sampled and every member in the sample was given a complete physical examination. After the

active phase of the study, lasting 3½ years, follow-up examinations were performed on the families sampled in the before period.

Although this study is open to many methodological problems, (e.g. the villages were not randomly allocated to either control and experimental units, observers were not blind and testing and instrumentation were not controlled) there were some positive findings. The most impressive finding was a reduction of infant mortality rates in the experimental villages whilst in the control villages with the usual (only curative) services, there was no change in the infant mortality rates. The results of this study suggest a combined curative and preventive programme in health centres leads to greater improvement in health than a purely curative one.

The relevance and effectiveness of prevention when united with care and cure is illustrated in Table IV. Cunningham[11,12] compared 2 nearby villages in Nigeria. In one of the villages, Imesi-Ile, an under-five clinic has been established with combined preventive and curative services on a daily basis. It was staffed by two trained nurses and 6 midwives and dealt with 41,000 visits by under fives each year. In the neighbouring village of Oke-Messi, the control village, there was a local government dispensary providing only curative services on a daily basis. It was staffed by a dispenser and two midwives, and they had about 3,700 under-five visits a year. From Table IV it is clear that the differences in infant and childhood mortality rate in the two villages are striking and unlikely to be accounted for by any factor other than health imputs.

There was also a highly significant difference in the immunization status of the under fives in the village with both curative and preventive services compared to other villages with only curative service. Of all children in the study village (i.e. village with both curative and preventive toddlers), 76.2 percent had at least 3 immunization compared to 35.4% in the other village.

11:2 Various Health Care Delivery Patterns

Identification of the problems alone is insufficient to indicate how scarce health resources should be allocated. Various health care delivery systems have been developed. These include comprehensive primary health care, basic health care, multiple disease control and selective primary health care (Walsh and Warren[63]). Priorities for deciding on the method of health care delivery best suited for the country must be established.

11:2:1 Comprehensive Primary Health Care

The best solution or strategy for a developing country like Sierra Leone where the majority of its population are living at poverty level and suffering from a plethora of infectious disease appears to be development of comprehensive primary health care. This was defined at the World Health Organization conference held in Alma-Ata in 1978 "as the attainment of all peoples of the world by the year 2000 of a level of health that will permit them to lead a socially and economically productive life". Comprehensive primary health care includes at least

education concerning prevailing health problems and methods of preventing and controlling them; promotion of food supply and proper nutrition, an adequate supply of safe water and basic sanitation; maternal and child care including family planning; immunization against major infectious diseases; appropriate treatment of common diseases and injuries; and provision of essential drugs.[69]

This, while laudable as a goal, may not be attainable in it full scope because of the cost and number of trained personnel required. The World Bank has estimated that it will cost billions of dollars to provide minimal basic and not comprehensive health services by the year 2000 to all the poor in developing countries.[20] If, however, we concede that this is an unattainable goal in the forseeable future, we have to consider the three other alternative strategies as proposed by Walsh and Warren.[63]

11:2:2 Basic Health Care

Basic health care services are simple and straight forward in their goals, which are to provide health workers and establish clinics for treating illness within a particular population. This model fits with the strong orientation towards curative medicine of most health professionals. For most people, the provision of health care means the availability of curative services for when they are sick. This approach is very expensive. The World Bank has estimated that the cost of providing basic health care services to all developing countries by the year 2000 will be between 5.4 - 9.3 U.S. billion dollars.[20] This

investment includes only initial capital investment without recurrent expenditure on salaries and drugs.

Despite the fact that basic care service is very expensive, it does very little to influence the actual incidence of disease and illness.[20]

11:2:3 Multiple Disease Control

Multiple disease control interventions include vector control water/sanitation programmes, and nutrition supplementation. They are more specific and easily controlled programmes than either comprehensive primary health or basic health care programmes. They have the added attraction of being able to control several diseases with one intervention. However, they have their limitations which will become obvious later.

11:2:3:1 Vector Control

This approach is aimed at controlling vectors that transmit diseases to human. Its strength is that, at present, it is comparatively inexpensive. However, such programmes may need to be continued indefinitely and possible emergence of resistance among the vectors could make the future very uncertain.

The control of malaria transmission through insecticide has been highly effective. In the tropical regions and savannas of Africa, twice yearly spraying with D.D.T. has decreased the death-rate from malaria approximately by 50%[32] at a cost estimated by W.H.O. at 24.5 dollars

per capita annually?[32] Unfortunately the control of malaria with insecticides is becoming more difficult and expensive because of the emergence of D.D.T. resistant insects. The alternative insecticides may raise the cost between five and ten times and there is no knowing how long they will remain toxic to the vector.

11:2:3:2 Water and Sanitation Programmes

It is generally agreed that the provision of adequate safe water and proper sanitation will considerably reduce the incidence of diarrhoeal diseases in an area. However, the financial investment involved is enormous. (U.N.I.C.E.F. has estimated a cost of about 2500 U.S. dollars for each protected well with a hand pump that it is installing in the Eastern Province in Sierra Leone!) Furthermore success depends upon rigorous and regular maintenance of the systems established. Often changes in deeply engrained cultural habits are required.

It has been demonstrated in different parts of the world that with the installation of a safe community water supply and sanitation, deaths from typhoid can be expected to decrease by 60 - 80%[3] and deaths from cholera by 0 - 70%[3,6,80,81] and from other diarrhoea 0 - 5%?[26,36] The reason for these differences is that typhoid, cholera and bacillary dysentary are principally water-borne diseases, while the other diarrhoeal diseases generally result from other means of faecal-oral transmissions and are reduced only by improved hygiene made possible by a greater quantity of water and the construction of pit latrines.

The construction of a safe well can break the transmission of typhoid and cholera, but may not significantly affect the incidence of other diarrhoeal diseases unless the quantity of water used for washing purposes increases.[14] All the evidence so far suggests that not until the supply of water is actually inside the house does the quantity used increase sufficiently to make a large impact upon diarrhoeal diseases. It has also been shown that when water sources are brought to within 50 yards of the house water consumption does increase with a consequent small reduction in the incidence of diarrhoea.[66]

Not all studies have shown that better water supply system and sanitation facilities results in improvement in health.[56] The answer to this paradox may possibly be due to cultural practices or the definition of health of the population studied. For example, in some areas of Sierra Leone, drinking water is often stored in cooling jars that are nearly always contaminated. Some families may continue to drink contaminated water from a stream because of greater convenience, better taste, social reasons or its supposed special qualities.[28]

There are also few studies reported in the literature where pit latrines had little effect on the prevalence of disease[38] or even had a negative effect.[61] Here too cultural habits may offer a partial explanation.

11:2:3:3 Nutrition Supplementation

The importance of good nutrition in preventing morbidity and mortality is well recognized,[23] but supplementation alone has had no

notable effect.

In a study of childhood deaths in Latin America, malnutrition was associated with 50% of deaths from infectious disease.[34] Poor nutrition undoubtedly increases susceptibility to diseases or predisposes an infected child to more severe illness.[27,29]

Only in one or two very closely controlled projects has nutrition supplementation alone achieved significant decreases in mortality rates. In these projects the cost of averting death by nutrition supplementation exceeded the cost of medical care alone.[59]

In the developing countries while nutrition education programmes (especially those directed at individual children, and/or pregnant and lactating women) are important, it is clear that for children, prevention and prompt treatment of diarrhoea and malaria may be more important than direct nutritional interventions.

11:2:3:4 Selective Primary Health Care

Selective primary health care is an approach which specially sets out to implement the most cost effective methods of controlling those diseases which have been identified as having the highest priority for intervention.

Walsh and Warren[63] suggests that priority needs be determined according to feasibility of control as well as prevalence, mortality and morbidity of the conditions. Table V uses this classification to sort

the most important disease problems in Sierra Leone into groups of High, Medium and Low priority.

Diarrhoeal diseases, measles, malaria, whooping cough and neonatal tetanus all fall into high priority group on account of their high prevalence, high mortality or morbidity rates and the existence of effective control measures. These diseases together with respiratory infection and malnutrition, in the medium priority group, account for most of the morbidity and mortality among infants and young children in Sierra Leone and in the developing countries in general[1,76]

Groups 11 and 111 contain health problems that are either less prevalent or more difficult to control. Respiratory infections and malnutrition, inspite of their high prevalence and mortality rates fall into the medium priority group because of the difficulty in controlling and treatment. Poliomyelitis also fall into medium priority group because although effective methods of control do exist, they do not have a high mortality or morbidity rate. On this basis the principal recipients of care would be children under five years old and women of childbearing age. Of first priority would be immunization of all children, tetanus toxide to women of childbearing age, encouragement of breast feeding and proper weaning and a major emphasis on oral rehydration using materials available locally.

Having considered the possible alternatives for improving health status of the rural communities, the next question is to identify what should constitute rural health care in Sierra Leone. Any answer to this

question must of necessity be a compromise: a compromise between what is optimal, and what is financially and humanly possible; a compromise between what is considered desirable and what is expedient and dictated by historical and political realities. Brown[50] said "It is becoming increasing clear that health care for the rural population is not being provided by doctors trained in the context of individualistic and curative medicine. The only practicable way of mediating the benefits of scientific medicine to the masses, of raising the standards of health and nutrition and of controlling endemic diseases is by the wide spread deployment of trained and supervised medical auxilliaries working from health centres". From the above quotation it is clear that the training of medical auxilliaries seems to be an attractive solutions for the health problems especially in the rural areas given the limited health resources available, the lack of trained manpower and the tendency of highly trained personnel to ignore community health problems.

11:3 Historical Development of the Medical Auxillaries

Auxillary health workers have been part of society since the beginning of the medical profession.[78] In some socialist countries (example U.S.S.R. and the People's Republic of China) as well as many third world countries, medical auxillaries have long been utilized.

The forerunner of the modern medical assistant was the baber-surgeon[78] - a military man who in centuries past tended the wounded in Europe during the wars.[44,45,49] He learned his craft by apprenticeship. During the transition from the medieval surgeons, European military

medical men were trained through apprenticeship or through special course. They were called Feldshers from the German word for field barbers.

Feldshers were introduced into the Russian army some 250 years ago. Retired military feldshers went into the country side where there were no physicians, and provided some medical care to the population. Historically they played a critical role in the health care of the Russian people and they continue to play substantial role in the Soviet health care to this present day.[44]

Feldshers in the Soviet Union are designated as medium grade medical workers. Such personnel are distinguished from physicians who are graduates of medical schools. Feldsher's functions are split into two roles which might be described as "substantial" and "complementary" roles. In isolated and rural areas, they provide a full scope of primary care using physicians as consultants, and they are regarded by patients as doctors in their own right. In the metropolitan situation, they are essentially assistants and work with the physicians but never as persons in independent practice.[49]

In the Peoples Republic of China, since 1949, in an attempt to meet the problems of health care, a number of "middle medical schools" were set up to prepare students who had reached the intermediate level of the secondary school to work as "assistant doctors" following a three year course. This category of health worker is comparable to the Russian Feldsher who is expected to act as physician when necessary.[47,48]

Despite the increased number of medical workers in the U.S.S.R. and China, the rural areas continue to receive inadequate health care.[15] In China, efforts were then made to train personnel in the rural areas who would continue to engage in agricultural production at the same time that they were involved in health care. This category of health worker, the "barefoot doctor", obtain three months of formal training followed by a variable period of on-the-job supervised experience. The barefoot doctors have responsibility for environmental sanitation, health education, immunization, First Aid, personal primary medical care and post illness follow-up.[47,48]

11:4 Medical Assistant in the Third World

In the third world countries, various names have been given to such auxillaries. The most common responsibilities performed by these health workers are: the recognition of the most common diseases, direct care of less complicated ones and referrals of the more severe problems to the nearest health centre. They also carry out preventive health care and the promotion of health in their region.[77]

In India, the sub-assistant surgeons represent a sub-professional cadre of physicians rather than a true auxillary. The sub-assistant surgeon attended the same classes as the medical students at Madras University School of Medicine and was required to take the same examination. The only difference between them and the medical student was that they had a lower pass marks and the duration of training was 3 years compared to 5 years for the medical students.[78] Later, separate

schools were established for the sub-assistant surgeon.

Around 1918 Para-Medical schools were started in many African countries (Uganda, Senegal, Ethiopia). These schools at first offered an abridged physician education. Later their standards were gradually raised, the duration of training lengthened and then developed into full medical schools.[78]

Because of the shortage of physicians, medical assistants are the main medical care auxillaries in Malawi. Their training initially was of four years duration but was later reduced to three years.[78] The main objective of the programme is to train someone with knowledge and the ability to assist physicians quickly, efficiently and economically and to provide health care for the rural communities.[78]

Algeria, after the achievement of independence in 1962, was faced with problems in providing health care to its rural population, because most of the physicians and medical auxillaries (most of them Europeans) left. One of the solutions considered to remedy the solution was to increase the number of indigenous health personnel, particularly medical auxillaries.[79] In 1962, three shcools for medical assistants were opened. They were devised as a temporary approach to accelerate the development of resources, and the curricula were designed and tailored according to the country's need.

Despite the fact that the concept of medical auxillaries has been recognized, very little has been done to evaluate their impact, in

terms of effectiveness and acceptance, on the health status of the community. The next section will look at the evaluation of medical auxillaries in North America as no study was found reporting an evaluation of medical auxillaries in developing countries.

11:5 Evaluation of Medical Auxillaries

The most important question when a new approach to health care is embarked upon is the efficacy or effectiveness of the approach.

