HEALTH TECHNOLOGY ASSESSMENT IN SUB-SAHARAN AFRICA:
A CROSS-NATIONAL STUDY OF KENYA AND SOUTH AFRICA

BY

MICHAEL OGEMBO KACHIENG'A

MSc (Distinction) ELECTRICAL ENGINEERING
C. Eng. (UK), R. Eng. (Kenya), Pr. Eng. (SA), MIEE, MIEEE

A THESIS PRESENTED FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN THE DEPARTMENT OF BIOMEDICAL ENGINEERING

UNIVERSITY OF CAPE TOWN

FEBRUARY 1999

DEDICATION

THIS WORK IS DEDICATED TO

MY DAUGHTERS MUGA AND ADERA

MY LATE MOTHER MAMA MUGA

MY LATE FATHER MZEE ACHIENG'A

MY MENTOR, THE LATE LOTHAR STAHL

DECLARATION

I, MICHAEL OGEMBO KACHIENG'A, HEREBY DECLARE THAT THE WORK CONTAINED IN THIS DISSERTATION IS MY OWN ORIGINAL WORK AND HAS NOT PREVIOUSLY IN ITS ENTIRETY OR IN PART BEEN SUBMITTED AT ANY UNIVERSITY FOR A DEGREE.

SIGNED: signature removed

DATE: 28th February 1999.

ACKNOWLEDGEMENTS

"If I have seen further it is by standing on the shoulders of giants."
Sir Isaac Newton, 1642-1727.

A large number of institutions, organisations and people contributed in various ways to the completion of this doctoral thesis. I would like to acknowledge this, and thank the following publicly and sincerely:

The initial part of this research benefited from financial contributions from the Foundation of Research Development, University of Cape Town and University of Nairobi.

The governments of Kenya and South Africa, for granting permission to carry out health care technology assessment research in various public health facilities.

The Ministry of Health (Kenya) and Department of Health (South Africa) who provided considerable administrative and logistical support in the fieldwork and data collection, and provided information on the structure and financing of public sector health services. In particular the national directors of health, Prof. J Meme of Kenya and Dr. O Shisana, of South Africa, as well as their provincial directors for assistance in the co-ordination of field research activities in the respective provinces. Here the KwaZulu Natal Director of Health, Dr. DB Hackland deserves a special mention. In the clinical engineering and technical services divisions – A Cunninghame, director of engineering services in the Department of Health, Western Cape Province (SA), and J Nyamu and J Paton, of the Medical Engineering Directorate, Ministry of Health, Nairobi, deserve a special mention.

TABLE OF CONTENTS

TABLE OF CONTENTS

PROLOGUE

AN AFRICAN SAFARI IN HEALTH TECHNOLOGY

FROM CAPE TOWN TO NAIROBI IN 10 DAYS

It all began on 25 May 1994 at the inaugural lecture of Prof. David Power of the Red Cross Children's Hospital in Cape Town. The only children's hospital in Africa, Red Cross is a symbol of health care for the continent's children. It is also one of the teaching hospitals for the University of Cape Town.

Prof. Power is a great believer in primary health care. In the apartheid era, he was among the few 'white' doctors who chose to work in South Africa's so-called homelands, during which time he spent several years developing and practising primary health care in the Eastern Cape. In his inaugural lecture entitled Child Health Services in the 'New' South Africa – a Dream, he passionately discussed the need for maternal and child health care in rural areas, and distributional equity between preventive and curative health care services.

After the lecture, I approached Prof. Power for advice on my impending research on health technology assessment in Sub-Saharan Africa. His advice was, "Visit as many hospitals as you can. Talk to the people who use the equipment." I took his advice, and began planning my Health Care Technology Safari.

Eventually I undertook a preliminary fact finding mission leaving Cape Town, South Africa, on 14 December 1995 and reaching Nairobi, Kenya, on 24 December, my birthday. The safari covered a total of 6 560 kilometres and traversed six countries, namely South Africa, Zimbabwe, Mozambique, Malawi, Tanzania and Kenya. A total of 17 hospitals were visited - three in each country except Mozambique, where only two hospitals were visited due to political insecurity.

The purpose of the safari was to look into problems associated with the use of health technology in general, and health care equipment in particular, in the region. Mainly, I wanted to know why high investments in health care technology have had such an insignificant impact on health in Africa.

On my journey I met many health care professionals from a wide spectrum of disciplines - health planners, hospital superintendents, physicians, clinical engineers, nurses, technologists and technicians. I exchanged research notes, and discussed reasons for various technology-related problems; I witnessed the different ways these problems are addressed in each country - and occasionally, I experienced their consequences. As I went, I developed a set of questions to guide me in my discussions. In all hospital visits I presented myself quite informally, as a health researcher interested in problems associated with health care technology. I had no wish to interrogate, find fault or lay blame; I had no authority to throw around. Consequently I met many colleagues who shared with me their burden of deep concern for health in Africa.

There were many highlights during the safari; only a few are mentioned here. A hospital in the Karoo (South Africa) was the only one among those I visited which maintained a 'complete' equipment inventory management system, even though it was a manual one. A renal unit in a major hospital in Harare had state-of-the-art equipment while other departments in the same hospital lacked essential and basic equipment. At the time, the wife of a leading politician happened to be a renal patient at the hospital. In a hospital in Tete Province, Mozambique there was a large group of amputees, many of them children, the victims of landmines from the liberation war. To this day, this stands out as one of the most distressing and painful sights of my life. In Kenya, Kajiado hospital in the Masai land had no water during the daytimes because some powerful individuals had diverted the hospital's supply to irrigate their large-scale flower farms. Kajiado is only 80 kilometres from Nairobi, the capital of Kenya.

PROLOGUE

AN AFRICAN SAFARI IN HEALTH TECHNOLOGY

FROM CAPE TOWN TO NAIROBI IN 10 DAYS

It all began on 25 May 1994 at the inaugural lecture of Prof. David Power of the Red Cross Children's Hospital in Cape Town. The only children's hospital in Africa, Red Cross is a symbol of health care for the continent's children. It is also one of the teaching hospitals for the University of Cape Town.

Prof. Power is a great believer in primary health care. In the apartheid era, he was among the few 'white' doctors who chose to work in South Africa's so-called homelands, during which time he spent several years developing and practising primary health care in the Eastern Cape. In his inaugural lecture entitled Child Health Services in the 'New' South Africa – a Dream, he passionately discussed the need for maternal and child health care in rural areas, and distributional equity between preventive and curative health care services.

After the lecture, I approached Prof. Power for advice on my impending research on health technology assessment in Sub-Saharan Africa. His advice was, "Visit as many hospitals as you can. Talk to the people who use the equipment." I took his advice, and began planning my Health Care Technology Safari.

Eventually I undertook a preliminary fact finding mission leaving Cape Town, South Africa, on 14 December 1995 and reaching Nairobi, Kenya, on 24 December, my birthday. The safari covered a total of 6 560 kilometres and traversed six countries, namely South Africa, Zimbabwe, Mozambique, Malawi, Tanzania and Kenya. A total of 17 hospitals were visited - three in each country except Mozambique, where only two hospitals were visited due to political insecurity.

The purpose of the safari was to look into problems associated with the use of health technology in general, and health care equipment in particular, in the region. Mainly, I wanted to know why high investments in health care technology have had such an insignificant impact on health in Africa.

On my journey I met many health care professionals from a wide spectrum of disciplines - health planners, hospital superintendents, physicians, clinical engineers, nurses, technologists and technicians. I exchanged research notes, and discussed reasons for various technology-related problems; I witnessed the different ways these problems are addressed in each country - and occasionally, I experienced their consequences. As I went, I developed a set of questions to guide me in my discussions. In all hospital visits I presented myself quite informally, as a health researcher interested in problems associated with health care technology. I had no wish to interrogate, find fault or lay blame; I had no authority to throw around. Consequently I met many colleagues who shared with me their burden of deep concern for health in Africa.

There were many highlights during the safari; only a few are mentioned here. A hospital in the Karoo (South Africa) was the only one among those I visited which maintained a 'complete' equipment inventory management system, even though it was a manual one. A renal unit in a major hospital in Harare had state-of-the-art equipment while other departments in the same hospital lacked essential and basic equipment. At the time, the wife of a leading politician happened to be a renal patient at the hospital. In a hospital in Tete Province, Mozambique there was a large group of amputees, many of them children, the victims of landmines from the liberation war. To this day, this stands out as one of the most distressing and painful sights of my life. In Kenya, Kajiado hospital in the Masai land had no water during the daytimes because some powerful individuals had diverted the hospital's supply to irrigate their large-scale flower farms. Kajiado is only 80 kilometres from Nairobi, the capital of Kenya.

What are the lessons I learned from taking this bird's eye view of health care problems in Africa? Firstly, it became evident to me that all health care systems have different characteristics. They evolve within nations and mirror the cultural value structure of the societies they serve. Yet problems with the use of technology seem to be universal in African countries, mainly originating from poor planning and procurement. Human capacity to manage existing technology stock is sorely lacking.

I learnt that health care systems in Sub-Saharan Africa are beset by four major problems: escalating costs of services; inequity in distribution of resources; inefficient management, and lack of long term vision in planning. Interestingly, many of the health planners and managers interviewed were not aware of these management problems. They attributed the stagnation in health development to low health budgets.

I felt that African governments should approach health problems from four fronts. First, there is need to create a good economic environment. Economic policies that enhance equity will reduce poverty and contribute to improved health. There is a direct correlation between poor health and poverty. Second, governments should direct their health spending to cost-effective programmes to assist the poor, and in particular women and children. Third, measures should be taken to promote greater diversity and competition in the financing of health services. There should be some incentives for private sector investment, especially in preventive health care services. Fourth, African governments should invest adequately in the promotion of health awareness and building a "culture for health" in all settings of the society. With co-operation and solidarity, families and communities can act to improve their own health. People need to be *empowered* with knowledge and awareness to able to make health choices, cope with changing patterns of vulnerability, and keep themselves and their families healthy. *Health interventions should start before disease manifestation.*

I also noticed a pervasive belief in the public health sector that "big problems require big budgets to achieve big solutions." However economic realities in the region indicate otherwise. For Africa, big health problems require a great number of small solutions. African health services need to be simplified and localised. That is what primary health care is all about – self-care. African health care systems need confidence in a community's potential to serve itself.

I met so many people on my journey who want to do good, but do not know how. We need, more than anything, training and capacity-building. We also need information and reliable data to aid decision-making.

Above all, my safari taught me this: African health care planners are glued to statistics that have no relevance to the actual situation on the ground. These hospital visits gave me insight into problems that no amount of statistics could ever have revealed. Health care is about results; it is about the relief of suffering to living, breathing human beings; not about statistics.

Michael Ogembo Kachieng'a

What are the lessons I learned from taking this bird's eye view of health care problems in Africa? Firstly, it became evident to me that all health care systems have different characteristics. They evolve within nations and mirror the cultural value structure of the societies they serve. Yet problems with the use of technology seem to be universal in African countries, mainly originating from poor planning and procurement. Human capacity to manage existing technology stock is sorely lacking.

I learnt that health care systems in Sub-Saharan Africa are beset by four major problems: escalating costs of services; inequity in distribution of resources; inefficient management, and lack of long term vision in planning. Interestingly, many of the health planners and managers interviewed were not aware of these management problems. They attributed the stagnation in health development to low health budgets.

I felt that African governments should approach health problems from four fronts. First, there is need to create a good economic environment. Economic policies that enhance equity will reduce poverty and contribute to improved health. There is a direct correlation between poor health and poverty. Second, governments should direct their health spending to cost-effective programmes to assist the poor, and in particular women and children. Third, measures should be taken to promote greater diversity and competition in the financing of health services. There should be some incentives for private sector investment, especially in preventive health care services. Fourth, African governments should invest adequately in the promotion of health awareness and building a "culture for health" in all settings of the society. With co-operation and solidarity, families and communities can act to improve their own health. People need to be *empowered* with knowledge and awareness to able to make health choices, cope with changing patterns of vulnerability, and keep themselves and their families healthy. *Health interventions should start before disease manifestation.*

I also noticed a pervasive belief in the public health sector that "big problems require big budgets to achieve big solutions." However economic realities in the region indicate otherwise. For Africa, big health problems require a great number of small solutions. African health services need to be simplified and localised. That is what primary health care is all about – self-care. African health care systems need confidence in a community's potential to serve itself.

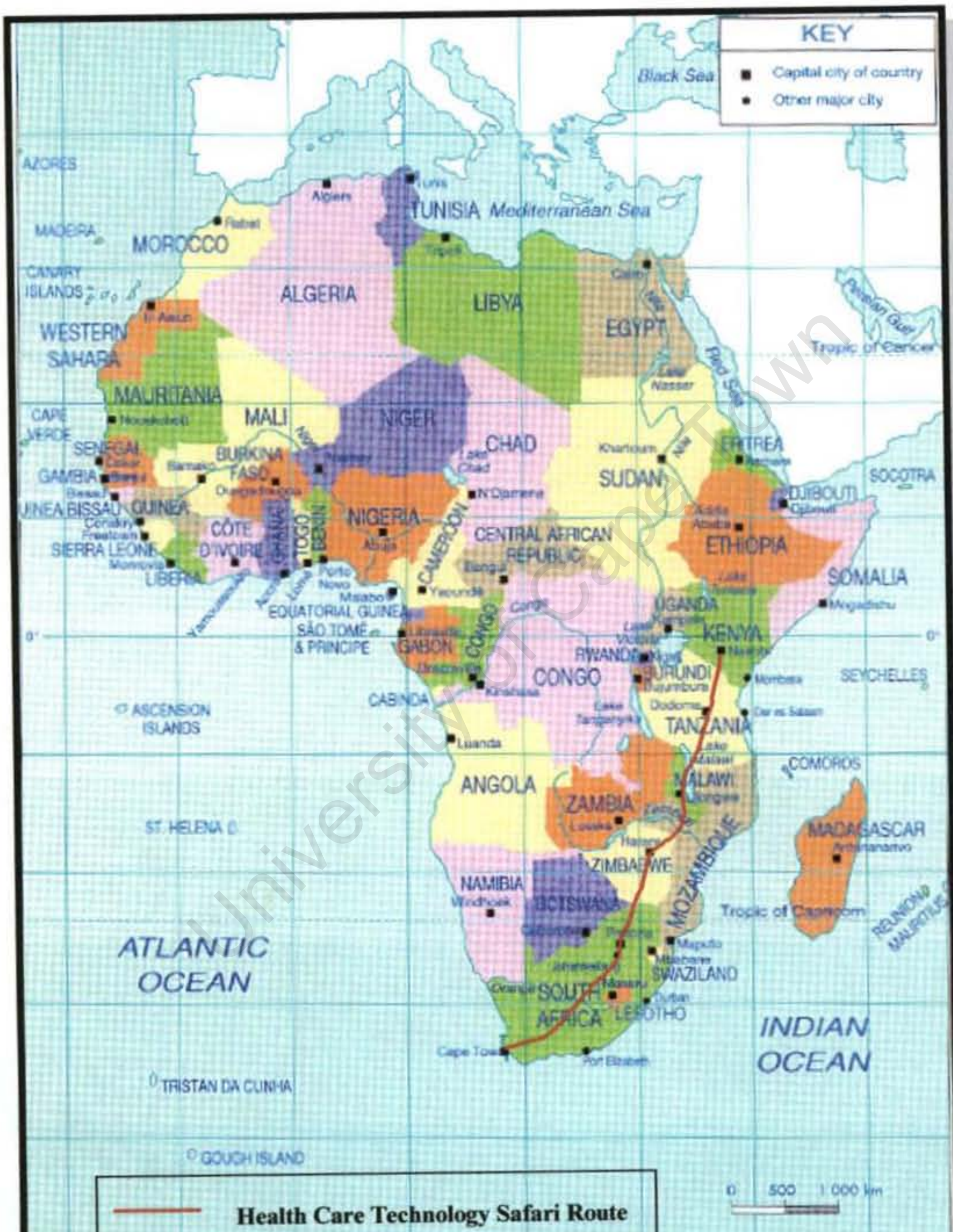
I met so many people on my journey who want to do good, but do not know how. We need, more than anything, training and capacity-building. We also need information and reliable data to aid decision-making.

Above all, my safari taught me this: African health care planners are glued to statistics that have no relevance to the actual situation on the ground. These hospital visits gave me insight into problems that no amount of statistics could ever have revealed. Health care is about results; it is about the relief of suffering to living, breathing human beings; not about statistics.

Michael Ogembo Kachieng'a

Map of Africa

Map of Africa



THESIS ORGANISATION

This thesis is concerned with the applications and use of health technology in Sub-Saharan Africa, and particularly in Kenya and South Africa. The focus is on technology planning, deployment, use, management and assessment in the public health sector. The objectives of the study are three-fold: (1) to investigate the problems that arise in the planning, deployment, use, management and assessment of technology in the health services of these countries; (2) to describe how these problems affect the delivery of health services; and (3) to provide suggestions, recommendations and a policy framework to alleviate the problems.

This thesis addresses several target groups: governments; multilateral and bilateral donor organisations and non-governmental organisations; health care equipment manufacturers and suppliers; health policymakers and planners; health care facility managers and other health care providers; health care professionals, including physicians and clinical engineers etc.; and patients.

The chapters in this thesis are organised around a theme or collection of arguments. The organisation of the chapters take into account the needs of the various target groups mentioned above. Several technical chapters provide chapter-specific recommendations.

This arrangement provides different target groups with access to specific recommendations arising from the research without the necessity to delve into the scientific and mathematical analysis of the dissertation. However, these chapter-specific recommendations synergistically converge to form the overall conclusions of the thesis and the recommendations emanating from the research. On this basis, the thesis has been divided into 13 chapters, as follows:

Chapter 1 describes the background of health care problems in Sub-Saharan Africa in general, and Kenya and South Africa in particular. The chapter also examines other factors, such as poverty, and lack of education and economic developments, that contribute to health problems in the region.

In Chapter 2 the specific research questions are formulated and the specific objectives of the thesis are stated. These are linked to the origins of health care problems and their association with technology.

Chapter 3 provides a literature review on applications and use of health technology in the public health sector in Sub-Saharan Africa, with the focus on Kenya and South Africa.

Chapter 4 examines Kenya's health care systems through analysis of public health care services, and includes pertinent information on population dynamics, health care financing, and the national economy.

Chapter 5 reviews health aid to Sub-Saharan Africa. In particular, a bilateral aid project in Kenya, the MOH/GTZ project is reviewed and assessed.

Chapter 6 provides a situational analysis of health care services in South Africa. This has been carried out similarly to that for Kenya (Chapter 4), and here again relevant aspects of the country's population dynamics and the national economy are included.

In Chapter 7 the conceptual framework for the development of structural models and methods for studying the planning, deployment, use and management of health technology is presented. This chapter also provides insights into linkages between technology and other health care factors.

Chapter 8 deals with a cross-national survey of health technology needs in Kenya and South Africa. The survey methodology and how it was conducted is explained before the finding of the survey on various essential aspects of health care technology are presented.

Chapter 9 is concerned specifically with a survey of the professional views of practising clinical engineers and technicians on the use of health care equipment in the public sector in Kenya and South Africa.

Chapter 10 focuses on the development of a standard essential equipment list for Kenya and South Africa. The chapter explains the necessity for such an essential equipment list and discusses how it was developed in the context of the particular needs of health care services in these two countries.

Chapter 11 deals with management of health technology in the hospital environment. It explains the problems and constraints facing hospital administrators and clinical engineers in the public sector. The process of establishing a clinical engineering department in a hospital is explained in detail.

Chapter 12 integrates all the diverse factors, insights, observations and information from all the previous chapters to facilitate the formulation of a health care technology policy framework for Kenya and South Africa.

Chapter 13 consolidates all the observations and recommendations arising from the research to provide overall conclusion and recommendations of this thesis. The implications of these recommendations for health care policy are briefly discussed.

Public Notice: Appendix **F** contains intellectual property. It is *closed* for public reproduction, in any form or by any means, electronic, photocopying, or otherwise without permission from the author.

All financial expenditures quoted in the thesis are in constant dollars, unless otherwise stated.

"Technology assessment has become a routine exercise for the scientific enterprises on which the country is obliged to spend vast sums for its needs. Brainy committees are continually evaluating the effectiveness and costs of doing various things in space, defence, transportation, and the likes, to give advice about prudent investments for the future.

Somehow medicine, for all that ...it costs the nation, has not yet come in for much of this analytical treatment. It seems taken for granted that the technology of medicine simply exists, take or leave it, and the only major technological problem which policymakers are interested in is how to deliver today's kind of health care, with equity, to all people.

When, as is bound to happen sooner or later, the analysts get around to the technology of medicine itself, they will have to face the problem of measuring the relative cost and effectiveness of all the things that are done in the management of disease. They will make their living at this kind of thing, and I wish them well, but I imagine they will have a bewildering time."

Lewis Thomas

The lives of a Cell, 1974

CHAPTER 1

INTRODUCTION

Chapter 1 describes the background of health care problems in Sub-Saharan Africa in general, and Kenya and South Africa in particular. The chapter also examines other factors, such as poverty, and lack of education and economic development, that contribute to health problems in the region.