Sackett and others[35] in the Burlington randomized controlled trial of nurse practitioner showed that there was no difference in outcomes of physical, social and emotional function, morbidity, mortality and quality of care between nurse practitioners patients and those receiving conventional care from physicians in a primary care office-based practice in a predominantly middle class to upper class communities.

In the United States there was great concern that physicians extenders with relatively brief clinical training would not be able to provide good patient care, even when closely supervised by physicians. Since the inception of the physician extenders programme, various studies have been reported that looked at the quality of care provided by physician extenders.[13,42,43,54] In all these studies there were no differences in the process and/or outcome measured used between patients of physician extenders and physicians reported. An important limitation of these studies is that they were done in an office setting, in which there are relatively few patients with potentially serious acute

illnesses. Also, none of these studies looked at physician extenders working solo in rural areas separately from a setting in which a physician can provide consultation.

In the developing countries, where there is a considerable shortage of physicians, physician extenders are often the only source of coverage in health centres in rural communities. The health care problems faced are also vastly different. Thus, there is no basis for extrapolating from these studies conducted in North America to physician extenders in developing countries.

Table IV

Selected measure of Health Status at Imesi-Ile and Oke-Messi (Nigeria) August 1966 - August 1967 (Cunningham 1978)

Health Indicators	Imesi-Ile	Oke-Messi
Live Births	302	327
Infants Deaths	14	26
Infant Mortality Rate/10000 Live Births	46	80
Child 1-4 Population Mid Year Estimate	896	997
Child Deaths (1-4 years)	16	48
Child 1-4 Mortality rate/1000 Children 1-4 Years	18	48

Table V

Priorities for disease control in Sierra Leone, based on prevalence, mortality, morbidity and feasibility (adapted from Walsh and Warren[63]).

PRIORITY GROUP	REASON OF ASSIGNMENT TO THIS CATEGORY
1 HIGH	
Diarrhoeal Disease	High Prevalence, High
Measles	Mortality or High Morbidity
Malaria	Effective Control
Whooping Cough	
Neonatal Tetanus	
11 MEDIUM	
Respiratory Diseases/ Infections	High Prevalence and Mortality Control Difficult
Poliomyelitis	High Prevalence, Low Mortality Effective Control
Tuberculosis	High Prevalence, High Mortality Control Difficult
Malnutrition	High Prevalence, High Morbidity and Mortality Control Complete
Meningitis	Medium Prevalence, High Mortality Control Difficult
Onchocersiasis	Medium Prevalence, High Morbidity Low Mortality Control Difficult
Schistosomiasis	Medium Prevalence, Medium Morbidity Effective Control
111 LOW	
Leprosy	Medium Prevalence, High Morbidity Control Difficult
Ascariasis	High Prevalence, Low Mortality Control Difficult
Filariasis	Low Mortality, Medium Morbidity Control Difficult
Lassa Fever	Low Prevalence, High Mortality Control Very Difficult

CHAPTER III

HEALTH CARE DELIVERY IN RURAL SIERRA LEONE

In rural Sierra Leone, health care is provided mainly by the government. Voluntary organizations, mining companies, and private organizations provide some health care to a small proportion of the population.

All personnel working in government health institutions are paid by the government according to a salary scale based on type of profession, experience and training. The services provided, whether preventive or curative, are practically free to the population.

111:1 Current Pattern of Rural Health Care Delivery

In each province, a government hospital provides both general and specialist care. These hospitals are located at each provincial capital. In addition to the provincial hospitals there are also smaller hospitals at each district headquarter town. There are 12 such hospitals, one per district.

At chiefdom levels there are either health centres, treatment centres or dispensaries. The definition of these units in Sierra Leone are:

Health Centres: They are usually staffed by a dispenser, and a maternal

and child health aide. They provide general out-patient, Antenatal and post natal services, and have limited in-patient facilities for maternity cases.

Dispensaries: They are staffed by trained dispensers with usually, no maternal and child health aide, and provides out-patient facilities only.

Treatment Centre: Similar to dispensary but staffed by endemic disease control assistants.

The health centre, treatment centre or dispensary are the smallest units providing health services to a geographically defined population and they offered mainly curative services. In addition to nurse dispensers there are also maternal and child health aides, traditional birth attendants and public health aides providing health care to the rural communities.

Most chiefdoms have at least one health unit although some may have two or more depending on the size of the chiefdoms. In chiefdoms with medical units, these units are grossly underutilized and consequently a sizeable proportion of the population is still not served by these units. In most cases the reasons for this under-utilization reflects such factors as:

(1) Insufficient awareness by the health personnel of the need for community knowledge and involvement;

(2) Poor transportation (distance of the centre from most of the people);

(3) Lack of community awareness of the types of health measures offered and the reason for them.

The "bypassing" phenomenon may also come into play. If people lack confidence in the local health institution, they may ignore it prefering when ill to go to district hospitals.

Tables VI and VII show the distribution of medical facilities and the population in each districts. When compared to the western area of Sierra Leone, where only 10 - 15% of the population lives, it is clear that medical facilities are unevenly distributed.

111:1:1 Health Manpower

One of the major obstacles to the development of health services in rural Sierra Leone has been the absence of clear thinking about the kind of health personnel required to provide the necessary services.

Tables VIII, IX, X shows the number of health personnel in a few developed and developing countries and in Sierra Leone respectively. These tables illustrate the great scarcity of trained health professionals at all levels in the developing countries. In the industrialized countries the doctor population ratio is very high, (of the order of 1:600) whilst for the developing countries it is often over 1:10,000. For Sierra Leone the physician/population ratio is about 1:16,000.

Further, the disparity between coverage in urban and rural areas is not only evident for physicians but also for nurses Midwives and other health professionals.

Some of the factors which affects the location and type of health manpower in Sierra Leone as well as in developing countries include:

(1) Migration:

A significant proportion of physician upon completion of their training either migrate to the developed countries where they have better facilities and higher salaries or stay in the developing countries working in large cities, rather than going to work in rural areas.

(2) Restricted use of medical auxillaries:

Medical specialists with 8 - 10 years of medical education may not be needed to provide medical care in rural areas. There are more appropriate and less specialized cadres capable of effective control of the rural health problems, but preventive and promotive health care appears to be of very low priority. However there is now a trend towards establishing a body of medical auxillaries who can be trained more rapidily less expensively and in greater numbers than doctors to be utilized in rural health centres.

111:2 Proposed New Strategy

The ministry of health in Sierra Leone has decided to embark on a programme of training a new category of medical auxillaries that could eventually be deployed in all rural health units. It is anticipated that these new auxillaries would provide not only curative services as the currently deployed rural health unit workers, but they in addition will provide both preventive and promotive health measures to a geographically defined population.

111:2:1 Sierra Leone Training Programme

The training school for medical auxillaries is located in Bo, the capital of the southern province. Bo was selected for the training programme because it has a provincial hospital. There are many health centres in the district and the epidemiology division of the ministry of health is also located in Bo. This will enable the students during their training to work with the staff of the endemic disease control unit.

Since the medical assistants will be working primarily in a rural setting, a large part of the training will take place in rural health centres and district hospitals. In the district hospital, the students will have the opportunity to observe and learn new skills and techniques without using sophisticated equipment and at the same time become aware of their limitations as compared with fully qualified physicians.

Starting in October 1981, the training programme will last for

3 years for students entering the training programme directly from secondary school but will be shorter for trained nurses and other health professional with sufficient training and experience in community health problems. The factors considered in selection for the training programme are:

(a) School leaving certificate in 4 subjects including a science subject and fluency in one of the local languages. Preference will be given to those living in rural areas.

(b) Letter indicating future career goals and why thay want to enter the programme.

(c) A personal interview.

During their training, the students will spend over 60% of their time in practical, rather than classroom work. The teaching staff initially will be drawn from physicians with public health training and/or with considerable experience in rural health problems, and from other related health professions such as nursing, sanitation, health education, laboratory, dentistry, and social work. Later, experienced medical assistants that have shown special aptitude in teaching will be recruited.

Most of the staff except for the principal, one or two experience public health staff and health education officer, will be recruited on a part-time basis. The Principal is a physician with public health training and is familiar with the intended duties of the medical assistants.

On completion of their training the medical assistant will be required to undertake the following duties:

(1) Work in Health Centres

(A) Care of the Sick

The health centres provides first line clinical services for the community including:

(i) the diagnosis and treatment of common diseases;

(ii) referring patients not responding to treatments, and those requiring prolonged inpatient care, investigations or major surgical procedures;

(iii) repair and treatment of minor surgical conditions;

(iv) life-saving management of all medical, surgical, gynaecological and obstetric emergencies before referring them for specialist care and

(v) provision of follow up care for chronic conditions like tuberculosis and leprosy as required.

(B) Promotion of Health

The staff of the health centre are responsible for the services concerned with the prevention of disease and promotion of health in the community. The medical assistant, as leader of the health centre, will assist and participate in the following:

(i) provision of safe obstetrical services including conducting

ante-natal clinics and health centre deliveries;

(ii) provision of family planning services;

(iii) provision of child welfare clinics, and

(iv) conducting health and nutrition education classes.

(C) Administration

The medical assistant will be in charge of the health centre and will be responsible for the following:

(i) daily administration of the health centre;

(ii) discipline and morale of the staff;

(iii) management of drugs supplies and inventory items;

(iv) collection of statistical data and preparation of monthly reports, and

(v) ensuring that the clinic building, equipment and vehicles are properly maintained.

(2) Work in the Community

(A) Development and support of primary health care programmes

The medical assistant in the community in collaboration with the paramount chief is responsible for initiating the formation of the community organization required for effective primary health care. His tasks are to:

(a) perform community surveys and present findings to the community;

(b) assist chiefdom authorities in forming health committees at chiefdom and town/village level;

(c) assist in training of health committee members;

(d) hold regular meetings with the health committees and supervise their work, and

(e) supply the necessary drugs and supplies to health committee members.

(B) Community Health Activities

A number of community health activities are to be carried out.

(a) Perform village clinics on a regular basis, immunizations, screening for high-risk pregnancies and for children "at risk" of malnutrition and treatment of common diseases.

(b) Support village health committees in constructing latrines and safe water and in other activities to improve the standard of hygiene.

(c) Initiate and support programmes to control endemic diseases.

(d) Collaborate with other government personnel and non-government personnel in national or local programmes aimed at improving the health or nutritional status of the community.

From the job description of the new medical assistants it is clear that they will be expected to work in close cooperation with the local community. It is anticipated that adequate coverage and use of preventive and curative health services at village level will have been achieved when the population takes major responsibility for health care

in collaboration with the health services.[76]

The community, through its local health committee, will participate in decision making about its health services. Participation usually enhances the community's acceptance and use the services and feeds information on its felt needs and aspirations back to the decision makers. This is particularly important if the people are to derive the greatest benefit from preventive and promotive measures and expensive curative care and unnecessary loss of human life are to be reduced to a minimum.

It is hoped that the fundamental changes in health care to the rural communities using medical assistants will improve the health status of rural Sierra Leoneans. The rest of this thesis will be devoted to designing a study to evaluate the impact on the health status of rural Sierra Leoneans of using the medical assistants as team leaders in the delivering of rural health care.

Table VI

Health establishments in Sierra Leone, 1979

No.	Districts	Hospitals	Health Centres	Dispen-series	Treatment Centres	MCH Centres
1	Western Area (including Freetown)	12	6	15	-	2
2	Bo	2	3	1	6	1
3	Bonthe	2	2	2	2	2
4	Moyamba	2	6	3	4	2
5	Pujehun	1	2	1	7	1
6	Kailahun	4	3	3	16	3
7	Kenema	4	-	3	12	2
8	Kono	4	2	-	7	1
9	Bombali	4	1	10	1	2
10	Kambia	1	3	4	3	1
11	Koinadugu	1	3	4	6	1
12	Port Loko	5	3	2	5	4
13	Tonkolili	2	6	5	3	1
TOTAL SIERRA LEONE		44	40	53	73	23

Source: Ministry of Health

Table VII

Population distribution, Sierra Leone (1974 Census)

No.	Administrative Division/ District	Population			Area in sq mls. - all inland included	Density: person per sq mi.
		Urban*	Rural	Total		
1	Western area (including Freetown)	276,247	40,065	316,312	2,108	150
2	Bo	39,371	178,340	217,711	2,015	108
3	Bonthe	6,955	80,606	87,561	1,339	65
4	Moyamba	6,425	182,320	188,745	2,665	71
5	Pujehun	-	102,741	102,741	1,585	65
6	Kailahun	14,099	166,266	180,365	1,490	121
7	Kenema	31,458	235,178	266,636	2,337	114
8	Kono	114,349	214,581	328,930	2,178	151
9	Bombali	26,781	206,845	233,626	3,083	76
10	Kambia	11,520	143,821	155,341	1,200	129
11	Koinadugu	7,847	150,779	158,626	4,680	34
12	Port Loko	27,223	265,021	292,244	2,208	132
13	Tonkolili	10,347	195,974	206,321	2,704	76
TOTAL SIERRA LEONE		572,065	2163,094	2735,159	27,699	99

* Urban population = population living in towns of 5,000 inhabitants or more

Table VIII

Health personnel in selected developing and developed countries, 1975

Country	Population 000	Physicians	Medical Assistants	Dentist	Pharmacists	Midwives	Nurses	Ratio Phys.-popul.
Burundi	3,600	81	-	6	11	38	224	1:45,432
U.A.E.	2,600	96	27	3	14	56	293	1:27,083
Congo	1,350	213	58	-	-	152	494	1: 6,338
Liberia	17,100	170	76	19	25	299	415	1:10,058
Nigeria	62,930	4,248	-	168	1,428	18,965	17,904	1:14,814
Haiti	4,580	394	-	41	10	20	413	1:11,624
Venezuela	11,990	13,608	-	3,497	-	-	9,733	1: 881
Ecuador	6,730	3,109	-	579	146	166	766	1: 2,165
Burma	31,240	5,500	1,061	596	68	804	4,816	1: 5,629
Austria	7,520	15,702	-	1,464	289	1,148	18,198	1: 479
Sweden	8,200	13,260	-	7,180	2,900	620	47,800	1: 619
Canada	22,830	39,104	-	8,922	-	13,200	-	1: 584
Sierra Leone	2,735	147	-	10	-	-	-	1:16,000

Source: W.H.O. Statistics Report #30, 1977.