Health is a state of complete physical, mental and social well-being and not merely absence of disease or infirmity.
World Health Organization
Women, Health and Environment: An Anthology, 1993

Because good health increases the economic productivity of individuals and the economic growth rate of countries, investing in health is one means of accelerating development. More important, good health is a goal in itself.
World Bank
Investing in Health, World Development Report, 1993

Health is fundamental to building a humane society.
President Nelson Mandela
Inaugural Speech, May 1994

Health technology holds benefits and burdens for the whole of humanity. The above insights are from the viewpoints of three diverse sectors of society, each with a major stake in health care: respectively, a medical, an economic and a societal perspective. Their juxtaposition points towards an underlying 'social contract' between technology and medicine. Hopefully, it also emphasises the wisdom, richness and strength to be found in their convergence, and in the wide multidisciplinary collaboration argued for in this thesis.

THESIS ORGANISATION

This thesis is concerned with the applications and use of health technology in Sub-Saharan Africa, and particularly in Kenya and South Africa. The focus is on technology planning, deployment, use, management and assessment in the public health sector. The objectives of the study are three-fold: (1) to investigate the problems that arise in the planning, deployment, use, management and assessment of technology in the health services of these countries; (2) to describe how these problems affect the delivery of health services; and (3) to provide suggestions, recommendations and a policy framework to alleviate the problems.

This thesis addresses several target groups: governments; multilateral and bilateral donor organisations and non-governmental organisations; health care equipment manufacturers and suppliers; health policymakers and planners; health care facility managers and other health care providers; health care professionals, including physicians and clinical engineers etc.; and patients.

The chapters in this thesis are organised around a theme or collection of arguments. The organisation of the chapters take into account the needs of the various target groups mentioned above. Several technical chapters provide chapter-specific recommendations.

This arrangement provides different target groups with access to specific recommendations arising from the research without the necessity to delve into the scientific and mathematical analysis of the dissertation. However, these chapter-specific recommendations synergistically converge to form the overall conclusions of the thesis and the recommendations emanating from the research. On this basis, the thesis has been divided into 13 chapters, as follows:

Chapter 1 describes the background of health care problems in Sub-Saharan Africa in general, and Kenya and South Africa in particular. The chapter also examines other factors, such as poverty, and lack of education and economic developments, that contribute to health problems in the region.

In Chapter 2 the specific research questions are formulated and the specific objectives of the thesis are stated. These are linked to the origins of health care problems and their association with technology.

Chapter 3 provides a literature review on applications and use of health technology in the public health sector in Sub-Saharan Africa, with the focus on Kenya and South Africa.

Chapter 4 examines Kenya's health care systems through analysis of public health care services, and includes pertinent information on population dynamics, health care financing, and the national economy.

Chapter 5 reviews health aid to Sub-Saharan Africa. In particular, a bilateral aid project in Kenya, the MOH/GTZ project is reviewed and assessed.

Chapter 6 provides a situational analysis of health care services in South Africa. This has been carried out similarly to that for Kenya (Chapter 4), and here again relevant aspects of the country's population dynamics and the national economy are included.

In Chapter 7 the conceptual framework for the development of structural models and methods for studying the planning, deployment, use and management of health technology is presented. This chapter also provides insights into linkages between technology and other health care factors.

Chapter 8 deals with a cross-national survey of health technology needs in Kenya and South Africa. The survey methodology and how it was conducted is explained before the finding of the survey on various essential aspects of health care technology are presented.

Chapter 9 is concerned specifically with a survey of the professional views of practising clinical engineers and technicians on the use of health care equipment in the public sector in Kenya and South Africa.

Chapter 10 focuses on the development of a standard essential equipment list for Kenya and South Africa. The chapter explains the necessity for such an essential equipment list and discusses how it was developed in the context of the particular needs of health care services in these two countries.

Chapter 11 deals with management of health technology in the hospital environment. It explains the problems and constraints facing hospital administrators and clinical engineers in the public sector. The process of establishing a clinical engineering department in a hospital is explained in detail.

Chapter 12 integrates all the diverse factors, insights, observations and information from all the previous chapters to facilitate the formulation of a health care technology policy framework for Kenya and South Africa.

Chapter 13 consolidates all the observations and recommendations arising from the research to provide overall conclusion and recommendations of this thesis. The implications of these recommendations for health care policy are briefly discussed.

Public Notice: Appendix **F** contains intellectual property. It is *closed* for public reproduction, in any form or by any means, electronic, photocopying, or otherwise without permission from the author.

All financial expenditures quoted in the thesis are in constant dollars, unless otherwise stated.

"Technology assessment has become a routine exercise for the scientific enterprises on which the country is obliged to spend vast sums for its needs. Brainy committees are continually evaluating the effectiveness and costs of doing various things in space, defence, transportation, and the likes, to give advice about prudent investments for the future.

Somehow medicine, for all that ...it costs the nation, has not yet come in for much of this analytical treatment. It seems taken for granted that the technology of medicine simply exists, take or leave it, and the only major technological problem which policymakers are interested in is how to deliver today's kind of health care, with equity, to all people.

When, as is bound to happen sooner or later, the analysts get around to the technology of medicine itself, they will have to face the problem of measuring the relative cost and effectiveness of all the things that are done in the management of disease. They will make their living at this kind of thing, and I wish them well, but I imagine they will have a bewildering time."

Lewis Thomas

The lives of a Cell, 1974

CHAPTER 1

INTRODUCTION

Chapter 1 describes the background of health care problems in Sub-Saharan Africa in general, and Kenya and South Africa in particular. The chapter also examines other factors, such as poverty, and lack of education and economic development, that contribute to health problems in the region.

Health is a state of complete physical, mental and social well-being and not merely absence of disease or infirmity.
World Health Organization
Women, Health and Environment: An Anthology, 1993

Because good health increases the economic productivity of individuals and the economic growth rate of countries, investing in health is one means of accelerating development. More important, good health is a goal in itself.
World Bank
Investing in Health, World Development Report, 1993

Health is fundamental to building a humane society.
President Nelson Mandela
Inaugural Speech, May 1994

Health technology holds benefits and burdens for the whole of humanity. The above insights are from the viewpoints of three diverse sectors of society, each with a major stake in health care: respectively, a medical, an economic and a societal perspective. Their juxtaposition points towards an underlying 'social contract' between technology and medicine. Hopefully, it also emphasises the wisdom, richness and strength to be found in their convergence, and in the wide multidisciplinary collaboration argued for in this thesis.

1.1 BACKGROUND

The most important dilemma in the world today – and the one most fraught with appalling consequences for the future – arises from the enormous and increasing economic gap between the developed and developing, the rich and the poor of the world. This central issue of world politics is likely to dominate political thinking well into the 21st century, if not longer, and in this connection health care is a crucial factor.

Poverty and poor health exist in tandem, one leading to the other. Poor people and communities rely primarily on their own energy, creativity and assets. Poor health reduces both human activity and mental creativity [Amax-Neef 1992]. As the experience of the fast-growing countries attests, basic education and health care are among the most powerful forces for economic development and consumption. Studies have repeatedly shown the high rates of return on these investments, particularly with regard to the plight of women [UNDP 1997]. Low consumption in the poorer regions of the world is retarding education and health developments in those areas. In its World Development Report, *Knowledge for Development*, the World Bank [1998], recommends that developing countries institute policies that will enable them to narrow the knowledge gaps which separate poor countries from rich countries, in order to achieve positive economic growth, health care development and social progress. Poverty and poor health have led to hunger, homelessness, loss of human dignity and death in the Sub-Saharan region. Health is central to development [WHO 1997a].

According to the 1997 UN Human Development Report [UNDP 1997], about 1.3 billion people world wide live on incomes of less than US$1 a day. Sub-Saharan Africa (SSA) has the highest proportion of people in - and the fastest growth in - human poverty in the world. The UNDP Report states that some 220 million people in the region are "income-poor" and estimates that by the year 2000, half the people in SSA will be in income poverty [UNDP 1997]. This will negatively influence both economic and health development in the region. SSA faces the biggest challenges in eradicating poverty in the next two or three decades [UNDP 1998].

According to this report [UNDP 1998], world consumption has expanded at an unprecedented pace over the course of the 20th century, with private and public expenditures reaching US$24 trillion in 1998, twice the level of 1975 and six times that of 1950. In 1900 real consumption expenditure was barely $1.5 trillion. Since countries with low consumption patterns generally exhibit poor health status, the present dynamics of consumption patterns are exacerbating inequalities in terms of health and socio-economic development. For example, the average African household today consumes 20% less than it did 25 years ago and the inequality between the richest 20% of the world's population and the poorest 20% is stark. The top fifth accounts for 86% of total consumption expenditure while the poorest fifth accounts for only 1.3% [UNDP 1998]. Consumption directly relates to the human development index, which is a composite measure of health status and economic development. Table 1.1 presents values of the human development index for selected countries.

The Sub-Saharan region's biggest asset is its people. The challenge to the governments of the region is to create the environment for the people's energies to be unleashed so that they can take care of themselves.

1.1 BACKGROUND

The most important dilemma in the world today – and the one most fraught with appalling consequences for the future – arises from the enormous and increasing economic gap between the developed and developing, the rich and the poor of the world. This central issue of world politics is likely to dominate political thinking well into the 21st century, if not longer, and in this connection health care is a crucial factor.

Poverty and poor health exist in tandem, one leading to the other. Poor people and communities rely primarily on their own energy, creativity and assets. Poor health reduces both human activity and mental creativity [Amax-Neef 1992]. As the experience of the fast-growing countries attests, basic education and health care are among the most powerful forces for economic development and consumption. Studies have repeatedly shown the high rates of return on these investments, particularly with regard to the plight of women [UNDP 1997]. Low consumption in the poorer regions of the world is retarding education and health developments in those areas. In its World Development Report, *Knowledge for Development*, the World Bank [1998], recommends that developing countries institute policies that will enable them to narrow the knowledge gaps which separate poor countries from rich countries, in order to achieve positive economic growth, health care development and social progress. Poverty and poor health have led to hunger, homelessness, loss of human dignity and death in the Sub-Saharan region. Health is central to development [WHO 1997a].

According to the 1997 UN Human Development Report [UNDP 1997], about 1.3 billion people world wide live on incomes of less than US$1 a day. Sub-Saharan Africa (SSA) has the highest proportion of people in - and the fastest growth in - human poverty in the world. The UNDP Report states that some 220 million people in the region are "income-poor" and estimates that by the year 2000, half the people in SSA will be in income poverty [UNDP 1997]. This will negatively influence both economic and health development in the region. SSA faces the biggest challenges in eradicating poverty in the next two or three decades [UNDP 1998].

According to this report [UNDP 1998], world consumption has expanded at an unprecedented pace over the course of the 20^{th} century, with private and public expenditures reaching US$24 trillion in 1998, twice the level of 1975 and six times that of 1950. In 1900 real consumption expenditure was barely $1.5 trillion. Since countries with low consumption patterns generally exhibit poor health status, the present dynamics of consumption patterns are exacerbating inequalities in terms of health and socio-economic development. For example, the average African household today consumes 20% less than it did 25 years ago and the inequality between the richest 20% of the world's population and the poorest 20% is stark. The top fifth accounts for 86% of total consumption expenditure while the poorest fifth accounts for only 1.3% [UNDP 1998]. Consumption directly relates to the human development index, which is a composite measure of health status and economic development. Table 1.1 presents values of the human development index for selected countries.

The Sub-Saharan region's biggest asset is its people. The challenge to the governments of the region is to create the environment for the people's energies to be unleashed so that they can take care of themselves.

TABLE 1.1:

HUMAN DEVELOPMENT INDEX FOR SELECTED COUNTRIES

Country	Life Expectancy at Birth (years) 1995	Adult Literacy Rate (%) 1995	Real GDP per Capita (PPP$) 1995	*Human Development Index (HDI) Value 1995
HIGH HUMAN DEVELOPMENT	**73.530**	**95.69**	**16241**	**0.897**
France	78.700	99	21176	0.946
USA	76.400	99	26977	0.943
Netherlands	77.500	99	19876	0.941
United Kingdom	76.800	99	19302	0.932
MEDIUM HUMAN DEVELOPMENT	**67.470**	**83.250**	**3390**	**0.670**
South Africa	**64.100**	**81.800**	**4334**	**0.717**
Botswana	51.700	69.800	5611	0.678
LOW HUMAN DEVELOPMENT	**56.670**	**50.850**	**1362**	**0.409**
Kenya	**53.800**	**78.100**	**1438**	**0.463**
Zimbabwe	48.900	85.100	2135	0.507
Tanzania	50.600	67.800	636	0.358
Malawi	41.000	56.400	773	0.334
Mozambique	46.300	40.100	959	0.281
ALL DEVELOPING COUNTRIES	62.200	70.440	3068	0.586
LEAST DEVELOPED COUNTRIES	51.160	49.200	1008	0.344
INDUSTRIAL COUNTRIES	74.170	98.630	16337	0.911
WORLD	63.620	77.580	5990	0.772

Source: The 1998 United Nations Human Development Report, UNDP [1998].

**Human Development Index* (HDI) - measures the average achievements in a country in three basic dimensions of human development – longevity, knowledge and a decent standard of living. A composite index, the HDI, thus contains three variables: life expectancy, educational attainment and real GDP per capita in purchasing power parity (PPP$).

TABLE 1.1:

HUMAN DEVELOPMENT INDEX FOR SELECTED COUNTRIES

Country	Life Expectancy at Birth (years) 1995	Adult Literacy Rate (%) 1995	Real GDP per Capita (PPP$) 1995	*Human Development Index (HDI) Value 1995
HIGH HUMAN DEVELOPMENT	**73.530**	**95.69**	**16241**	**0.897**
France	78.700	99	21176	0.946
USA	76.400	99	26977	0.943
Netherlands	77.500	99	19876	0.941
United Kingdom	76.800	99	19302	0.932
MEDIUM HUMAN DEVELOPMENT	**67.470**	**83.250**	**3390**	**0.670**
South Africa	**64.100**	**81.800**	**4334**	**0.717**
Botswana	51.700	69.800	5611	0.678
LOW HUMAN DEVELOPMENT	**56.670**	**50.850**	**1362**	**0.409**
Kenya	**53.800**	**78.100**	**1438**	**0.463**
Zimbabwe	48.900	85.100	2135	0.507
Tanzania	50.600	67.800	636	0.358
Malawi	41.000	56.400	773	0.334
Mozambique	46.300	40.100	959	0.281
ALL DEVELOPING COUNTRIES	62.200	70.440	3068	0.586
LEAST DEVELOPED COUNTRIES	51.160	49.200	1008	0.344
INDUSTRIAL COUNTRIES	74.170	98.630	16337	0.911
WORLD	63.620	77.580	5990	0.772

Source: The 1998 United Nations Human Development Report, UNDP [1998].

**Human Development Index* (HDI) - measures the average achievements in a country in three basic dimensions of human development – longevity, knowledge and a decent standard of living. A composite index, the HDI, thus contains three variables: life expectancy, educational attainment and real GDP per capita in purchasing power parity (PPP$).

1.2 HEALTH PROBLEMS IN SUB-SAHARAN AFRICA

Health care is a special commodity in most developing countries, in both economic and social terms. For many it is only one problem on a priority scale that is dominated by poverty, starvation, a growing population, political turmoil, refugees, corruption and rural-to-urban migration. However, it is recognised that better health is desirable not only as an end in itself, but also because it brings substantial economic benefits - releasing resources that can then be used to achieve other development goals.

World Development Reports of 1990 and 1991 considered good health and nutrition to be basic requirements for sustainable economic growth and slower population growth [World Bank 1990, 1991c, 1993a]. Better health and nutrition raise workers' productivity and prolong their potential working lives. Better health directly contributes to socio-economic development. Poor health inhibits human capital development, reduces returns from learning, impedes entrepreneurial activities, and holds back growth of gross national product (GNP) [World Bank 1995a].

The health care problems encountered in the developing countries, where infectious and parasitic diseases remain the main threats, are quite different from those in the industrialised countries. In 1991, out of 38 million deaths in developing countries, 53.3% were caused by infectious and parasitic diseases while only 4.4% of 11 million deaths in developed countries resulted from similar diseases [World Bank 1991c]. Despite these figures, developing countries accounted for only a small share (12%) of the total world use of medicines in the 1980s [D'Arcy 1984], a trend that has not altered significantly in the 1990s [World Bank 1995a].

The absence of clean and safe water and sanitation is another factor contributing to poor health in the developing countries. Although rural water programmes are encouraged, maintenance of equipment and systems remains a major problem. Urban water and sanitation systems have also generally suffered from poor planning and population pressure [World Bank 1993a, 1993b].

The World Development Reports of 1990 and 1993 indicated that the sub-Sahara is the only region in the developing world where health and nutrition have worsened in recent years. In most of SSA life expectancy averages around 50 years, but it is as low as 40 in Somalia and in some parts of West Africa. Infant mortality ranges from 70 per 1000 births in Kenya to 190 in Guinea and Sierra Leone. In Zambia and Zimbabwe, more than 20% of children suffer from second or third-degree malnutrition; in Burundi, Sudan and Tanzania, the proportion exceeds 50% [World Bank 1993a].

The HIV/AIDS scourge is a major factor threatening health development in the Sub-Saharan region. The effects of the AIDS epidemic on this region have been significant, with reduced life expectancy, decreased productivity, social systems being thrown into disarray and an already poor region of the world suffering increased poverty [Osenya 1998].

It is believed that AIDS is the leading cause of death in the age group range 15 – 39 years in Botswana, Malawi, Uganda, Zambia and Zimbabwe. Estimates vary as to the number of infected persons south of the Sahara, but it is believed to be between 11 million and 16 million. The Global AIDS Policy Coalition (GAPC), based at the Harvard School of Public Health in the USA, has estimated the figure to be closer to 19 million. GAPC predicts that between 60 and 70 million people will be HIV infected by the end of the century, and SSA will account for 40% of these [Hollandia 1996].

HIV/ AIDS poses a major problem to human development and utilisation as it strains all sectors of the economy. Nineteen countries in the region have been severely hit by the infection, with the prevalence rate between 8 and 32% of the population [Osenya 1998].

The continued over-stretching of resources in both public and private sectors could cripple health development in the region, and also economic development, since the disease affects mainly the productive members of the labour force. Osenya [1998] has stated that patients suffering from HIV/AIDS-related ailments currently occupy about 60% of public hospital beds in some countries in the SSA region. These patients have already put pressure on hospitals' resources, including the use of diagnostic and therapeutic health care technologies.

African countries, faced with severe limitations and scarcity of resources, are trying to develop modern health services with appropriate and cost-effective health technologies. After the Alma-Ata Declaration by WHO and UNICEF in 1987, most African countries, in theory, have modified their health policies to focus on primary health care. Unfortunately these policies have not gained much momentum due to lack of political will to bring about the necessary infrastructural reforms, and to ineffective policies on funding technological investments in health care [WHO/AFRO 1993b, Power 1994, Kachieng'a 1998a].

Most developing countries have chosen systems of health care that do not meet the health needs of their people [Carrol 1971, Bader 1977, Blix 1979, Hu 1991, Free 1992, Perry and Max 1992, Serpa-Florez 1993, Walters and Bunn 1995]. They have emphasised urban health care, particularly in the form of well-equipped hospitals with highly trained medical staff. Such hospital-based systems are favoured partly as symbols of modernity [Banta 1986, Free 1992, Perry and Marx 1992, Barnum and Kutzin 1993, Kachienga and Boonzaier 1999], a bias often supported by the preference of international aid donors for large, turn-key capital-intensive projects [Banta 1986, World Bank 1995a]. Rural-based labour-intensive health projects are neglected in spite of high unemployment in these countries. Such rural-based educative, promotive and preventive health care projects are downplayed [World Bank 1991d, 1993a].

Developing countries of SSA have their own particular health care problems. Generally, the majority of the population is rural-based while, as mentioned above, health care services are urban-based and tend to be very expensive. These rural areas are often sparsely provided with public health centres and dispensaries, usually understaffed, poorly supervised, and lacking essential drugs and equipment. Most patients reach hospital late, when their diseases are already advanced. Poor roads, lack of transport, poor communication and inadequate local medical care may transform simple and curable diseases into chronic or life-threatening conditions [World Bank 1993a].

The problem of medically servicing remote and scattered rural populations poses a serious challenge to African governments in terms of staff deployment, transport and management of health delivery logistics. There is also lack of essential health care equipment in rural areas, mainly as a result of poor technology planning and deployment. African governments have no other option but to find solutions of their own design, fitting their particular situations and problems.

The unequal development of health systems in SSA has discounted the poor majority, and the governments in the region are beginning to pay the *penalties of omission*. The poverty of the masses has imposed limits on both economic growth and health care development, since economic development precedes health care expansion [World Bank 1990]. The state of the economy in the SSA defines health status of people in the region. The lack of economic growth this decade will make it increasingly difficult for Sub-Saharan African countries to improve the health status of their populations. The health sectors of most developing countries of the SSA region have slowed in their expansion precisely ***because*** they have neglected the rural poor. The rising poverty in SSA should be treated as a danger signal and should be checked to avert health problems, as well as social disintegration and unrest.

Sub-Saharan Africa needs accelerated human development and economic growth, underpinned by substantive and sustained regional and international support for health, education and strengthened institutions of state, if the poorest people and communities in the region are to emerge from poverty over the next few decades. Economic policies that enhance equity will reduce poverty and contribute to improved health.