Table IX

Distribution of physicians in some developing countries in 1964.

Country	Capital		Rest of Country	
	Physicians %	Populations %	Physicians %	Populations %
Jamaica	70	26	30	74
Guatemala	82	15	18	85
Senegal	63	15	37	85
Thailand	60	8	40	92
Kenya	54	5	46	95

Source: Fendall, 1972

Table X

Health manpower,* Sierra Leone 1979

No.	Districts	Doctors	Dentists	Dispensers	Sanitation	Endemic Disease Control Assistants
1	Western area (including Freetown)	95	6	54	23	9
2	Bo	10	1	12		132
3	Bonthe	1	-	5		2
4	Moyamba	15**	-	11	19	7
5	Pujehun	2	-	5		9
6	Kailahun	1	-	8		19
7	Kenema	6	1	8	18	15
8	Kono	2	-	6		7
9	Bombali	4	1	6		4
10	Kambia	1	-	5		3
11	Koinadugu	2	-	6	18	9
12	Port Loko	3	-	6		5
13	Tonkolili	5***	1	10		3
TOTAL SIERRA LEONE		147	10	142	78	224

* No. of nurses, midwives and auxiliary nurses (Were not readily available).

** Includes 11 Chinese physicians

*** Includes 3 Russian physicians

Source: Ministry of Health

CHAPTER IV

HEALTH STATUS INDICATORS

IV:1 Purpose of Health Status Indicators

Health status refers in general to the degree of well being of a population. Since health status cannot be measured directly, suitable indicators which can be measured are used to describe the health status of the population.

Bickner[4] suggests that health status indicators serves three primary functions:

(1) Public information: This is simply given readily understandable information about health to the public. This information would be used by health professionals as a means of informing the general public and the legislation on the health situation in order to gain more attention for health, and the need to allocate more money for health.

(2) Administration: Health status indicators will help managers be better health planners, evaluators and decision makers.

(3) Medical Science: Health status indicators would help those who are interested in performing descriptive and experimental research in medical and health care.

Health status indicators can also be used in assessing quality of care in terms of patient outcome, estimating population needs and in measuring the efficiency or effectiveness of medical interventions.

For this thesis, health status indicators are being used in the context of the third function (medical science) of Bickner[4] classification.

IV:2 Definition of Health Status Indicators

In this thesis a health status indicator is defined as a health condition, or problem which is common in the community and for which there are suitable data available to document the extent of the condition or problem in the community.

IV:3 Selection of Health Status Indicators

The World Health Organization defines health as "A state of physical, mental and social well being and not merely the abscence of disease and infirmity".[75] From this definition, health status indicators must measure not only disease status, but also physical mental and social well being of the community.

However, the health status indicators chosen depend on the characteristic of the population that is being studied. When describing the health of the general population, it is often better to use positive health status indicators. this is preferable because only a limited percentage of the population will have chronic

physical limitations and mental impairment. A negative health status indicator will tell little or nothing about the health of the majority of the population. However, if the population that is being studied has a high mortality and morbidity rate, then it is appropriate to use negative health status indicators.

A number of health status indicators are currently being used. In the developed countries the value of mortality and morbidity as health status indicators has declined because of a change in disease pattern from infectious diseases to chronic degenerative diseases. Consequently other indicators such as patient satisfaction, disability days, physical and emotional status are currently used. In Sierra Leone mortality and morbidity are still sensitive as health status indicators, because of very high mortality and morbidity from infectious diseases that still exists.

For this study because of the high mortality in the under five age group in Sierra Leone, positively defined health status indicators will not be used. The intended effect of the intervention planned is to decrease mortality and morbidity. Thus the proposed health status indicators are chosen because they are the most sensitive to the presumed effects of the intervention. The following indicators will be used in this study:

(i) Infant mortality

(ii) Childhood mortality

(iii) Malnutrition in children under five years of age (under fives).

(iv) Number of pit latrines, wells and garbage collecting sites.

The major objective of the new medical assistant programme is to reduce infant and childhood mortality through improved nutrition and environmental sanitation. This is a major priority of the ministry of health in Sierra Leone. Thus three of the health status indicators selected pertain only to the under five age group. The fourth indicator reflecting sanitation conditions and quality of water supply has a major influence on the disease pattern in the developing countries. It has been shown [20,64] that a successful health education programme can modify the health behaviour and awareness of the community leading to an improvement in environmental health and sanitation. This results in a decline in mortality and morbidity of children.

IV:3:1 Infant Mortality

This is perhaps the most popular of the mortality index and it has been regarded as one of the most sensitive indicator of socio-economic and health status of a nation.[14,19] Numerous studies have been reported in the literature using infant mortality as the measure of health and it is still a key index for the international comparison of health.[33,57,70]

Infant mortality includes all deaths from birth to one year. However the causes of death in this age group are not evenly distributed. Low birth weight, birth injuries, congenital anomalies asphyxia and

tetanus neonatorum characterize mortality in the perinatal and neonatal periods. (The perinatal period is from 28 weeks gestation up to the first 7 days from birth and the neonatal period is from birth up to 28 days)

Deaths during the last eleven months of the first year of life are chiefly from infectious diseases acquired post neonatally and progressively increased incidence of malnutrition.[17] Mortality in infants is relatively low between the second and the fifth month of life.

During this age period most babies are breast fed and nutritional status are quite good, but after the fifth month when supplementary food (mainly infant formula are often introduced), malnutrition and diarrhea become major problems. Several factors contribute to these problems. The most important is that the infant formula may not be prepared under hygenic conditions. In addition, it may be over-diluted and thus lack the required nutritional value. By age five months, passive immunity acquired from the mother is diminishing and the children are becoming susceptible to various infectious diseases.

IV:3:2 Malnutrition

The prevalence of malnutrition is also a good indicator of the general level of health, since it represents the cumulative effect of many disease episodes as well as the availability and use of food.[23]

Birth weight and growth patterns are two most important predictors of childhood health and both of these factors are strongly

influenced by the nutritional status of mother and child, and early childhood nutritional status is also strongly correlated with health status and mortality risk of children?[23]

Although nutritional diseases per se account for only a small percentage of all infant and early deaths, poor nutritional status underlies many of the other deaths in other specific disease and age categories. Malnutrition can thus be characterized as a hidden killer. It is the background variable that determines much of the excess mortality from the common infectious diseases.

Nutritional status in childhood is itself determined both by nutritional intake and by the stresses of repeated minor and chronic infections in early life. In the developing countries, two particular kinds of risk are of importance for the health of children. First is the risk imposed by inappropriate foods of over diluted infant formula products, therefore the total calorie and protein intake may be insufficient for health and growth. They may also be exposed to additional risks of contaminated food by inappropriate preparation of artificial milk product or other supplementary foods and poor sanitary conditions under which they are stored.

In 1978 a national nutrition survey conducted in Sierra Leone[52] found the prevalence of malnutrition was 30% in the under fives and for anaemia (haemaglobin less than 11 grams/100) was 60%. It should be noted that these data were gathered during the dry season when food is plentiful and the incidence of infectious diseases at its lowest. The

amount of malnutrition and anaemia can be expected to be greater if the survey was conducted during the rainy season.

IV:3:3 Childhood Mortality

In most developing countries the bulk of deaths are in children under 5 years of age. In general the higher the overall mortality in a country the larger the proportion of deaths are of children under the age of five years.[20]

The current death rate in this age group in Sierra Leone is about 30% whilst the overall crude death rate for the country is 20 per 1000 population.[50] The causes of death in this age group is due mainly to infectious diseases and malnutrition. These diseases can be prevented by immunization, improved nutrition and environmental hygiene and sanitation or treated by relatively simple means. Studies in Nigeria, Guatemala and India (Table XI) have demonstrated that preventive health care and increased nutrition could have substantial impact on mortality among both infants and children under five years.

IV:3:4 Changes in Environmental Hygiene and Sanitation

The predominant environmental health problem in Sierra Leone are still the communicable diseases which result from identifiable features such as lack of protected water supplies and inadequate disposal of human wastes.

It has been documented in the literature[20,39,64] that infectious

and parasitic diseases are highly prevalent in areas with inadequate method of excreta disposal and protected water supplies and that with the provision these facilities together with environmental hygiene and sanitation education programme, not in isolation but within an integrated health care programmes, the prevalence of these diseases and hence mortality declined[20,24,53,64]

It is therefore anticipated that with the increased environmental health and sanitation education in the experimental villages more use will be made of the environmental facilities provided instead of using streams for bathing, washing, toilet facilities, and also collecting water from these stream for cooking and drinking purposes.

The indicators that will be used to measure changes in environmental health and sanitation will be pit latrines, protected wells and garbage collecting sites.

The provision of these facilities are partly the responsibility of the chiefdom people and the local government.

If the environmental health education programme is successful the rural communities will make effort to build more pit latrines and garbage collection sites, and put pressure on the local government for funds for the improvement of existing wells of building more wells or even collect money on a voluntary basis or through fund-raising activities towards the improvement of existing wells or digging of new wells.

IV:4 Summary

Thus in selecting four outcome indicators for this study we have chosen two mortality rates which are direct measures of health relevant to the intervention and potentially sensitive to change. We have complemented these direct measures with a common morbid condition, malnutrition, which has a direct bearing on a wide variety of disease. Finally we have added an indirect measure (the introduction of clean water, sanitation and garbage control). While not a measure of health per se it is so clearly identified as a key precusor to improved health, that it qualifies as a valid outcome measure in its own right.

Table XI

Impact of health and nutrition improvements on mortality.

Project Area	Infant Mortality rate per 1,000 Live Births		Mortality rate per 1,000 children 1-4 years old	
	Before	After	Before	After
Indian Study[20]	120	81	19	10-13
Nigerian Study[20]	295	72	69	28
Guatemalan Study[20]	139	55	28	6

Source: World Bank Health sector policy paper 1980[20]

CHAPTER V

RESEARCH DESIGN

V:1 Objective for the Study

This study evaluates the effectiveness of trained medical assistants in improving the health status of rural Sierra Leoneans as measured by selected health status indicators.

V:2 Research Question

Does the introduction of medical assistants (replacing nurse dispensers) as members of the health care personnel servicing a chiefdom result in improved health status (as measured by the selected health status indicators) for rural communities in Sierra Leone when compared to chiefdoms that continue to be provided care by nurse dispensers?

V:3 Study Design

This study is directed at reliably establishing whether or not the intervention produces its intended effects. A critical element in estimating the effect of the intervention is the identification and selection of comparable experimental and control communities.

Comparability between experimental and control communities means in the broadest terms that the experimental and control communities should be identical except for the experience of the intervention. Exact

one to one comparability is impossible to achieve. Any two individuals who are identical in some respects such as age, sex are likely to be different in other respects such as life style and education. Similarly, two exactly identical communities would be impossible to find. However, identical one to one comparability is not necessary. It is only necessary that the control and experimental communities be identical in aggregate terms and in respects that are relevant to the intended effects of the intervention.

Comparability between experimental and control communities is best accomplished by randomly allocating communities. Whether a community is offered the intervention or not is decided by chance. Therefore a randomized control study would be the most favoured approach to obtain estimates of the effect of the intervention.

A randomized controlled experimental design with pre and post manoeuvre measurements is chosen to address the research question. (See Figure 5.1) The unit of randomization will be chiefdoms that meet the pre-set eligibility criteria (See Section V:3:2).

The pre-manoeuvre measurements will serve as the baseline measure. They will provide an indication of the similarity or differences in the health status indicators in the experimental and control chiefdoms. They will also be used to observe changes over time in the health status indicators after the manoeuvre. (See Chapter 4 for a description of the health status indicators)

V:3:1 Stratification and Matching within 'Strata'

When large numbers of people or communities are randomly allocated to either experimental and control groups, one would expect that the randomization process would equally distribute extraneous factors that may influence the outcome equally across the experimental and control groups. However in this study it is likely that the number of chiefdoms that will meet the pre-set eligibility criteria will be small. It is possible that randomization will not control for all the extraneous variables that might otherwise influence the outcome. To avoid any confounding effect, factors suspected as having influence on the outcome should be used as a stratification variable before randomization or as a matching variable after stratification. Such factors could be demographic or could be characteristics of the condition being studied. Chiefdom size is a factor believed to affect utilization of health services[76] and this will in turn reflect on the health status of the community. Thus chiefdom size will be used as a stratification variable. Chiefdoms will be divided into three strata:

(i) Chiefdoms between 6,000 and under 8,000 people.

(ii) Chiefdoms between 8,000 and under 10,000 people.

(iii) Chiefdoms between 10,000 and under 12,000 people.

Chiefdoms in each strata will be matched by distance to the nearest referral hospital. This variable is likely to be a confounder because it is believed that distance from a referral hospital might affect the utilization of the referral service and thus affect outcome.[76]

V:3:2 Selection of Study Communities

Inclusion/Exclusion Criteria

There will be set criteria for a chiefdom to be eligible to participate in the study. These criteria are:

(i) Existence of a health centre. This criterion is necessary because medical assistants and nurse dispensers will have to work from a health centre.