1.3 MANAGEMENT OF HEALTH TECHNOLOGY IN SUB-SAHARAN AFRICA

In most African countries health technology is under-utilised or non-functional. For example, a study of twelve Kenyan hospitals in 1984 found that sterilisers operated for an average of two years instead of the six expected while incubators also lasted only two years rather than eight years [World Bank 1995a]. Equipment failed prematurely because maintenance budgets represented only 1% of the capital stock whereas 10% is considered optimal [World Bank 1993a, 1995a]. A similar study done in Nigeria in 1988, covering 16 hospitals, revealed that 30% of medical equipment was out of use because recurrent expenditures on maintenance were inadequate [Erinosho 1991]. A field study by the author in South African hospitals also revealed that equipment maintenance budgets were inadequate and most clinical engineering departments were understaffed [Kachieng'a 1998b].

Some technological problems also stem from overly ambitious plans and the natural temptation to accept foreign funds for buildings, equipment and medical systems that cannot be maintained with existing local expertise. Sometimes even the expected benefits are not realised because operating costs cannot be adequately financed by national governments [World Bank 1995a, Kachieng'a 1998a].

Most of the health technologies available in the international markets have been designed, developed and manufactured in industrialised countries for health interventions prevalent in those societies, and therefore may not be suitable for developing countries. The performance requirements and cost of manufacture of these technologies are matched to the economies of the industrialised countries in which they originated. Right from the outset these technologies are often too expensive for developing countries. It is for this reason that the appropriateness of the selection, diffusion, utilisation and management of health technologies has become a matter of pressing economic interest to health planners in these countries [Banta 1986, 1990, Serpa-Florez 1993].

Most African countries do not have sufficient technical expertise available to make rational technological choices. The new products of the international health care equipment industry have vastly exceeded the capacity of the purchasers to evaluate their clinical usefulness and cost-effectiveness. Presently most African countries are burdened with equipment problems flowing from investment decisions which ignored long term implications.

Both Kenya and South Africa, where many of these problems have manifested themselves, are considering taking decisive steps to restructure health services in order to meet the demands of their diverse population groups. This includes integration of curative and preventive care services. Technological interventions in each case are different, but not mutually exclusive. Development of equitable, efficient and cost-effective health care in these countries requires health policy design, which promotes equity and the application of appropriate technological interventions at each of the strategic levels of health care. There is thus a need for in-depth research into the processes of technology planning, deployment and management in health care systems [Banta 1986, WHO 1991b, Free 1992, Issakov 1994, World Bank 1995a].

Another research concern worth highlighting is the need to investigate the barriers preventing mass-utilisation of simple, inexpensive and effective technologies like immunization and the development of high-impact and wide-coverage technologies for the prevention and control of major health problems, such as tropical diseases [Halbwachs and Issakov 1990, PATH 1992, Kachieng'a 1998a].

1.4 CHALLENGES IN HEALTH TECHNOLOGY PLANNING, DEPLOYMENT AND MANAGEMENT

The main questions facing health care planners and policy makers in Kenya and South Africa, pertaining to use of technology, are:

1. How can the technical capacity in selection, procurement, commissioning, maintenance and management of HT be improved?

2. How can bargaining power in the international markets be strengthened so that technologies identified as most suited to the country's needs can be acquired on the most favourable terms?

3. How can technology in health care services be financed and efficiently managed so as to ensure better returns on investment and better health outcomes?

4. How can sustainable infrastructural support systems (technical and financial) be developed for HT purchased and especially for the maintenance of health care equipment and devices?

5. How can short-term and long-term transfer of HT be planned, deployed and managed for present and future sustainable health care systems and services?

6. How can health programmes that ensure optimal use of equipment resources be planned and implemented?

These questions are related to the fundamental problem in health care - allocation of scarce health resources. Their solutions will influence how medicine is practised, and how health care services are organised and paid for in Kenya and South Africa. They will also have significant effects on health expenditures, the accessibility of services and health benefits (outcomes). In other words, health policy and planning will need to redefine its priorities to gain optimal benefits and a competitive advantage from technology.

The common denominator in the above questions is that there is an urgent need for health technology assessment to generate data for rational decision making in technology-based health services. Decision makers (in government and in health care facilities) require well-researched data, which analyses the consequences for society of various health care technologies under the circumstances prevailing in that society, in order to establish policies on planning, acquisition, deployment and utilisation of such health care technologies.

1.5 STATEMENT OF THE PROBLEM

The main problem with health technology (HT) in Kenya and South Africa can be summarised as: How can health care technologies be selected for diffusion and utilisation and how can they be managed rationally to improve the quality of health care?

HT in current use in the two countries is costly, capital-intensive and often not matched to actual health needs. The technologies require highly trained technical personnel to maintain and repair, thus incurring high maintenance budgets. High investments in health technology in the two countries have not impacted on health outcomes as much as they should, because of poor technology planning, deployment and management. In addition, there is no comprehensive plan in the public sector for health technology assessment and management in the public sector.

Kenya and South Africa lack the technical capacity to plan, deploy and implement programmes that ensure optimal use of technological resources. The need to select from a broad range of technologies requires information on appropriateness, effectiveness, efficacy and cost-effectiveness - that is, the trade-offs between capital investments and recurrent costs. This information is lacking in both countries.

1.6 BASIS OF THE PROBLEM

The following observations form the basis of the research problem that is addressed in this thesis:

1. The health problems in Kenya and South Africa are so great and resources so scarce that it is essential that measures taken to improve health should be both effective and economical in their utilisation of resources and equitable in their design and impact. It is imperative that the orientation in both countries change from one of giving high-quality care to the few, to one of providing an acceptable level of care for all. To this end, far more emphasis should be put on improvement of infrastructural support and technical and allocative budgetary efficiency as more funds will not be readily available.

2. Since Kenya and South Africa are subject to severe constraints in health care funding compared to other countries of similar economic development, the only option is to *add value* to health care services thus enhancing quality of life through appropriately selected, efficiently managed, and cost-effectively utilised health technologies. There is need for design and development of appropriate health technology for public health and primary health care services. Modern health care systems and services are driven by technology; therefore the selection, procurement, management and maintenance of technology and the development of new technologies must not only make health services affordable and cost-effective, but also provide for better health outcomes.

3. State health planning mechanisms in both countries are viewed with scepticism by the public because substantial efforts to date have had little impact on decisions regarding allocation of resources to the health sector in these countries [Power 1994, Kachieng'a 1998a, Kachieng'a and Boonzaier 1999]. Much of the planning has been normative, based on international estimates of the number of personnel and hospital beds needed to establish or extend coverage of services. The nature of the health needs of various population groups and the cost-effectiveness of various methods of health interventions have not been considered to any great extent. Most planning mechanisms and management methods are centralised, without regard to the actual constraints at implementation level [Power 1994, Walters and Bunn 1995, Kachieng'a and Boonzaier 1999].

4. The practical problems of transferring health technology from industrialised to developing countries have major implications for technology assessment that warrant the attention of governments, aid agencies and health providers.

1.7 DISCUSSION AND CONCLUSION

The leading question to ask in the design of health policy is: how can Government best serve the health needs of its population now and in years to come? This deceptively simple question has no easy answer, especially when the national priorities in the allocation of resources lie not only in improving health outcomes but also in providing cost-effective, equitable, affordable and accessible health care services. Doing more with less is the demand facing health care service planners in Kenya and South Africa.

The problem of providing a satisfactory health service to all the people of Kenya and South Africa at costs they can afford is a pressing one. At present, many people do not receive a service that is adequate either in quantity or in quality, and services are inequitably distributed and often costly. The result is a tremendous amount of preventable physical pain and mental anguish, needless deaths, economic inefficiency, and social waste. The principal issue of health care in the 1990s and into the next century seems to be cost-containment, subsumed into the general problem of efficiency and distributional equity, and in this regard health care technology is highly relevant.

Realising the benefits from technological investments in health care systems in Kenya and South Africa requires more than quantity and quality of equipment, and personnel trained to use, operate and maintain it. How those inputs are planned, allocated, organised, and managed can determine whether or not the services are cost-effective and can make the difference between sustainable and unsustainable outcomes.

Health technology assessment as a policy tool is an attempt to establish an early warning system to help plan, control, direct and if necessary restrain utilisation of technology so as to maximise public good while minimising public risks. Technology has become an integral part of any health care system, and therefore an assessment of technology is an assessment of the health care system. Health technology assessment is perhaps the most important yet unappreciated feature of any health care system.

The research presented in this thesis has been concerned with such an assessment of health care technology, by means of a survey of health facilities in Kenya and South Africa. The specific objectives and research questions are formulated in the following chapter.

1.2 HEALTH PROBLEMS IN SUB-SAHARAN AFRICA

Health care is a special commodity in most developing countries, in both economic and social terms. For many it is only one problem on a priority scale that is dominated by poverty, starvation, a growing population, political turmoil, refugees, corruption and rural-to-urban migration. However, it is recognised that better health is desirable not only as an end in itself, but also because it brings substantial economic benefits - releasing resources that can then be used to achieve other development goals.

World Development Reports of 1990 and 1991 considered good health and nutrition to be basic requirements for sustainable economic growth and slower population growth [World Bank 1990, 1991c, 1993a]. Better health and nutrition raise workers' productivity and prolong their potential working lives. Better health directly contributes to socio-economic development. Poor health inhibits human capital development, reduces returns from learning, impedes entrepreneurial activities, and holds back growth of gross national product (GNP) [World Bank 1995a].

The health care problems encountered in the developing countries, where infectious and parasitic diseases remain the main threats, are quite different from those in the industrialised countries. In 1991, out of 38 million deaths in developing countries, 53.3% were caused by infectious and parasitic diseases while only 4.4% of 11 million deaths in developed countries resulted from similar diseases [World Bank 1991c]. Despite these figures, developing countries accounted for only a small share (12%) of the total world use of medicines in the 1980s [D'Arcy 1984], a trend that has not altered significantly in the 1990s [World Bank 1995a].

The absence of clean and safe water and sanitation is another factor contributing to poor health in the developing countries. Although rural water programmes are encouraged, maintenance of equipment and systems remains a major problem. Urban water and sanitation systems have also generally suffered from poor planning and population pressure [World Bank 1993a, 1993b].

The World Development Reports of 1990 and 1993 indicated that the sub-Sahara is the only region in the developing world where health and nutrition have worsened in recent years. In most of SSA life expectancy averages around 50 years, but it is as low as 40 in Somalia and in some parts of West Africa. Infant mortality ranges from 70 per 1000 births in Kenya to 190 in Guinea and Sierra Leone. In Zambia and Zimbabwe, more than 20% of children suffer from second or third-degree malnutrition; in Burundi, Sudan and Tanzania, the proportion exceeds 50% [World Bank 1993a].