(ii) The Chiefdom must have a population between 6,000 and 12,000 people. This is necessary because:

(a) Only chiefdoms with a population of 6,000 and above have health centres. Chiefdoms below 6,000 people have either treatment centres or dispensaries.

(b) The upper limit of 12,000 people is selected because most chiefdoms with population above 12,000 people do have more than one health unit in the chiefdom.

(iii) The main occupation of each chiefdom must be farming and trading of local agriculture commodities. In Sierra Leone, occupation usually provides an indication of way of life and utilization of health care facilities. By choosing chiefdoms with similar occupations, the investigator can assume that the socio-economic status of the chiefdoms are comparable.

V:3:3 Selection of Study Communities (Chiefdoms)

The criteria for a chiefdom to be eligible to participate in the

study has been discussed earlier (Section V:3:2).

In order to identify communities that meet the inclusion criteria, the investigator will obtain pertinent information from the various ministries and departments in Sierra Leone. Information to identify chiefdoms with health centres and approximate distances of these chiefdoms from the nearest hospital will be sought from the Ministry of Health. The central statistics department will be asked to identify chiefdoms with population between 6,000 and 12,000 people. Finally, a list of chiefdoms that are involved only in small scale farming and trading of local agricultural commodities will be obtained from the Ministry of Economic Planning, Trade and Industries.

After the investigator has received all the necessary information for the various chiefdoms he will then select all the chiefdoms that meet the eligibility criteria. Based on the principal investigator's past experience, it is anticipated that between 10-15 chiefdoms in a district (geographic area)will meet the eligibility criteria.

The selection of eligible chiefdoms will be restricted to one district only, because of constraints such as transportation of research staff and limited financial resources that will be available to implement the study. The district in which the study will be conducted will be randomly selected from all districts that have sufficient chiefdoms that meet the eligibility criteria.

The chiefdoms selected will be stratified into three strata according to chiefdom size (See Section V:3:1). After stratification

the chiefdoms in each strata will be matched for distance to the nearest hospital (within 10 - 15 miles), before randomization to experimental and control chiefdoms (See Figure 5.1)

Once the chiefdoms have been selected and the randomization process completed, the investigator will arrange a meeting of all chiefs and elders of all the chiefdoms selected. The purpose of the meeting is to explain to them that the ministry of health wants to test three types of health care delivery systems (See Section V:4:3), to find out which is the most effective in improving health in the chiefdoms. Further, the investigator will explain to them that at the beginning of the manoeuvre they will have new medical assistants or nurse dispensers posted to their respective chiefdoms and that the nurse dispensers working in these chiefdoms presently will be transfered to other districts. The investigator will then solicit their cooperation. It is anticipated that the chiefs and the chiefdom people will cooperate. From past experience chiefdoms always cooperate on matters concerning their health.

V:4 Description of the Manoeuvre

The experimental manoeuvre in this study is the provision of health care by trained medical assistants to rural communities (chiefdoms) in Sierra Leone. The chiefdoms in the control groups will receive care from nurse dispensers. All medical assistants and nurse dispensers participating in the study are men (only men are trained as medical assistants and nurse dispensers to work in rural communities).

The medical assistants and nurse dispensers will be relocated to their respective chiefdoms just before the start of the manoeuvre.

Each chiefdom will have other health care personnel (maternal and child health aide, traditional birth attendants and public health aide). Maternal and child health aides and traditional birth attendants are women selected by the chiefdoms and trained by the ministry of health in elementary maternal and child health care practices. On completion of their training they return to their chiefdoms to work. The public health aides are men also selected by the chiefdoms, trained by the ministry of health in basic environmental hygiene and sanitation techniques. On completion of their training, they too return to the chiefdom to work. The ministry of health policy is that chiefdoms up to about 12,000 people have one maternal and child health aide, three traditional birth attendants and one public health aide. They usually work in the health centre and in the chiefdoms. The maternal and child health aide and the traditional birth attendants usually provide maternal and child health care services to the women and children in the chiefdom. Thus, stratifying on chiefdom size will also control the number of additional health personnel in the selected chiefdoms.

V:4:1 Selection of Health Care Personnel for the Manoeuvre

V:4:1:1 Medical Assistants

Inclusion/Exclusion Criteria

(i) They must have completed the prescribed course of training,

have passed the final examination, and graduated from the paramedical school at Bo in Sierra Leone.

(ii) They must have completed a 6 month post graduation internship.

(iii) They must have worked not more than six months after the internship (not more than 12 months after graduation).

These criteria have been selected to ensure that the medical assistants have comparable work experience.

V:4:1:2 Selection of Medical Assistants

All medical assistants that meet the pre set eligibility criteria (See Section V:5) will form the sampling frame for selection. (About twenty medical assistants are expected to meet these criteria.)

The investigator will request from the principal of the medical assistant training school a list of all graduates that meet the eligibility criteria. From this list the required number of medical assistants will be randomly selected using a table of random numbers and then randomly allocated to the experimental communities in each strata. (See Figure 5.2)

When the selection and allocation process of medical assistants has been completed, the list of selected medical assistants and their respective chiefdoms in which they will be working will be submitted to the ministry of health. The ministry will then take the necessary administrative action to transfer the medical assistants to their

allocated chiefdoms at the beginning of the trial. This transfer will not create any difficulty. All employees of the ministry of health can be transferred to work anywhere in Sierra Leone at the discretion of the chief medical officer.

V:4:1:3 Nurse Dispensers

Inclusion/Exclusion Criteria

(i) They must be in service in the Sierra Leone Ministry of Health.
(ii) They must have worked not more than 12 months after completion of their training as nurse dispensers.

Like the criteria for selecting medical assistants, these criteria for nurse dispensers have been selected to ensure that they have comparable work experience.

V:4:1:4 Selection of Nurse Dispensers

The required number of nurse dispensers to provide care to the control chiefdoms will be randomly selected from all nurses that meet the eligibility criteria. It is anticipated that about 30 nurse dispensers will form the sampling frame (See Figure 5.3).

The nurse dispensers selected will be randomly allocated to the control chiefdoms. The list of nurse dispensers selected and the communities that they will be working will be submitted to the ministry of health. The ministry will then take the necessary administrative action

to transfer them to their respective communities at the beginning of the trial. Like the medical assistants, the nurse dispensers are expected to work anywhere in Sierra Leone at the discretion of the chief medical officer.

V:5 Experimental Chiefdoms

Each experimental chiefdom will be assigned two medical assistants who will be asked to carry out the health care tasks for which they were trained. One of the two medical assistants in the chiefdom will be attached to the chiefdom health centre. The second medical assistant will be deployed in the community providing community health care duties on an out-reach basis. Selection of the medical assistants to either the health centre or the community will be done by random allocation.

The medical assistant engaged in community out-reach programmes will be based in the chiefdom headquarter town and will visit all subsections and villages in the chiefdom on a weekly basis spending at least one day in a section or village carrying out preventive, promotive and curative care as described in Chapter 3. He will prepare a monthly schedule for the various sections and villages within his chiefdom that he will be visiting. Copies of these schedules will be sent to the chief and the investigator. The chief will inform the respective villages the time the medical assistants will be in their village.

The medical assistants that will be based in the health centres will carry out curative care from the health centre. They will also

carry out promotive, and preventive health care activities as described in Chapter 3 to patients that report to the centre for treatment. They are expected to organize health and nutrition education classes for those coming to the health centre for treatment, antenatal clinic, and immunization of children.

V:5:1 Control Chiefdoms

Each control chiefdom willhave a similar number of maternal and child health aides, traditional birth attendants and public health aides to the experimental chiefdoms. The only difference between the experimental and control chiefdoms is that in the control chiefdoms, nurse dispensers will be the providers of care instead of medical assistants. These nurse dispensers are trained to provide only curative care to the chiefdom from the health centre. They will continue to function normally as they had been functioning before they were selected to participate in the trial. Three control chiefdoms will each be assigned one nurse dispenser while an additional three control chiefdoms will have two nurse dispensers assigned to each. Each control chiefdom with one nurse dispenser is matched with a control chiefdom with two nurse dispensers and an experimental chiefdom (with two medical assistants).

V:6 Methodological Issues with the Manoeuvre

Currently in rural Sierra Leone health care to chiefdoms with health centres is provided by one nurse dispenser, in addition to maternal and child health aide, public health aide and traditional birth attendants. In the proposed new system, two medical assistants would

provide care in addition to the maternal and child health aide, traditional birth attendants and public health aide. If these two systems were compared, the experimental and control chiefdoms would not have equal numbers of health care personnel. With this unequal number (two medical assistants to one nurse dispenser) one could not decide whether any change in the health status in the experimental chiefdom was attributable to the increase in number of health workers and/or the difference in training of the health workers as these two factors would be confounded.

There are three possible solutions available to solve the problem:

(a) Reduce the number of medical assistants from two to one in each experimental chiefdom.

(b) Increase the number of nurse dispensers in each control chiefdom from one to two.

(c) Design the study as such that there are three matched chiefdoms in a strata. The experimental chiefdom will have two medical assistants. The other two chiefdoms will form the control chiefdoms, with one having two nurse dispensers and the other having just one.

The third approach is selected because the ministry of health has decided that two medical assistants will be allocated to a chiefdom. It would be difficult to convince them to change this policy. There is

no fixed policy concerning the number of nurse dispensers per chiefdom. They have been using one just because the need for two did not arise. However, the second approach is also rejected because the investigator will not be able to detect the changes that increasing personnel alone will create.

Having two nurse dispensers per control chiefdom providing only curative care may also create some methodological problems. It is possible that the workload of these nurse dispensers will be lessened, giving them more time to engage in other activities that they are not particularly trained to carry out (i.e. holding discussions with the chiefs and chiefdom authorities on health related matters paying casual visits to other sections in the chiefdom and carrying out informal health education activities).

The extent to which the nurse dispenser uses his additional time to undertake non-curative activities will be monitored (see compliance section later). These activities will of course, not be discouraged but neither will they be encouraged. The nurse dispensers will be left to their own devices as to how they use their newly found time.

With the third approach the three chiefdoms in a strata (similar population size) will be matched for distance to the nearest referral hospital. One of the three will be randomly allocated to be the experimental chiefdom. The other two will form the control chiefdoms. One of the two control chiefdoms will be randomly allocated to have two nurse

dispensers, whilst the third chiefdom will have one nurse dispenser. In addition to the medical assistants or nurse dispensers each chiefdom within the strata will have similar number of maternal and child health aides, traditional birth attendants and public health aides. This design will enable the investigator to estimate the effects of increasing personnel as well as training of personnel on the health status of the people in the chiefdoms (See Figure 5.1)

V:6:1 Co-intervention

To assess the "true" effects of the manoeuvre, the investigator will try to ensure that no other programme apart from the manoeuvre is introduced in any of the study chiefdoms. If this is not possible, then every effort will be made to see that the other programmes that are being introduced are carried out equally in all study chiefdoms.

V:6:2 Contamination

This is the inadvertant administration of the manoeuvre to members of the control chiefdoms. Fortunately this will not be an issue in this study. There is usually very little interaction between chiefdoms in rural Sierra Leone. Thus it is not anticipated that families from the control chiefdoms will move to the experimental chiefdoms for health care.

V:6:3 Compliance

Traditionally compliance refers to the fact that patients take the drugs prescribed or keep to a regime given to him by the physician. The manouevre in this study is directed to the chiefdom as a whole and

not to individual community members in the chiefdom. Therefore, individual community members' compliance is not an issue. The issue here is to determine whether or not the medical assistants and nurse dispensers do comply and carry out only expected duties for which they were trained. This can be monitored either by direct observation over the entire duration of the manoeuvre or by making unannounced random spot checks to see if they are performing their expected duties.

(I) Direct Observation

This involves having a trained observer in each health centre in the study chiefdoms throughout the duration of the manoeuvre, monitoring the performance of the medical assistants or nurse dispensers. This method can be a very expensive venture and the presence of the observers in the chiefdoms may itself be an intervention and produce a reactive (Hawthorne) effect. Another problem with direct observation is that observers report may be flavoured with the pre-conceived ideas of the observer.

(II) Spot Checks

Regular unannounced visits on randomly selected days is the second alternative available to monitor their compliance. A member of the research team will visit study chiefdoms unannounced and indirectly observe the performance of the medical assistants or nurse dispensers. This will not create any Hawthorne effect because the research team member will not only be observing how medical assistants and nurse dispensers carry out their expected duties, but will also have routine

discussions with the health centre staff, the chiefs and the chiefdom people as a whole. He will also use these unannounced visits to see if the medical assistants in the out-reach programme are adhering to their schedule. The nurse dispensers or the medical assistants will not even know that their performance are being monitored, as such visits from the ministry personnel are routine.

Bearing in mind the practical difficulties in terms of cost and reactive effects direct observations may have, compliance will be checked by the second alternative given above (unannounced spot check). It is proposed that about 5 spot visits will be made per month to every study chiefdom. These visits will not follow any definite pattern. At the beginning of every month the investigator will randomly select days for the month in which a member of the research team will make the unannounced visits.

V:7 Duration of the Study

The study will be carried out over a period of 52 months (See Table XII). The manoeuvre will last for 32 months. This length of time is needed to ensure the manoeuvre has had sufficient time to make an impact on the health status of the people in the chiefdom. Most studies reported in the literature[4,5,20] in which curative and preventive health care programmes were seen as having an impact on the community were conducted over a 24 month period. The additional eight months in this study is to enable the medical assistants and nurse dispensers to adjust to their new environment.

V:8 Blinding of Medical Assistants and Nurse Dispensers

The medical assistants and nurse dispensers participating in the study will be blinded to the research question and to the outcomes of interests. This is necessary to prevent them devoting most of their time and efforts only to procedures that will influence the outcomes measured. If this happened the health indicies measured would not reflect the general health status of the chiefdoms.

V:9 Generalizability of the Results

The result of this study are generalizable to the newly trained medical assistants and nurse dispensers and provide information regarding their relative effectiveness in improving health care in rural communities of Sierra Leone. The medical personnel participating in the study represent about 30% and 18% of all recently trained medical assistants and nurse dispensers respectively. The selection of participating medical assistants and nurse dispensers will be done by random selection and not on the basis of grades or previous performances. Thus the selection procedure should ensure a representative group of both medical assistants and nurse dispensers who have demonstrated a spectrum of previous performances will be included.

V:10 Sample Size

a) Available Sample

Like many trials of this nature, sample size is not totally under

the control of the investigators. Thus, rather than posing the question of sample size in terms of "what size is necessary to reliable detect a particular effect (if present)", we must ask "what effect can we reliably detect with the available sample size".

As discussed in the design section this study can only feasibly be conducted in one district of Sierra Leone and that probably about 10 - 12 of the district's chiefdoms will meet the entry criteria. Conservatively, we thus expect to randomize three chiefdoms to each treatment totalling perhaps 27,000 people per treatment. From the country's demographic statistics (See Chapter I) we can expect to estimate infant mortality rates from about 1270 births per treatment group, and the prevalence of malnutrition from 4600 children per group (this will also apply to under five mortality).

b) Within Chiefdom Changes

Although the important research questions are between groups of chiefdoms, we may also be interested in testing before to after changes within individual chiefdoms. Since three out of the four outcome indices are simple binomial proportions, it is a straight forward matter to determine the power to detect various changes given the above sample size. In Table XIII we have calculated the change associated with an 80% power for the three outcomes infant mortality, 1 - 5 year mortality, and malnutrition rate. We have done this for the expected population sizes of the three chiefdom strata. The results show that we can reasonably be sure of detecting changes of the order of 8% in the expected infant

mortality rate of 27%. Similarly, we will be able to reliably detect changes as small as 5% in the 1 - 5 year old mortality rate, whereas changes of only 4% could be picked up in malnutrition rate. This last index will, in fact, be treated as a continuous variable in the analysis, but for simplicity here we have dictotomized it. We have no available data on the statistical properties of the change in the number of sanitary facilities and so we cannot consider them here.

c) Between Group Changes

Two basic features of this study make sample size assessment difficult. The first is that random allocation is actually by chiefdom and thus it is the between chiefdom variance which will dominate the test's performance. Secondly, we will be analysing the mean change scores as the basic data in the test and thus to assess sample size we need, among other things, an estimate of the standard deviation of these scores between chiefdoms.

As in most practical situations, we have resorted to some simplifying assumptions. Firstly, we have assumed the best possible situation namely that there is no additional between chiefdom variation and the inherent variability in the change score is the result of the random sampling of two binomial proportions. As an alternative conservative calculation, we have assumed that there is substantial additional variation which doubles the minimum standard deviation and causes us to adopt a student's t test between a pair of treatment groups rather than a test based on the normal approximation to the binomial. Whether this is

conservative enough cannot be judged until we have some data for actual chiefdoms, but it would seem reasonable. We have used one side 5% α levels for all calculations.

The resulting power curves are presented in Figure 5.4, the left hand curve being the result of the liberal approach and the right hand one the "conservative" assumption. The implications of these curves is that the available sample size should achieve 80% power against absolute reductions in infant mortality rate of 7 - 14%, which from the literature review earlier is within the range that has been observed in earlier studies. The equivalent effects detectable with 80% power for the 1 - 5 year old mortality is from 4 - 9% which again is in line with what we might achieve based on the other studies. Finally, the situation for malnutrition is quite adequate with the 80% power effects being 3 - 8%.

We thus conclude that based upon fairly conservate assumptions the available sample size will provide adequate power for realistic effect sizes.

Table XII

Duration of the study

Time 1982 as an example	Activity	Groups Carrying out activity
Sept. - Nov. 1982 3 months	Selection of study communities medical assistants and nurse dispensers. Pre testing of survey instruments	Research team
December 1982 1 month	Meeting with chiefs and chiefdom authorities in the study chiefdoms to explain purpose of study and to solicit their cooperation of the communities	
Jan. - April 1983 6 months	Pre manoeuvre data collection	Survey teams
February 1983	Notification of nurse dispensers and medical assistants of their transfer to their allocated chiefdoms	Ministry of Health
May 1983	Relocation of medical assistants and nurse dispensers to their respective chiefdoms	Ministry of Health
May - Dec. 1983 Jan. - Dec. 1984 Jan. - Dec. 1985	Manoeuvre: 32 months	Medical assistants and nurse dispensers
Jan. - April 1986 4 months	Post manoeuvre data collection	Survey teams
May - Dec.1986 8 months	Final analysis writing of report	Research team

Total duration of the study - 52 months

Table XIII

Within chiefdom changes corresponding to 80% power

Outcome	Chiefdom Population Size		
	7000	9000	11000
Infant Mortality (27%)*	8.5%	7.5%	6.8%
1-5 Year Mortality(25%)*	5.0%	4.5%	4.1%
Rate of Malnutrition (30%)*	4.6%	4.1%	3.7%