The HIV/AIDS scourge is a major factor threatening health development in the Sub-Saharan region. The effects of the AIDS epidemic on this region have been significant, with reduced life expectancy, decreased productivity, social systems being thrown into disarray and an already poor region of the world suffering increased poverty [Osenya 1998].

It is believed that AIDS is the leading cause of death in the age group range 15 – 39 years in Botswana, Malawi, Uganda, Zambia and Zimbabwe. Estimates vary as to the number of infected persons south of the Sahara, but it is believed to be between 11 million and 16 million. The Global AIDS Policy Coalition (GAPC), based at the Harvard School of Public Health in the USA, has estimated the figure to be closer to 19 million. GAPC predicts that between 60 and 70 million people will be HIV infected by the end of the century, and SSA will account for 40% of these [Hollandia 1996].

HIV/ AIDS poses a major problem to human development and utilisation as it strains all sectors of the economy. Nineteen countries in the region have been severely hit by the infection, with the prevalence rate between 8 and 32% of the population [Osenya 1998].

The continued over-stretching of resources in both public and private sectors could cripple health development in the region, and also economic development, since the disease affects mainly the productive members of the labour force. Osenya [1998] has stated that patients suffering from HIV/AIDS-related ailments currently occupy about 60% of public hospital beds in some countries in the SSA region. These patients have already put pressure on hospitals' resources, including the use of diagnostic and therapeutic health care technologies.

African countries, faced with severe limitations and scarcity of resources, are trying to develop modern health services with appropriate and cost-effective health technologies. After the Alma-Ata Declaration by WHO and UNICEF in 1987, most African countries, in theory, have modified their health policies to focus on primary health care. Unfortunately these policies have not gained much momentum due to lack of political will to bring about the necessary infrastructural reforms, and to ineffective policies on funding technological investments in health care [WHO/AFRO 1993b, Power 1994, Kachieng'a 1998a].

Most developing countries have chosen systems of health care that do not meet the health needs of their people [Carrol 1971, Bader 1977, Blix 1979, Hu 1991, Free 1992, Perry and Max 1992, Serpa-Florez 1993, Walters and Bunn 1995]. They have emphasised urban health care, particularly in the form of well-equipped hospitals with highly trained medical staff. Such hospital-based systems are favoured partly as symbols of modernity [Banta 1986, Free 1992, Perry and Marx 1992, Barnum and Kutzin 1993, Kachienga and Boonzaier 1999], a bias often supported by the preference of international aid donors for large, turn-key capital-intensive projects [Banta 1986, World Bank 1995a]. Rural-based labour-intensive health projects are neglected in spite of high unemployment in these countries. Such rural-based educative, promotive and preventive health care projects are downplayed [World Bank 1991d, 1993a].

Developing countries of SSA have their own particular health care problems. Generally, the majority of the population is rural-based while, as mentioned above, health care services are urban-based and tend to be very expensive. These rural areas are often sparsely provided with public health centres and dispensaries, usually understaffed, poorly supervised, and lacking essential drugs and equipment. Most patients reach hospital late, when their diseases are already advanced. Poor roads, lack of transport, poor communication and inadequate local medical care may transform simple and curable diseases into chronic or life-threatening conditions [World Bank 1993a].

The problem of medically servicing remote and scattered rural populations poses a serious challenge to African governments in terms of staff deployment, transport and management of health delivery logistics. There is also lack of essential health care equipment in rural areas, mainly as a result of poor technology planning and deployment. African governments have no other option but to find solutions of their own design, fitting their particular situations and problems.

The unequal development of health systems in SSA has discounted the poor majority, and the governments in the region are beginning to pay the *penalties of omission*. The poverty of the masses has imposed limits on both economic growth and health care development, since economic development precedes health care expansion [World Bank 1990]. The state of the economy in the SSA defines health status of people in the region. The lack of economic growth this decade will make it increasingly difficult for Sub-Saharan African countries to improve the health status of their populations. The health sectors of most developing countries of the SSA region have slowed in their expansion precisely ***because*** they have neglected the rural poor. The rising poverty in SSA should be treated as a danger signal and should be checked to avert health problems, as well as social disintegration and unrest.

Sub-Saharan Africa needs accelerated human development and economic growth, underpinned by substantive and sustained regional and international support for health, education and strengthened institutions of state, if the poorest people and communities in the region are to emerge from poverty over the next few decades. Economic policies that enhance equity will reduce poverty and contribute to improved health.

1.3 MANAGEMENT OF HEALTH TECHNOLOGY IN SUB-SAHARAN AFRICA

In most African countries health technology is under-utilised or non-functional. For example, a study of twelve Kenyan hospitals in 1984 found that sterilisers operated for an average of two years instead of the six expected while incubators also lasted only two years rather than eight years [World Bank 1995a]. Equipment failed prematurely because maintenance budgets represented only 1% of the capital stock whereas 10% is considered optimal [World Bank 1993a, 1995a]. A similar study done in Nigeria in 1988, covering 16 hospitals, revealed that 30% of medical equipment was out of use because recurrent expenditures on maintenance were inadequate [Erinosho 1991]. A field study by the author in South African hospitals also revealed that equipment maintenance budgets were inadequate and most clinical engineering departments were understaffed [Kachieng'a 1998b].

Some technological problems also stem from overly ambitious plans and the natural temptation to accept foreign funds for buildings, equipment and medical systems that cannot be maintained with existing local expertise. Sometimes even the expected benefits are not realised because operating costs cannot be adequately financed by national governments [World Bank 1995a, Kachieng'a 1998a].

Most of the health technologies available in the international markets have been designed, developed and manufactured in industrialised countries for health interventions prevalent in those societies, and therefore may not be suitable for developing countries. The performance requirements and cost of manufacture of these technologies are matched to the economies of the industrialised countries in which they originated. Right from the outset these technologies are often too expensive for developing countries. It is for this reason that the appropriateness of the selection, diffusion, utilisation and management of health technologies has become a matter of pressing economic interest to health planners in these countries [Banta 1986, 1990, Serpa-Florez 1993].

Most African countries do not have sufficient technical expertise available to make rational technological choices. The new products of the international health care equipment industry have vastly exceeded the capacity of the purchasers to evaluate their clinical usefulness and cost-effectiveness. Presently most African countries are burdened with equipment problems flowing from investment decisions which ignored long term implications.

Both Kenya and South Africa, where many of these problems have manifested themselves, are considering taking decisive steps to restructure health services in order to meet the demands of their diverse population groups. This includes integration of curative and preventive care services. Technological interventions in each case are different, but not mutually exclusive. Development of equitable, efficient and cost-effective health care in these countries requires health policy design, which promotes equity and the application of appropriate technological interventions at each of the strategic levels of health care. There is thus a need for in-depth research into the processes of technology planning, deployment and management in health care systems [Banta 1986, WHO 1991b, Free 1992, Issakov 1994, World Bank 1995a].

Another research concern worth highlighting is the need to investigate the barriers preventing mass-utilisation of simple, inexpensive and effective technologies like immunization and the development of high-impact and wide-coverage technologies for the prevention and control of major health problems, such as tropical diseases [Halbwachs and Issakov 1990, PATH 1992, Kachieng'a 1998a].

1.4 CHALLENGES IN HEALTH TECHNOLOGY PLANNING, DEPLOYMENT AND MANAGEMENT

The main questions facing health care planners and policy makers in Kenya and South Africa, pertaining to use of technology, are:

1. How can the technical capacity in selection, procurement, commissioning, maintenance and management of HT be improved?

2. How can bargaining power in the international markets be strengthened so that technologies identified as most suited to the country's needs can be acquired on the most favourable terms?

3. How can technology in health care services be financed and efficiently managed so as to ensure better returns on investment and better health outcomes?

4. How can sustainable infrastructural support systems (technical and financial) be developed for HT purchased and especially for the maintenance of health care equipment and devices?

5. How can short-term and long-term transfer of HT be planned, deployed and managed for present and future sustainable health care systems and services?

6. How can health programmes that ensure optimal use of equipment resources be planned and implemented?

These questions are related to the fundamental problem in health care - allocation of scarce health resources. Their solutions will influence how medicine is practised, and how health care services are organised and paid for in Kenya and South Africa. They will also have significant effects on health expenditures, the accessibility of services and health benefits (outcomes). In other words, health policy and planning will need to redefine its priorities to gain optimal benefits and a competitive advantage from technology.

The common denominator in the above questions is that there is an urgent need for health technology assessment to generate data for rational decision making in technology-based health services. Decision makers (in government and in health care facilities) require well-researched data, which analyses the consequences for society of various health care technologies under the circumstances prevailing in that society, in order to establish policies on planning, acquisition, deployment and utilisation of such health care technologies.

1.5 STATEMENT OF THE PROBLEM

The main problem with health technology (HT) in Kenya and South Africa can be summarised as: How can health care technologies be selected for diffusion and utilisation and how can they be managed rationally to improve the quality of health care?

HT in current use in the two countries is costly, capital-intensive and often not matched to actual health needs. The technologies require highly trained technical personnel to maintain and repair, thus incurring high maintenance budgets. High investments in health technology in the two countries have not impacted on health outcomes as much as they should, because of poor technology planning, deployment and management. In addition, there is no comprehensive plan in the public sector for health technology assessment and management in the public sector.

Kenya and South Africa lack the technical capacity to plan, deploy and implement programmes that ensure optimal use of technological resources. The need to select from a broad range of technologies requires information on appropriateness, effectiveness, efficacy and cost-effectiveness - that is, the trade-offs between capital investments and recurrent costs. This information is lacking in both countries.

1.6 BASIS OF THE PROBLEM

The following observations form the basis of the research problem that is addressed in this thesis:

1. The health problems in Kenya and South Africa are so great and resources so scarce that it is essential that measures taken to improve health should be both effective and economical in their utilisation of resources and equitable in their design and impact. It is imperative that the orientation in both countries change from one of giving high-quality care to the few, to one of providing an acceptable level of care for all. To this end, far more emphasis should be put on improvement of infrastructural support and technical and allocative budgetary efficiency as more funds will not be readily available.

2. Since Kenya and South Africa are subject to severe constraints in health care funding compared to other countries of similar economic development, the only option is to *add value* to health care services thus enhancing quality of life through appropriately selected, efficiently managed, and cost-effectively utilised health technologies. There is need for design and development of appropriate health technology for public health and primary health care services. Modern health care systems and services are driven by technology; therefore the selection, procurement, management and maintenance of technology and the development of new technologies must not only make health services affordable and cost-effective, but also provide for better health outcomes.