* Expected current rates

Figure 5.1

Flow chart of study design

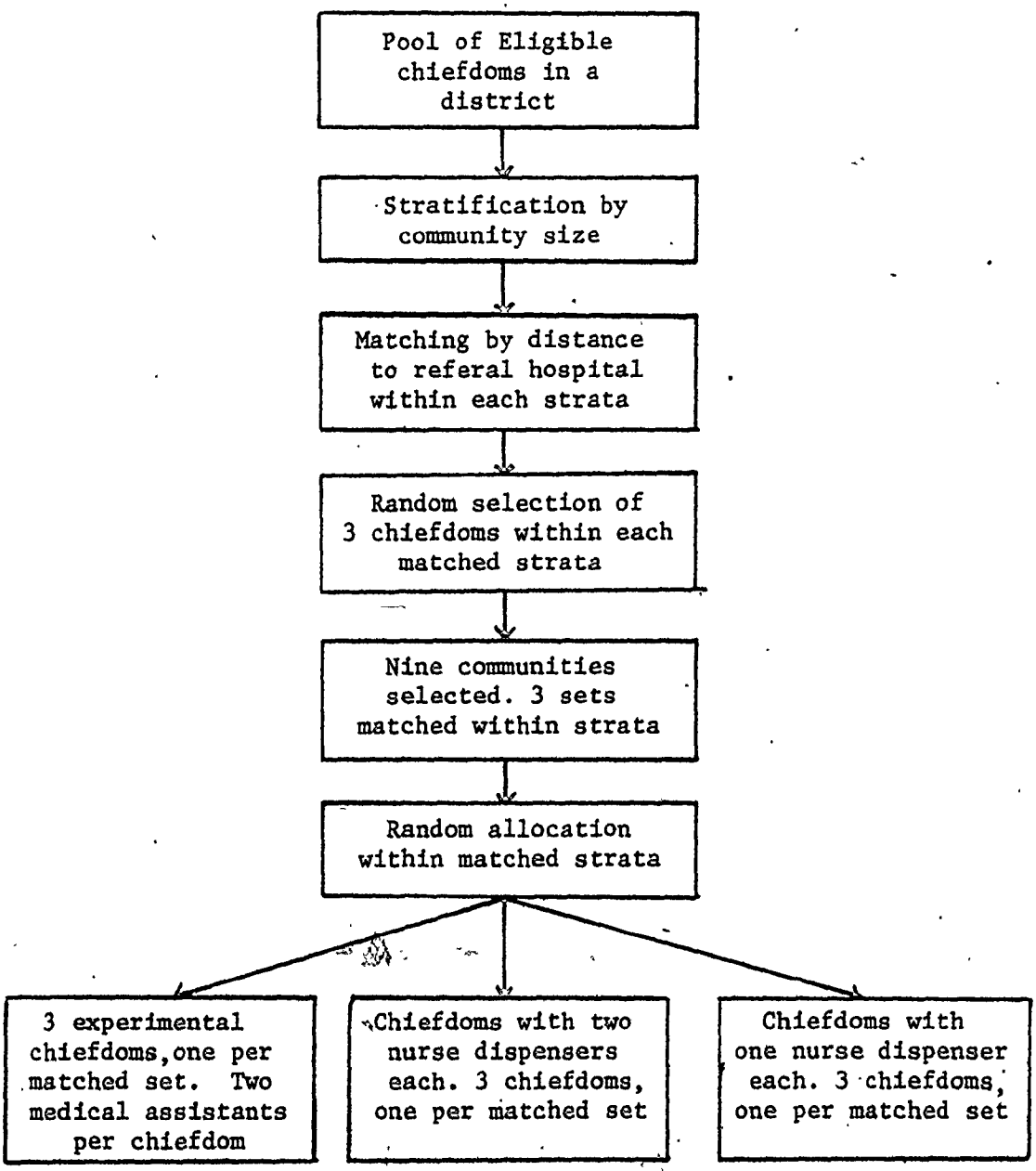


Figure 5.2

Flow chart for selection of medical assistants

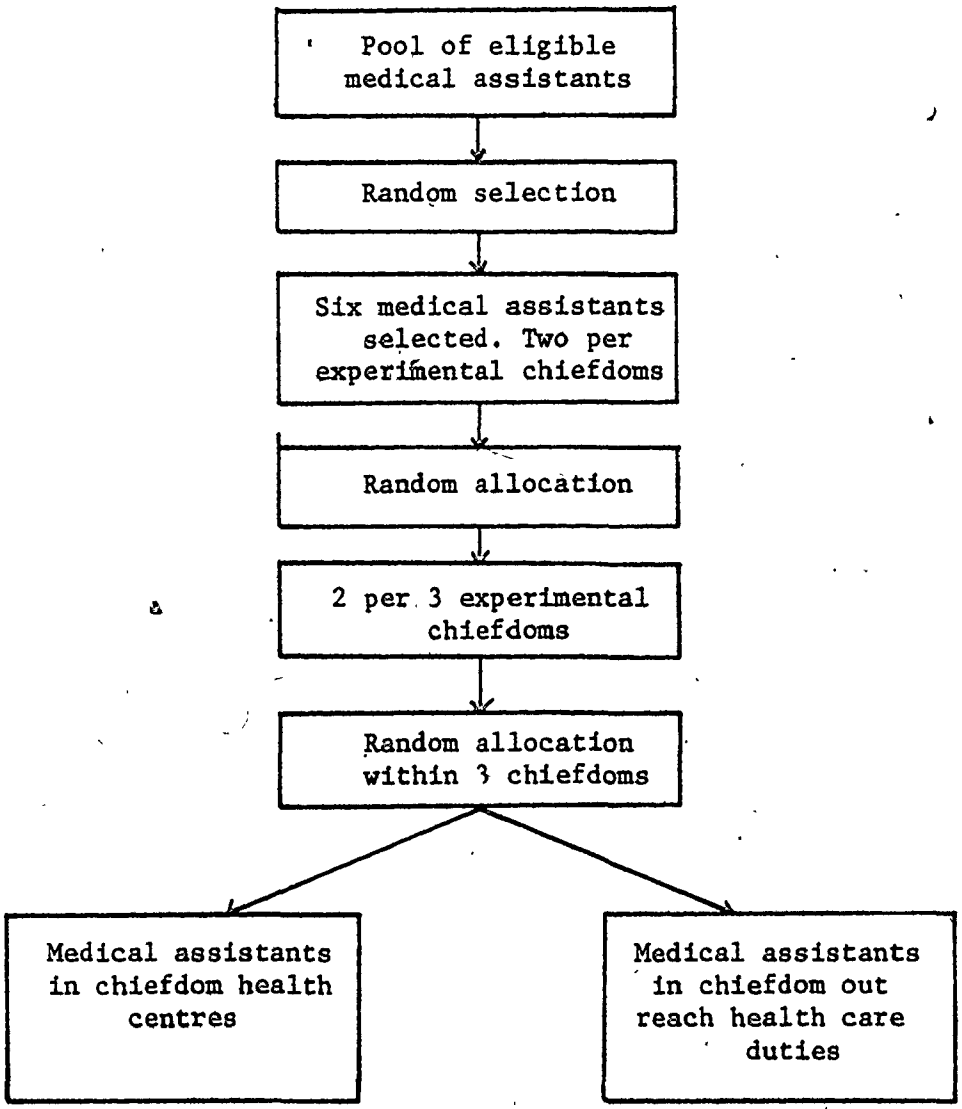


Figure 5.3

Flow chart for selection of nurse dispensers

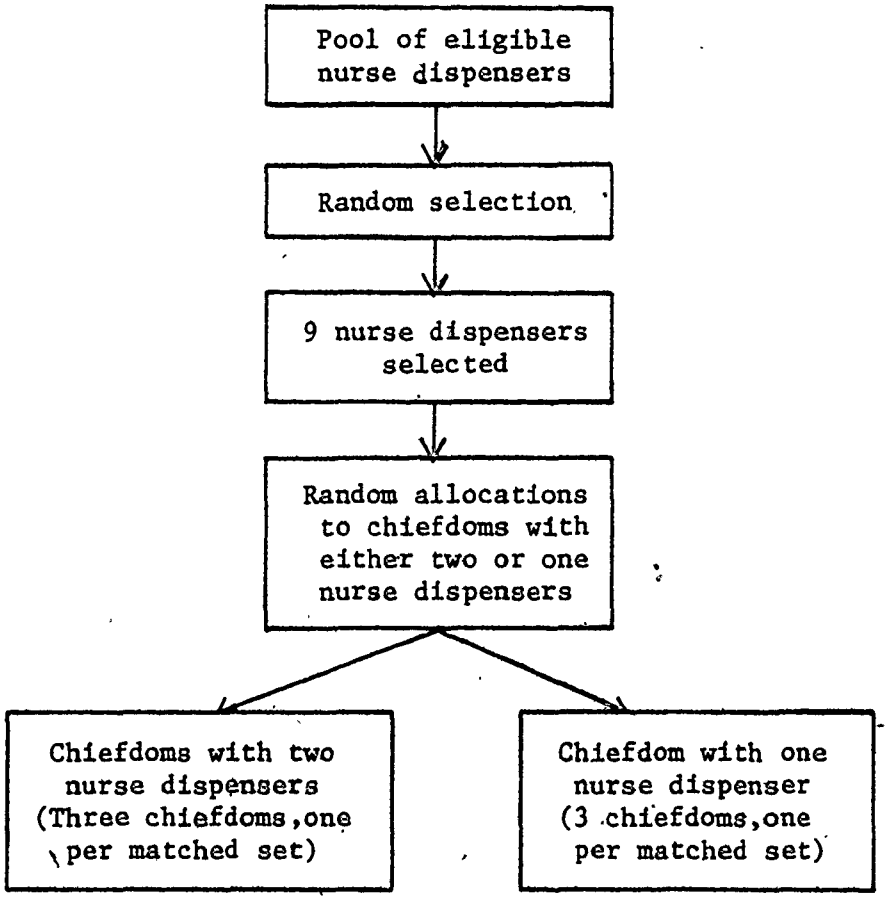
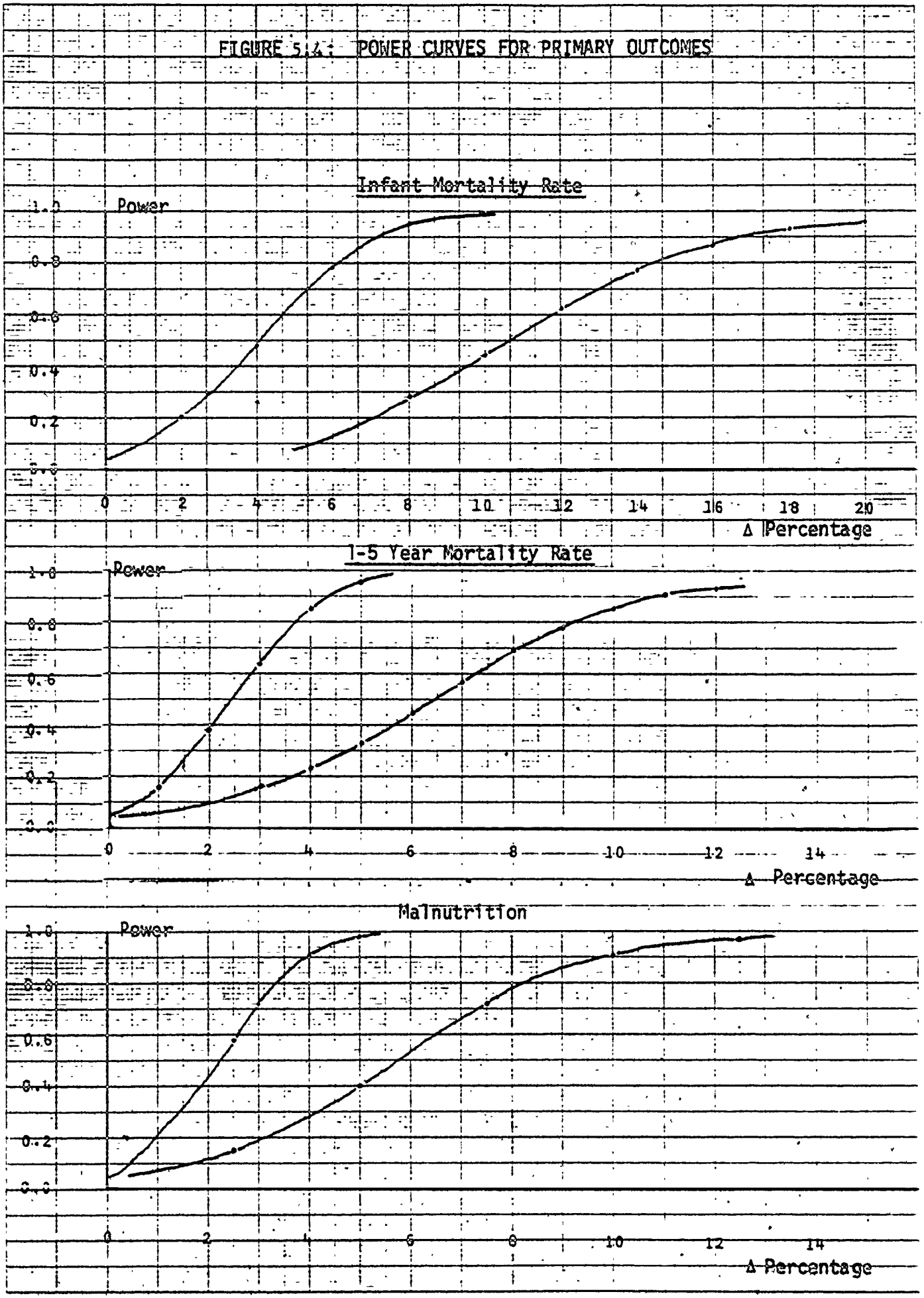


FIGURE 5.4: POWER CURVES FOR PRIMARY OUTCOMES



CHAPTER VI

MEASUREMENT

VI:1 Measurement of Health Status Indicators: An Overview

To measure health status it is necessary to select the appropriate indicies, to select methods for acquiring the data, and to ensure the indicies and methods used are reliable and valid.

The indicies that will be used to measure the chiefdom health status for this study before and after the manoeuvre are:

(i) Infant mortality rate

(ii) Childhood mortality rate

(iii) Prevalence of malnutrition in children under five years of age, and

(iv) Number of pit latrines, wells and garbage collecting sites.

(See Chapter IV for the justification of their use)

To measure the above indicies the following data will be required:

(i) Population at risk at the time of the survey

(ii) Number of births in the previous 12 months

(iii) Number of deaths among children born in the previous 12 months

(iv) Number of deaths among children under five years of age in the

previous 12 months

(v) Number of pit latrines, wells and garbage collecting sites at the time of the survey.

The required data will be obtained from a special health survey that will be conducted. This health survey will be conducted in all study chiefdoms in the pre and post manoeuvre period. The methods to be used to obtain these data by the health survey teams are discussed in the next sections.

VI:2 Survey Teams

Experienced survey teams under the direction of a member of the research team, will be responsible for the execution of the survey. Currently in Sierra Leone there is a field survey unit attached to the Endemic Disease Control unit. The investigator will request permission to utilize the field staff of this unit from the officer in charge of the unit. It is anticipated that approval will be granted as this field survey unit was formed in order to have trained personnel ready to conduct field surveys of interest to the ministry of health. The staff in this unit have participated in several surveys, and are quite experienced in field work.

There will be three survey teams, one for each matched set of chiefdom in a strata. Each team will consist of 10 field assistants from the survey unit from the endemic disease control unit, and a local representative of the chiefdom nominated by the chief in the chiefdom

they are working. A local community representative is included to improve the acceptance of the survey teams by the chiefdom people.

Each survey team will select a team leader from amongst members of the team. The ten members of the team will work in pairs once they are in the chiefdom (five interview teams). The chief representative will alternate visits among interview teams. He will not participate in any of the duties of the survey team.

The survey teams will be responsible for carrying out the following duties:

(i) Determination of the number of children under five years of age in the study chiefdoms by household.

(ii) Collection of information on the number of deaths in children under five years of age for the previous 12 month period (January - December) prior to the survey.

(iii) Collection of information on the number of births for the previous 12 month period (January - December) prior to the survey and ascertainment of the number of deaths among these children born during that 12 month period.

(iv) Measurement of the nutritional status of all children under five years of age identified in (i).

(v) Mapping of all pit latrines, wells and garbage collecting sites that meet the ministry of health criteria in force at the time of the survey.

The survey will be conducted in both the pre and post manoeuvre periods in all the study chiefdoms. Because of seasonal variation in nutritional status in children in Sierra Leone, the survey will be conducted during the same season in the pre and post manoeuvre. The survey will be conducted over a period of 16 weeks in each period. In order to reduce observer variation, the same survey team will be used in each of the matched set of three chiefdoms in a strata.

They will work for one week at a time in each of the three chiefdoms in the strata, alternating among chiefdoms until the survey is completed. This method is adopted to minimize any seasonal effects on the data, and changes in data collection as experience with this survey increases. Also, additional differences in data collection attributable to the survey team will be minimized within the matched set chiefdoms in the strata. The survey teams will be blind to the research questions and the purpose of the study. The objective here is to avoid the effects of prior expectation, which might otherwise influence data gathering.

At the end of each day during the survey, the interview teams will meet and they will check each other's work, to monitor the quality of data collected. This method could ensure data not recorded or recorded illegibly gets properly recorded. Also they will use this time to plan the next day's work, and arrange their time schedule to accommodate those households that either the children were out or there were no adults to provide pertinent information when these households were

visited during the day. A member of the research team will make regular (up to about 3 visits per week) unannounced spot checks to monitor the quality of data collection.

VI:3 Methodological Issues in Survey Design

The methodological decisions of a survey design fall into three broad groups:

(i) From whom the data will be collected. This involves the definition of the target group and both geographical and demographic boundries.

(ii) Methods for collecting the required information (Personal interviewing self administered questionnaire).

(iii) Coverage. Complete census (100% survey) or sample survey.

For this study information about the health status of children under five years of age and the sanitation facilities (pit latrines, wells and garbage collecting sites) that meet the ministry of health criteria at the time of the survey in a geographically defined community (chiefdom in this study) is needed.

The method for collecting the required data will be a structured face to face interview. In the structured interview method, the interviewer follows a well defined format of an objective questionnaire. This method is selected because it is the only feasible one. Mail questionnaire or telephone interviewing are not possible in rural Sierra Leone because there are no telephone networks and about 60% of the rural

population cannot read or write.

The data on the number of wells and garbage collecting sites which meets the ministry of health criteria will be collected by mapping the wells and garbage collecting sites in the chiefdom using a key informant (eg. village elders, local school teacher). The reason for this is because these facilities are being used on communal basis. The remainder of the data needed will be gathered in a survey of all households in the study chiefdoms in both the pre and post manoeuvre period. Although a sample survey is quicker and more economical than a total survey, the total survey is chosen for two major reasons. No appropriate sampling frame exists. A list of all households in the rural chiefdoms from which the sample will be drawn is not available. Further, there is great variability in household size (3-20 children) due to extended family units living in the same household and the polygamy that exists in rural Sierra Leone. This makes the estimation of the number of children in the rural community from even a sample of 50% of households imprecise.

VI:4 Methods of Data Collection

Data on mortality, nutritional status and pit latrines (See Table XIV) will be collected by a house to house survey using a structured questionnaire. When a survey team (interview team) visits a house, a member of the team will request to see the head of the household. If the head of the household is not available he will ask to see any responsible adult who is in a position to supply the required information. He

will then explain the purpose of the survey and will request the following information:

(i) Number of children under five years old at the time of the survey (children under five years of age is defined in this study as all children that have not reached their fifth birthday on the day of the survey) living in the household. If there are any children under five years of age, their names, age and sex will be recorded and their nutritional status will be assessed (See Section VI:6).

(ii) Any birth in the household during the past 12 months (January - December) prior to the survey. If there had been any births, the interview teams will enquire about the status of all children born during that period to ascertain the number that have died.

(iii) Any childhood deaths (under fives) during the past 12 months period (January - December) prior to the survey. If there had been any deaths,then the teams will record the names and sex of the children that died, their age at death and date of death if known.

(iv) The availability of pit latrines in the household. If there is one, a member of the team will request to see it to verify it exists.

In every 10th household birth certificates will be requested to verify the age of the children given. In cases where birth records are not available, the parental declaration of the childs age combined with

a calender of local events will provide the basis for age verification. This later method has been found to be reliable in rural Sierra Leone.[52]

Since wells and garbage collecting sites are used on a communal basis, information on the number of wells and garbage collecting sites will be obtained not at the household level, but at the community level.

The chief will be asked to identify a member of the chiefdom (key informant) who together with the survey team leader will visit all the wells and garbage collecting sites in the chiefdom. The survey team leader will then map all the wells and garbage collecting sites in the chiefdoms that meets the ministry of health criteria in force at the time of the survey.

VI:5 Justification for Collecting Mortality Data at the Household Level

Although registration of births and deaths in Sierra Leone is compulsory by law, there is still underreporting of births and especially deaths in the rural communities. Unless this underreporting is improved, infant and childhood mortality data will be biased. In the pre-manoeuvre period, the underreporting of deaths should occur equally in the experimental and control chiefdoms. But in the post manoeuvre period, because the medical assistants are trained to increase statistical reporting of health related matters, it is possible that the experimental communities in which they will be working will increase reporting (stop underreporting) of these health related vital statistics. If this occurred the experimental chiefdoms could show an increase on infant and childhood mortality when in fact a positive change (a decrease in number of deaths

per 1,000 children) has occurred.

A major limitation in collecting data on infant and childhood deaths at the household level is that there also may be some underreporting. Taiwo et al.[82] in a sample survey of 250 households in a rural community in Nigeria, reported an 87% recall rate of deaths in children under 10 years old and 76% for perinatal deaths for a 24 month period. It is anticipated that the recall rate for deaths in this study will be higher than those reported by Taiwo et al.[82], because of the shorter duration for the recall (12 months). Further, since this underreporting is equally likely to occur in the experimental and control chiefdoms in both the pre and post manoeuvre period, it will not bias the assessment of effects of the manoeuvre.

VI:6 Assessment of Nutritional Status

The nutritional status of all the children under five years of age identified in the study chiefdoms at the time of the survey will be assessed. Anthropometric measurement will be used to measure the nutritional status. This method is selected because it is simple, quicker and inexpensive when compared to other clinical and biochemical methods. It can also be done by lay personnel with very little training.

There are a number of anthropometric measurements available to measure nutritional status. The commonest are; weight for age[40] weight for height[41] and arm circumference for height.[2] The weight for age and weight for height are usually not ideal for field settings because

accurate scales are necessary for measuring weight and scales often do break down. For this study it is proposed to use the arm circumference for height (Quaker arm circumference technique)[2]. This method utilizes arm circumference to determine weight, since the primary components of body mass (muscle and adipose tissue) are also the major constituents of arm bulk. Height is an alternative for age because it is a summation of growth and it is not reduced in acute malnutrition[5,40]. This method relates arm circumference to height and is applicable within the range of 70 to 132 cm. Three groups of nutritional status will be defined.

(a) Well nourished (85% and above of the expected arm circumference for height);

(b) mildly undernourished (80% and under 85% of the expected arm circumference for height);

(c) malnourished (below 80% of of the expected arm circumference height).

This method of classifying nutritional status has also been used previously in West Africa[5].

A major limitation of this method is that there is no upper limit for a well nourished child. An obese child will be classified as well nourished.

There are two ways in which the nutritional status can be assessed. Either recording arm circumference and height and then later

classified the observation using Morley's and Wolanskis table[2], or use the Quac stick in which the expected arm circumference for a specific height are marked directly on the stick at the corresponding height levels. The method of choice in this study depends on the result of the pretesting of the instrument (See Section VI:7:2).

VI:7 Reliability of the Quaker Arm Circumference Technique

This method was first used in Nigeria[2] in 1969 to assess nutritional status. Since then various studies have been demonstrating its reliability and validity as an indicator of nutritional status.[40] It is a reliable and valid indicator of nutritional status when applied consistently and correctly. A high level of agreement between the survey teams using this method is required for this study. The reason for this is to reduce observer variation. In this study such variation may increase error variance and obscure a real difference.

VI:7:1 Pretesting of Survey Instrumentation

Before the start of the survey the survey teams will be given a brief training on the use of the questionnaire that will be used to obtain data at the household level and the use of the Quaker arm circumference technique. After their brief training sessions, the survey instruments will be pre-tested. The purpose of this pre-test is to determine the following:

(i) Is the content of the questionnaire appropriate to obtain the information required?

(ii) Will the information obtained be reliable?

(iii) Is there a high level of agreement between the survey teams using the Quaker arm circumference method to assess nutritional status?

VI:7:2 Pretesting of Questionnaire

A sample of about 40 household in chiefdoms not participating in the study and for whom there are records of births and deaths (from registry data) in the last twelve months will be selected. The survey teams will interview the head of the household. At the end of the interview, the interview team will be asked about the clarity of the questions. Two to three weeks after the completion of the interviews, the survey team will visit these households again and conduct another interview using the same questionnaire. The answers from the two interviews will be examined to see the degree of disagreement. The intra-household agreement will be calculated and a 90% agreement will be the accepted level for the method to be adopted. If a lower level of agreement is reached other methods of collecting the data will be decided upon by members of the research team.

For assessing the inter and intra rater agreement of the survey teams in assessing the nutritional status, 120 children under five years of age will be randomly selected from a district headquarter town not participating in the study. Two experienced nutritionists from the ministry of health will be asked to assess the nutritional status of those 120 children twice. The order of the second assessment will be

randomly varied. A 95% or above agreement on their classification of these children will be accepted as the gold standard. The two nutritionists will record the arm circumference and height of each child and the data will be classified into three nutritional status categories: malnourished, mildly undernourished and well nourished using Morleys height data and Wolanskis arm circumference figures (See Appendix II).

Once the "gold" standard has been determined, the survey team members will each examine all the 120 children twice (40 children per survey team). The order of the second assessment will also be randomly varied. Every team member will be asked to record observation for one group of 20 children and inference on another 20 children (the order will be randomly chosen).

The observations recorded will be classified to either malnourished, mildly malnourished or well nourished according to Morleys and Wolanskis figures? The inferences will be recorded as malnourished, mildly undernourished and well nourished directly from the Quac stick (See Appendix II).

The investigator will then examine the data to see which set of measurement (observation/inference) approximate the gold standard best across survey teams. In the main study observation (arm circumference to height later classified) will be used, unless this pretest result shows that recording inferences directly from the Quac stick categorizing these children into three categories (malnutrition, mildly undernourished and well nourished) best approximate the gold standard across the survey

teams.

VI:8 Duration of the Survey

It is estimated that the survey will be conducted over a period of four months in both the pre and post manoeuvre periods of the study. Four months will be needed if one estimates that the average chiefdom will have about 600 households. If each interview team spends one hour per household including travelling time between households in the chiefdom then 600 hours will be required to complete the survey in a chiefdom.

Each survey team consists of 10 members. They will work in pairs (five interview teams) once they are in the chiefdom. Each interview team will be expected to interview 6 households a day (3 before lunch and 3 after lunch). The last hour every day will be used by the interview teams to monitor the quality of each others data (See Section VI:2) and plan their schedule for the next day and also decide on the time that they will return to any household that data were not obtained either because the children were not available or an adult to give the pertinent data were not available. If we estimate that they have to return to 10% of the households in the chiefdom, then an additional 60 hours will be needed. Thus 660 hours will be needed to complete the survey in a chiefdom. With the survey teams working 6 hours a day collecting data, 22 working days will be needed for the five interview teams to complete a chiefdom. Since the same survey team will conduct the survey in the three matched chiefdom in a strata (experimental and

2 controls), 66 working days (13 weeks) will be required to complete the survey. The remaining three weeks is allocated for travelling time between chiefdoms.

Table XIV

Summary of type of data that will be collected

Health Status Indicators	Data to be Collected	Source of Data	Who will Collect Data	From whom Data will be Collected	Duration of Data Collection
Infant Mortality	Number of Infants Death in a 12 month period (Jan. - Dec.) Number of children born in the same period.	Household	Survey Team	Head of Household	16 weeks
Childhood Mortality (under fives)	No. of under fives deaths in a 12 month period (Jan.-Dec.) No. of children under five years of age at time of survey.	Household	Survey Team	Head of Household	
Malnutrition in the under fives	Arm circumference and height of children under five years of age	Household Survey Measurement	Survey Team	All children under five in each household in the chiefdom	
Pit latrines	Number of pit latrines	Household Survey	Survey Team	Head of household (verified by direct observation of a survey team member)	
Wells and garbage collecting sites	Number of wells and garbage collecting sites	Mapping of all wells & garbage collecting sites	Leader of survey Team	Key informant (community member) and site visits	

CHAPTER VII

ANALYSIS

VII:1 Unit of Analysis

The analysis of this trial is clearly complicated by the fact that allocation has been by chiefdom as opposed to individual subject as is more usual. Allocation by group was, of course, the appropriate tactic given that the intervention can only be applied to groups of people.

Since the allocation was by chiefdom, we must resign ourselves to the realization that we have only 9 independent pieces of data for each outcome. Each of these are very precise in their own right because they are based on hundreds of subjects. However, we must be prepared for the possibility of an important extra source of variation resulting from chiefdom to chiefdom differences. While we fully expect there to be variation between chiefdoms, we hope that it will be much reduced in our study by the tactics of a) stratifying on the basis of size, b) using before to after change scores.

VII:2 Summarization of Data

The first step in any data analysis is to summarize the mass of data into a few usable statistics. We will now look at the four outcome variables in turn to describe the approach.

V11:2:1 Infant Mortality Rate/1-5 Year Mortality Rate

The direct method of estimating say infant mortality rate (death within the first year) would be to monitor births over a period of time and then revisit the homes one year later to see if the child was alive. This is not quite what will occur in this study because we plan to conduct a cross-sectional survey. Thus, by asking two questions a) how many births have occurred in the last 12 months, and b) are these children alive on the day of survey, we will have a spectrum of lengths of follow-up from very recent births to those almost one year old.

The crux of the summarization process is thus to combine these data into a single "best estimate" of survival at 1 year or its complement, infant mortality rate. One can see that we are faced with a very similar problem for the 1-5 year old data in that we will have a full year of follow-up, but on a variety of differently aged children from which we would like to estimate the cumulative mortality in the 1-5 year period.

This is a classic situation for the application of the life table technique.[9] The method builds up the cumulative survival (and thus cumulative mortality) by producting the individual probabilities of surviving earlier time intervals. The value is that even though a subject has not been followed to say one year their data will contribute to earlier time points which, in turn, will improve the precision at the one year point.

Figure 7.1 is a schematic of the data available for the life table. From the survey of new births (within the last 12 months) we will have an approximate date of birth and either an approximate death date or age at the time of survey. We have used the word "approximate" here because it may be difficult for the parents to recall an actual date. However, estimates within one month would be adequate precision in our view.

The lower half of Figure 7.1 indicates the data available for the 1-5 year olds. For children in this age group alive on the day of survey we will ascertain their age and thus their age one year earlier. For all deaths that have occurred in the previous 12 months we will ascertain the date of death and age at death, and hence the age one year prior to the date of survey.

The actual calculation of the life table is illustrated in Figure 7.2 in which we have placed the individual periods of observation on a common age scale. Newborns in the previous 12 months are observed from birth (year zero) through to either death or the age at survey (up to one year). Children who are one or more at time of survey are observed from their age at one year before survey for 12 months (if alive at survey) or to death. In the example calculation we have divided the time scale up into six month periods and calculated a) the number of subjects alive (ie. at risk) at the start and end of the period, b) the number of deaths during the period, c) the number of live withdrawals during the period (ie. those who were surveyed alive during the period). Following this we have applied the standard life table procedure to estimate the probability of surviving

each period and the cumulative survival (the product of the preceding interval survival probabilities).

When the actual data are analysed, we propose to use one month periods up until one year and 3 month periods from 1 to 5 years. Although in the example calculation we have adopted the standard assumption that live withdrawals on average are at risk for half the period, we will, in fact, have actual follow-up times which will make the calculation slightly more precise. Finally, the bottom line of this exercise will be an estimated cumulative mortality at 1 year and in the 1-5 year period for each chiefdom, together with their associated standard errors.

V11:2:2 Malnutrition

The nutritional status of each child surveyed will be measured in terms of the arm circumference for height index. The summarization procedure will be to calculate an age standardized mean (and associated standard error) separately for each chiefdom and separately for pre and post experiment data. The standardizing age structure will be the pooled population of children from all chiefdoms and both surveys.

V11:2:3 Sanitary Measures

The two surveys will collect information on the presence of pit latrines in each dwelling and inquire/inspect community water sources and garbage disposal facilities. The latrine information will

be treated as a paired binomial outcome and summarized in a four-fold table (see dummy table XV) for each chiefdom. The presence or absence of clear water and good garbage disposal will be quantified on a community basis. Again, the information will be summarized as in table XV , but now the sum frequency, labelled N in table XV , is equal to the number of communities surveyed as opposed to households.

V11:3 Before/After Changes

Although not directly relevant to the research questions, analysis will commence by testing the statistical importance of observed before to after changes within each chiefdom. For the two life table outcomes this will involve a z test of the form:

$$z = \frac{P_B - P_A}{\sqrt{Var(P_B) + Var(P_A)}}$$

where P_B is the infant mortality rate, and $Var(P_B)$ its associated variance resulting from the life table analysis of the before data. The corresponding values from the after survey data and P_A and $Var(P_A)$. Then z is an approximate standard normal variate which will provide a test of the hypothesis that the before and after infant mortality rates are equal in the chiefdom. A similar approach will be adopted for the 1-5 year mortality rate.

The change in mean nutritional score will be tested also with a z statistic:

$$z = \frac{\bar{x}_B - \bar{x}_A}{\sqrt{Var(\bar{x}_B) + Var(\bar{x}_A)}} .$$

$$Var(\bar{x}) = \sum_{j=1}^{5} P_j^2 \frac{S_j^2}{n_j}$$

where P_j = proportion of standard population in the j^{th} age group

S_j = standard deviation of the index in the j^{th} age group

n_j = number of observations in the j^{th} age group

Since the volume of data will be quite large in each age group the z test is appropriate rather than the student's t.

Changes in the prevalence of pit latrines, clean water, and garbage disposal facilities will be tested using a McNemar chi square test[9], directly on the data in Table XV. The test statistic is,

$$X_1^2 = \frac{(|b - c| - 1)^2}{b + c}$$

and assesses the null hypothesis of equal prevalences at the two survey times.

V11:4 Between Intervention Group Comparisons

The analytic approach to comparing the three intervention groups will be via two way analysis of variance. The layout of the data are as in Table XVI with the two factors being strata and intervention group. The data (one observation per cell) are the changes

recorded on a particular outcome from before to after the experimental period. One table and corresponding analysis will be constructed for each outcome measure.