3. State health planning mechanisms in both countries are viewed with scepticism by the public because substantial efforts to date have had little impact on decisions regarding allocation of resources to the health sector in these countries [Power 1994, Kachieng'a 1998a, Kachieng'a and Boonzaier 1999]. Much of the planning has been normative, based on international estimates of the number of personnel and hospital beds needed to establish or extend coverage of services. The nature of the health needs of various population groups and the cost-effectiveness of various methods of health interventions have not been considered to any great extent. Most planning mechanisms and management methods are centralised, without regard to the actual constraints at implementation level [Power 1994, Walters and Bunn 1995, Kachieng'a and Boonzaier 1999].

4. The practical problems of transferring health technology from industrialised to developing countries have major implications for technology assessment that warrant the attention of governments, aid agencies and health providers.

1.7 DISCUSSION AND CONCLUSION

The leading question to ask in the design of health policy is: how can Government best serve the health needs of its population now and in years to come? This deceptively simple question has no easy answer, especially when the national priorities in the allocation of resources lie not only in improving health outcomes but also in providing cost-effective, equitable, affordable and accessible health care services. Doing more with less is the demand facing health care service planners in Kenya and South Africa.

The problem of providing a satisfactory health service to all the people of Kenya and South Africa at costs they can afford is a pressing one. At present, many people do not receive a service that is adequate either in quantity or in quality, and services are inequitably distributed and often costly. The result is a tremendous amount of preventable physical pain and mental anguish, needless deaths, economic inefficiency, and social waste. The principal issue of health care in the 1990s and into the next century seems to be cost-containment, subsumed into the general problem of efficiency and distributional equity, and in this regard health care technology is highly relevant.

Realising the benefits from technological investments in health care systems in Kenya and South Africa requires more than quantity and quality of equipment, and personnel trained to use, operate and maintain it. How those inputs are planned, allocated, organised, and managed can determine whether or not the services are cost-effective and can make the difference between sustainable and unsustainable outcomes.

Health technology assessment as a policy tool is an attempt to establish an early warning system to help plan, control, direct and if necessary restrain utilisation of technology so as to maximise public good while minimising public risks. Technology has become an integral part of any health care system, and therefore an assessment of technology is an assessment of the health care system. Health technology assessment is perhaps the most important yet unappreciated feature of any health care system.

The research presented in this thesis has been concerned with such an assessment of health care technology, by means of a survey of health facilities in Kenya and South Africa. The specific objectives and research questions are formulated in the following chapter.

CHAPTER 2

PURPOSE AND SCOPE OF THE RESEARCH

In Chapter 2 the specific research questions are formulated and the specific objectives of the thesis are stated. These are linked to the origins of health care problems and their association with technology.

Look beneath the surface: do not let a thing's intrinsic qualities or worth escape you.

Marcus Aurelius, 121-180

Meditations, Republished 1961

2.1 BROAD RESEARCH OBJECTIVES

The objective of the research presented in this thesis is to investigate problems and constraints with regard to utilisation of health technologies in Kenya and South Africa, the focus being on technology planning, deployment and management. Following identification of major constraints and obstacles to optimal technology utilisation, rational interventions directed at overcoming these problems will be recommended.

This thesis aims to bridge the gap between health policy and the effective utilisation of health technology (HT) in order to provide rational insight into technology planning, deployment, management and assessment, with a view to increasing the efficiency of national health care systems through cost containment, and reduction of waste in technology. It is the contention of this thesis that appropriate planning and deployment of technological innovations contribute to a general improvement in the quality of health care, and to increased access to the health care system for all population groups.

2.2 SIGNIFICANCE OF THIS RESEARCH

Of all the factors that will shape the health of humanity in the future, the one that most often captures the imagination is health technology [David 1993]. The rising investments in technology in the health sectors of both Kenya and South Africa demonstrate the perceived importance of and the benefits expected from deployment of technology in health care systems [Kachieng'a 1998a, Kachieng'a and Boonzaier 1999]. Similar growth of technology in health care has been recorded in both Europe and America [Fuchs 1993, Rettig 1996, Ziekenfodraad 1998].

The health care systems in both Kenya and South Africa are going through a transition that is being driven by three major driving forces: cost, social expectations and technology [Kachieng'a 1998a, Kachieng'a and Boonzaier 1999]. The impact of these forces may change from time to time, as does their relative significance. Nor is the human factor that interacts with these forces constant. The ability to forecast and manage this continual evolution and its implications has become a major component in all health care policy decisions. Both health care systems in this study are being subjected to mounting pressures: firstly a need to identify goals, secondly to prioritise these goals, and finally to allocate the limited resources with maximum effect.

The strategic planning, deployment and management of health technology is the only link between technical capabilities and clinical outcomes. It is therefore imperative to design a technology programme that:

1. Guides resource allocation;
2. Identifies and evaluates technological opportunities and/or threats;
3. Guides capital investment prioritisation, facility preparation and staff planning;
4. Maximises the value of investments in health technology;
5. Meets - and indeed exceeds - the necessary standard of care;
6. Reduces costs; and
7. Reduces risks.

Whereas patterns of management in other spheres, such as the business world, are well documented, the science of management of the health care delivery system in general and of HT in particular is still in its infancy [David 1993]. To manage their investments in technology objectively, many hospitals in Kenya and South Africa require pertinent information on how to plan for new equipment and reduce ownership costs of existing equipment.

This thesis therefore aims to generate data that would assist in technology planning, deployment and management, as well as cost containment. The aims are thus:

1. To accumulate pertinent information on health equipment.
2. To facilitate formulation of equipment replacement criteria.
3. To create an ongoing technology planning and assessment methodology.
4. To improve the equipment capital budget process by integrating the current technology position with long-term needs relative to health care equipment.

2.3 SPECIFIC RESEARCH OBJECTIVES

The specific objectives of this study are:

1. To review the literature on technology utilisation in health care for developing countries, with special reference to Sub-Saharan Africa (SSA), but with the focus on Kenya and South Africa.
2. To develop a logistical framework for planning, deployment, management and assessment of health technology (HT), with the focus on short-term and long-term technology transfer.
3. To carry out a survey of HT needs in small, medium and large hospitals in Kenya and South Africa, through questionnaires and field interviews.
4. To carry out a professional opinion survey, also through questionnaires and field interviews, of health care equipment maintenance experts (clinical engineers and technicians) on equipment problems in small, medium and large hospitals and regional maintenance workshops in Kenya and South Africa.
5. To promote the development of a Standard Essential Equipment List, through field audit and interviews with users, operators and clinical engineers and technicians in small, medium and large hospitals in Kenya and South Africa.
6. To propose a conceptual framework for HT policy that would meet the special needs of Kenya and South Africa, and could possibly be adaptable for application in other developing countries.

2.4 BENEFITS FROM THIS RESEARCH

In Kenya and South Africa there are no government or private institutions responsible for assessment of health technologies (HT), except the Medical Research Council (SA) which has a unit engaged in qualitative and quantitative measurements of health outcomes in relation to some technology [TBDG 1998]. Consequently, no single government unit or organization in the private sector has the responsibility for addressing broad policy issues such as assessment of existing health care technologies and adoption of new technologies. There is a need for information on which to base decisions regarding investment in HT and its rational use.

The research findings are expected to:

1. Highlight deficiencies in planning, deployment and use of existing health care technologies in public health facilities in Kenya and South Africa.
2. Improve understanding of the relationship between HT and health care systems in SSA.
3. Develop practicable methods for planning future health care systems in SSA.
4. Identify and document essential health care equipment in public health facilities in these two countries.
5. Develop a logistical framework for technology assessment in Kenya and South Africa.
6. Propose a health technology policy framework for the two countries under study.

Respective stakeholders in the health system will use the research as an information resource in the following areas:

Governments

- Prioritisation and allocation of national health resources;
- Formulation of an Standard Essential Equipment List (SEEL) for planning and budgeting and for equipping different categories of public health facilities;
- Design of equipment maintenance budgets;
- Planning of health facilities and services;
- Planning, deployment and management of health technology;
- Formulation of technology policy (short and long term);
- Planning and managing technology transfer;
- Restructuring and reforming health services;
- Equipment asset management systems;
- Formulation of health policy; and
- Selection of technologies for local manufacture.

Regional Governments (Sub-Saharan Africa)

- Development of a regional technology assessment database;
- As a basis for establishment of regional co-operation and collaboration in:
  - development and manufacture of health care equipment and other products,
  - technology assessment research, and
  - training of clinical engineers and technicians for the maintenance of health care equipment.

Bilateral & Multilateral Donor/ Non-Governmental Organisations

- Screening health care investment proposals from governments;
- Evaluation and assessment of ongoing health care projects;
- Impact analysis of investments in health technology; and
- Designing future health aid programmes.

Private Sector: Health Care Equipment Industry

- Quantification of "health market" demands for health equipment, devices, consumables and services; and
- Identification of manufacturing opportunities (national and regional) for health equipment, devices and consumables based on real local needs.

Scientific Community

The logistic model framework developed for strategic planning, deployment, development and management of HT and the proposed HT policy framework will open a new chapter in technology assessment research in Sub-Saharan Africa (SSA). No study on HT needs assessment has ever been done in the SSA region, and therefore this research represents a special initiative in finding the means to optimise the utilisation and management of HT in the region. With minor modifications the HT strategic planning and management model, and the proposed HT policy framework could be applied in other developing countries.

Broad Benefits

This is pioneering research. It was intended as a contribution towards better planning, deployment and management of health care technology. However because of its exploratory nature, all of the consequences – beneficial or otherwise – cannot yet be known, let alone quantified. Yet it is believed that the consequences will be largely beneficial. Further, it is hoped that there will be indirect benefits, such as stimulation of further research; or the establishment of institutions to co-ordinate HT management and assessment – nationally or regionally – or even simply inspiration to those who believed that health care problems in Africa were insurmountable.

CHAPTER 3

LITERATURE REVIEW

Chapter 3 provides a literature review on applications and use of health care technology in the public health sector in Sub-Saharan Africa, with the focus on Kenya and South Africa. The literature review covered the 1960 – 1999 period, and the tools used were Medicus Index, Medline, Dialogue and Citation Indices (social and science). Most arguments, discussion s, recommendations and conclusion were based on peer-reviewed sources. The primary data from surveys and information collected during hospital visits and face to face interviews were used to facilitate corroboration of facts and arguments, and to enhance recommendations.

Fools you are to say you learn by experience. I prefer to profit by others' mistakes and avoid the price of my own.

Otto van Bismarck-Schonhausen, 1815 – 1898

Bismarck, The Man and the Statesman 1898

AJ Butler (ed.) 1898.

3.1 WHAT IS HEALTH CARE TECHNOLOGY?

Technology may connote 'any tool or technique, any product or process, any physical equipment or method of doing or making by which human activity is extended' [Elliot and Elliot 1976]. Galbraith (1977) defined it as "the systematic application of scientific or other organised knowledge to practical tasks." Health technology refers to drugs, devices, medical and surgical procedures, support systems and organisational and administrative capacity [IOM 1985, OTA 1982].