The two key assumptions for analysis of variance are that the inherent variability of the data is normally distributed and that the variance is constant from one cell to another. The normality assumption is reasonable given that these data are themselves averages over hundreds of individual subjects. The homogeneity of variance is a little more questionable, however. At least two of the outcomes (infant mortality rate, 1-5 year mortality rate) are essentially binomial proportions and so an arc sine $\sqrt{P}$ transformation is probably of value to make the inherent variance independent of the mean.

A second problem with variance results from there being slightly different volumes of data certainly between strata, but also perhaps between intervention groups within strata, due to varying population size. If the dominant source of variation is due to between chiefdom sources (as discussed earlier) the resulting differences in variance may be trivial and a standard Anova will be appropriate. If there is little additional between chiefdom variation then we will undertake an Anova using weighted least squares to account for the different volumes of data. Finally, if there is no additional between chiefdom variation we will use the method of unweighted means and estimate the error variance from within chiefdom variation.

In order to investigate whether a medical assistants effects is

due to training and/or number of health professionals, we will construct two contrasts comparing the medical assistant chiefdoms with each of the one and two nurse dispenser groups. Each outcome will be analysed separately although individual measures will be correlated to determine the extent to which they are measuring different effects.

Table XV

Summarization of Pit Latrine Data

			After Survey: Pit Latrine: Present	After Survey: Pit Latrine: Absent
Before Survey	Pit Latrine	Present	a	b
		Absent	c	d

N

N = total number of households surveyed on two occasions in chiefdom

Table XVI

Layout of Data

Intervention

Strata	1. One Nurse Dispenser	2. Two Nurse Dispensers	3. Two Medical Assistants
1	Δ_{11}	Δ_{12}	Δ_{13}
2	Δ_{21}	Δ_{22}	Δ_{23}
3	Δ_{31}	Δ_{32}	Δ_{33}

Δ_{ij} = Before to after change in mean outcome in i^{th} strata for j^{th} intervention group

Figure 7.1: Data Available for Life Table

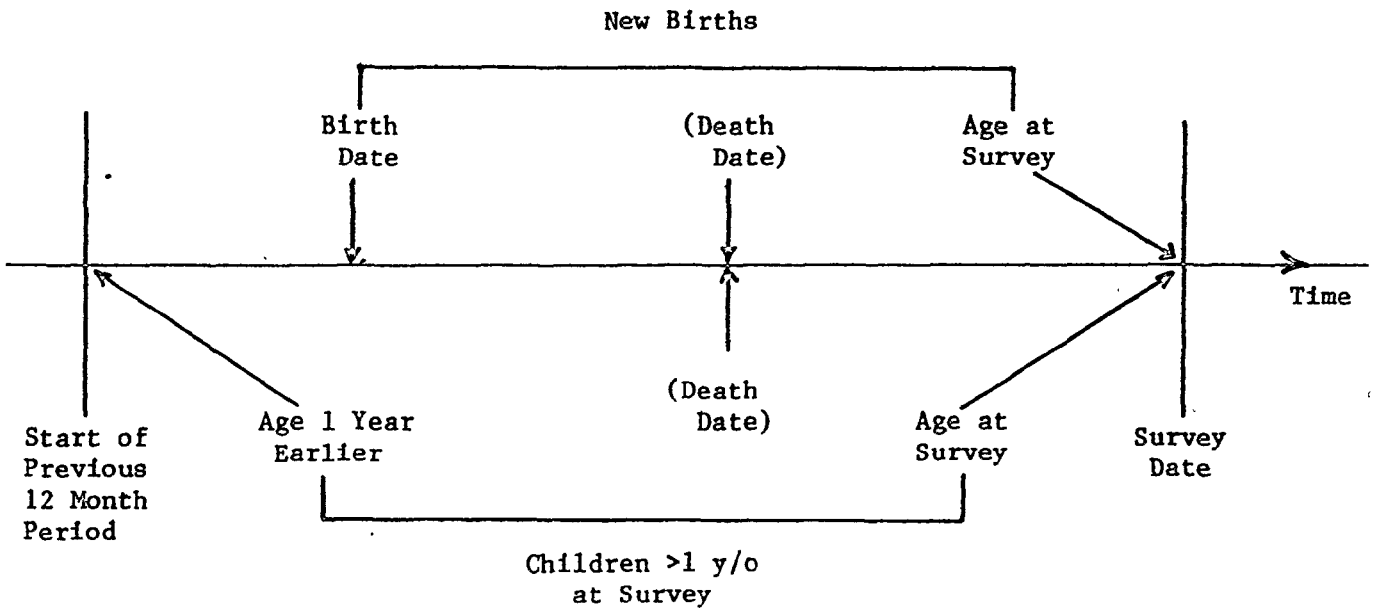
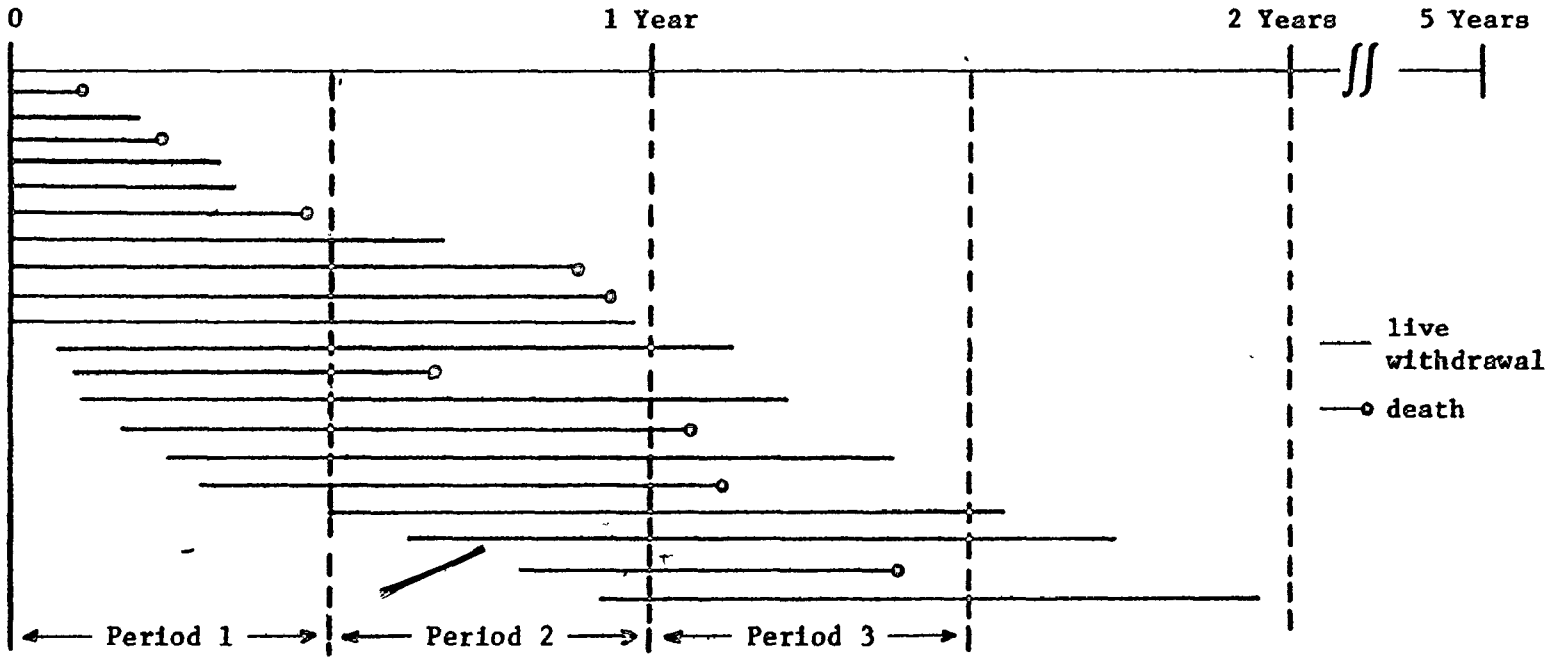


Figure 7.2: The Calculation of the Life Table



At Risk at Start of Period	10	11	9	3	R_j
Survived to End of Period	4	6	3	0	
Died During Period	3	3	3	0	D_j
Live Withdrawals	3	2	3	3	W_j
Probability of Surviving Period	0.65	0.70	0.60	1.0	$p_j = \frac{R_j - \frac{W_j}{2} - D_j}{R_j - \frac{W_j}{2}}$
Cumulative Survival to End of Period	0.65	0.46	0.28	0.28	$P_j = \prod_{k=1}^{j} p_k$

CHAPTER VIII

ETHICAL CONSIDERATION

This study is not likely to meet with any major ethical problems, since care will not be withheld from any of the communities participating in the study.

The medical assistants and nurse dispensers participating in the study will be told before the start of the study that their performance and the result of the study will in no way jeopardize their positions with the Ministry of Health.

CHAPTER IX

CONCLUSION

A design for a randomized controlled trial to evaluate the effectiveness of medical assistants in improving the health status of rural Sierra Leoneans has been presented.

The research literature was reviewed under broad headings as general health programme evaluation, various health care delivery patterns, historical developments of medical auxillaries and the evaluation of medical auxillaries in North America.

The current rural health care delivery system in rural Sierra Leone together with some of the reasons why the current system have had only a modest impact on the health status of rural Sierra Leoneans were also discussed.

The proposed new health care delivery system using the newly trained medical assistants were also discussed.

The proposed study is intended to be carried out in rural Sierra Leone and will last for 52 months. It is anticipated that the result of this study will serve as a basis for a future health care delivery system in rural Sierra Leone.

Appendix I

QUESTIONNAIRE FOR THE HOUSEHOLD SURVEY

1. Are you the head of this household? ☐ YES

   ☐ NO If no, relationship to head of household _____

> Ask if the person you meet can provide you with the information regarding numbers of people in the household, births in last year and children under five. If he/she cannot, then move to the next household.

2. How many people are living in the household? _____

3. Were there any children born to members of this household in the last year (January-December)?

   ☐ NO If no, go to question 4

   ☐ YES If yes, please list below

Name	Sex	Age/date of birth	Source of verification

4. Were there any infant deaths (children under one year of age) last year (January-December) in this household?

☐ NO If no, go to question 5

☐ YES If yes, please list below

Name	Date of Birth	Date of Death	Sex

5. Do you have a pit latrine in the household?

☐ NO Ask: where do you to to the toilet_____

_____

Go to question 7

☐ YES Ask: may I see it? Make a not below if it meets the Ministry of Health criteria in force for pit latrines.

☐ meets criteria ☐ doesn't meet criteria

6. Are there children under five years of age living in this household?

☐ NO If no, go to question 7

☐ YES Please list below

Name	Sex	Age/date of birth	Source of verification	Arm Circumference	Height

(These children will have their nutritional status assesses immediately after the questionnaire has been completed.)

7. Were there any deaths in children under five years of age last year (January-December) in this household?

☐ NO If no, go to question 8

☐ YES If yes, please list below

Name	Date of Birth/Age	Date of Death	Sex

8. Name of head of household or person supplying the information, if not head of the household.

Name: _____

Address: _____

_____

_____

APPENDIX II

Manufacture and Use of the Quac Stick[2]

(1) Construction

(a) Secure a straight pole - a split palm frond stem can be used- 140 cm. long and 4 cm. wide. (b) Smooth one surface to take marking by ball point pen. (c) Tape a centimeter rule to the stick so that it will not move during marking. Measuring from the bottom, mark the stick at the respective adcending height measures indicated by one particular scale: 85% or 80% or 75% of normal. (d) Not more than two scales can be marked on one surface. Put the higher, say 85% scale on the left and the lower scale on the right. Alternatively, different scales can be put on different surfaces of a pole. Then remove the taped centimeter rule. (e) Connect the height marks to the edge of the stick with a clearly marked line, using different colours for the left and right scales. Do not make any line more than 1.5 cm. long so that it cannot become confused with the other scale. (f) Using the scale below, at the line for each height mark the actual AC figure for that height.

(2) Arm Circumference for Height

Three scales are given below showing 85%, 80%, and 75% levels of arm circumference for height based on Morley's height data and Wolanski's arm circumference figures.

Height (cm.)	AC-85% (cm.)	Height (cm.)	AC-80% (cm.)	Height (cm.)	AC-75% (cm.)
132	17.50	133	16.50	132-1/2	15.50
129	17.00	129	16.00	129	15.00
126	16.50	125	15.50	125	14.50
122	16.00	121	15.00	122-1/2	14.25
117-1/2	15.50	118-1/2	14.75	120	14.00
112	15.00	116	14.50	117-1/2	13.75
108-1/2	14.75	113-1/2	14.25	115	13.50
105	14.50	110	14.00	112	13.25
101	14.25	106-1/2	13.75	109	13.00
96	14.00	103	13.50	105-1/2	12.75
89	13.75	97-1/2	13.25	100	12.50
78	13.50	90	13.00	92	12.25
70	13.25	80	12.75	82-1/2	12.00
		70	12.50	70-1/2	11.75

(3) Measuring Method

(a) With the tape, measure the left arm hanging freely at the side of the body at the midway point between the acromion process (shoulder) and olecranon (elbow).

(b) Measure against the 10 cm. mark of the tape so that your hands do not touch the arm, but adjust the pressure of the tape by holding the

tape itself. The tape must rest lightly on the skin at all points, around the arm but it must not depress the skin anywhere. Subtract 10 cm. from your actual reading.

(c) Stand the child against the measuring stick, heels together head level. In the great majority of cases it will be immediately apparent into which nutritional category the child falls:

Normal (symbol O) if he is shorter than the level of his AC on the stick; Malnourished (symbol M), if he is taller than his AC level; Severely malnourished (symbol MM), if he is taller than the more stringent right hand AC line.

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