Health technology, broadly construed, embraces innovations in medicine – new drugs, biologics, health care equipment and procedures, as well as existing therapeutic and diagnostic capabilities [Rettig 1996]. Health technology, viewed from the perspective of equipment, includes not only small simple devices such as thermometers and stethoscopes, but also highly sophisticated combinations of electrical, mechanical and electronic systems, for example, computerised ultrasonic tomography units and linear accelerators. In hospital environment, health technology also includes central information processing systems and health services management support systems [Hawkins 1992]. Modern health technology use computer-based techniques to enhance efficiency and productivity. In future, computer technology is bound to play a greater role in health service delivery and management.

For the present study the term "health technology" (HT) is defined as: *All devices, equipment, systems, software, pharmaceuticals, bio-technologies, and medical and surgical procedures used in health education, promotion, prevention, control, diagnosis/treatment, rehabilitation and public hygiene, and the organisational and supporting systems through which such care is* *provided* [David and Judd 1993]. This study focuses on the health care equipment products (devices, systems, hardware and software), rather than pharmaceuticals, bio-technologies or procedures.

More technological developments are expected in health care, not less, and projections into the future predict an even greater role for technology in medical practice, especially in the application of computer-aided equipment [Hellman and Vokes 1996]. "Laennec's stethoscope and Jenner's use of the cowpox virus to eliminate one of the world's greatest scourges, smallpox, were surely both high technology when they were introduced" [Mumford 1934, McGregor 1989]. Now, we expect the term high technology in medicine to signify CT scanners, MRI units, total physiological monitoring systems, surgical lasers, and gamma cameras.

3.2 APPLICATIONS OF TECHNOLOGY IN HEALTH CARE

Medical practice and health care services depend increasingly on technology to meet their large variety of needs [Reiser 1984]. They use technology to gather information necessary for appropriate diagnosis; to process this information and present it in comprehensive forms; to treat disorders effectively when diagnosed; to monitor treatment and evaluate its efficacy; and last, but not least, to prevent disease. There is practically no step in the sequence of medical actions and health care delivery services (Table 3:1) which is not dependent on technology [Anbar 1984, Kachieng'a 1998a]. Some medical specialities, such as surgery, orthopaedics, physiotherapy or ophthalmology, are more technology-intensive than others; however, even non-technological specialities such as psychiatry adopt technology wherever necessary (e.g., video cameras and tape recorders).

Health technology has changed all facets of modern medicine and health care services. The modern hospital is a wonderland of complicated equipment and thousands of people around the world depend upon artificial body parts for survival and to improve the quality of their lives - from artificial hips through intraocular lenses to heart pacemakers. Modern technology is exciting and expensive. In modern consulting offices physicians use lasers to remove cataracts without need of hospitalisation; ultrasound monitors take pictures of unborn babies. "The allure of health technology innovation is powerful, holding out the possibility of perfect outcome, an amelioration of pain, a delay in our inexorable decline toward death" [Foote 1992].

TABLE 3.1:

SEQUENCE OF ACTIONS OF MEDICAL PRACTICE

History and physical examination

↓

Selection of diagnostic tests

↓

Results of diagnostic tests

↓

Correlation with diagnostic tests

↓

Correlation with known pathology

↓

Diagnosis

↓

Selection of treatment

↓

Monitoring of treatment

↓

Evaluation of treatment

↓

Rehabilitation

Source: Modified from Anbar [1984] and Kachieng'a [1998a].

The compelling desire for good health and long life has led to excessive demands upon medicine and technology [Foote 1992]. In the words of the neurologist, Oliver Sacks, "medicine is asked to transcend the possible" [Sacks 1990]. The need for assessing technology and managing it efficiently is essential for a successful health care system.

Several parties with different motivations drive the forces behind technological innovations:

- Physicians seek technology that will enhance their ability as diagnosticians or therapists, or to make performance of their services easier or more efficient and thus increase their productivity.
- Clinical and biomedical engineers view medicine as an area of application for the products of their profession.
- Equipment manufacturers search for products that will have a profitable market or, more frequently, for profitable markets for existing products.
- Medical insurance companies, governments that pay for health care and hospital administrators look for technology to provide services less expensively or more expeditiously by substituting human labour with capital-intensive automatic equipment or devices.
- Patients (consumers) are always concerned about early diagnosis, less dangerous or uncomfortable diagnostic procedures, more favourable outcomes, and the affordability of services.
- Research institutions and organisations such as WHO are interested in qualitative and quantitative measurements of health outcomes analysis of technological interventions and service planning

The development of new health technologies is dominated by the USA, Japan and a few European countries [Hailey and Roseman 1990]. The majority of developing nations are net importers of health technologies. The size of the equipment industrial complex and market is in itself a powerful attraction for those preoccupied with political or financial gain, and it is unfortunate that factors of this nature, rather than the health and welfare of society, sometimes motivate the acquisition of technologies that may not be suitable for a particular country under current circumstances. For these reasons health technology assessment [HTA] can be a critical component in any policy developed to reconcile the interests of the various stakeholders in the health care sector of a country. This is further discussed in sections 3.3 and 3.4 of this chapter.

Innovations in HT – with life-saving promises, potential risks, and often high price tags – are deeply embedded in the broad debate about technology and health care policy [Banta 1986, Jennett 1986, Fuchs 1993]. The advances of medicine in the 1980s have been stupendous. The necessity for making an accurate diagnosis is more evident today than it has been at any other time in history. Much can be done to cure, to alleviate, to rehabilitate, and/or to comfort with conviction and understanding. Technology deserves a great deal of credit for these advances [Farber 1982, Reiser 1984].

Unfortunately many technologies are introduced without adequate assessment and without the necessary data to support the allocation of large portions of health budgets to the purchase of expensive health care equipment. Increasingly, governments have been called to regulate and control the developments of big ticket technologies [Foote 1992, Fuchs 1993].

3.3 WHAT IS HEALTH TECHNOLOGY ASSESSMENT?

In 1899, Charles H. Duell, Commissioner of the USA Office of patents, urged President McKinley to abolish the Patent Office by saying, "Everything that can be invented has been invented" [Tyson 1989]. Fortunately for the health industry, there have been more significant "medical inventions" in the 99 years following Duell's utterance than in all of recorded history preceding it.

Innovations in medicine are regarded by many as a primary guarantor of quality health care and the only pathway to finding new solutions to both old and new clinical problems [Rettig 1996]. Such innovations include developments in HT, which have been identified by many analysts as a major factor driving the relentless increase in national expenditures for health care services [Banta 1982, 1986, Bronzino 1995]. There is a deeply-rooted societal ambivalence toward HT - the wish to control health care costs, but not at the expense of innovation, quality, or clinical progress [Banta 1984a]. It is these two conflicting needs, coupled with the societal consequences of certain technologies such as artificial hearts [Kachieng'a 1982] and genetic screening [Hasset 1984], that have stimulated the need for health technology assessment.

The evaluation of the clinical efficacy, the cost-benefit and cost-effectiveness of HT is therefore a matter of substantial interest to health policy makers and planners, health care providers (public and private hospitals), medical insurance companies and patients. Health technology assessment (HTA) is the term applied to these technical, clinical and economic evaluation studies [Rettig 1996].

HTA is considered by some as the least controversial means of controlling health care costs. To others, it is an instrument of social policy, embracing issues beyond those of technical effectiveness and finance - such as unintended, indirect or delayed social impacts of a technology [Banta 1984b, Jennett 1986, Bronzino 1995]. Banta [1986] states that technology assessment is a comprehensive policy research that examines short - and long-term technical, economic and social consequences of applications of technology in health care.

According to Menon [1993], technology assessment is a research that is intended to deal with the development, acquisition and utilisation of HT. Health care professionals, such as physicians and clinical engineers, now recognise the need for assessment information in decision making. Technology assessment in recent years has broadened in scope, to encompass the measurement of effectiveness, consideration of quality of life and patients' preferences [Banta 1984a] and especially the costs and benefits [Jennett 1986,Goodman 1993, Menon 1993, Bronzino 1995]. Such kinds of extensive assessment - of both financial and social costs and benefits – now inform decisions about resources and have become an integral part of health policy and planning decisions in industrialized countries [Hawkins 1992, Rettig 1996].

Good health care technology must by definition be useful. It must be able to survive fierce buffeting by market forces, government policies, whims of medical fashions and all the vagaries of human nature and customs [Jennett 1986, Battista 1990]. Under ideal circumstances, new technology should make medical practice cost-effective and valuable for the patient [Tannenberger 1984]. Unfortunately, this is not always true. In his article, "When must a new approach to treatment be introduced?" in the *International Journal of*

Technology Assessment in Health Care, Stephan Tannenberger [1984] emphasises the need to assess new technology:

"Prior to nation-wide diffusion of a new technology, evidence must be assembled to demonstrate that a new technology is, in the terminology of WHO, appropriate. Not everything that is new in health care technology is good; not all that is good is needed".

In most developing countries, however, technology assessment research is non-existent [World Bank 1993a, Muller and Jaros 1994] and therefore health policy and planning are ultimately little more than a giant guessing game with potentially expensive outcomes. The tradition of policymakers in Kenya and South Africa has been to assume that technological innovations are efficacious and commit large amounts of resources on the basis of faith, rather than to seek out evidence of relative advantage in outcomes and costs [Jaros and Boonzaier 1993, Kachieng'a 1998a]. It is not often realised that what matters most is not how much is spent, but where it is spent and for what [Kachieng'a 1998a]. The *raison de'etre* of health technology assessment is therefore to provide information to aid health policy decision-making [Banta 1982, Muller and Jaros 1994].

The benefits, risks and burdens of technologies depend on a balance between many factors - technical, clinical, economic and social [Jennett 1986, Goodman 1993, David 1993]. Not enough is known about these factors - we need knowledge and more data to facilitate better equipment planning, procurement and deployment. In most African countries such data are at best inadequate and more often completely lacking. In health care, it is always easy to see the costs, but not benefits. The challenge is to track the benefits, quantify them and match them against costs. That is a function of health technology assessment.

In selecting a certain technological solution to a given medical problem, the benefit/cost ratio should always be maximised. The use made of HT depends much more on decisions made by doctors than on policies formulated by health authorities or professional organisations. However, doctors should not regard their clinical freedom as a licence to ignore all consideration of costs and resources. Many clinical decisions have strong economic components [Jennett 1986]. It is only through technology assessment that both promises and pitfalls of modern health care technologies can be brought to the attention of governments and all other health care providers. What is regarded as the most important contribution of the HTA studies is the ability to induce changes in *clinical practice behaviour* by sharing the evidence which has been accumulated with the medical profession and the public [DOH 1997]. Another major area of contribution of HTA is in informing reimbursement and investment decisions made by government agencies [Fuchs 1993].

According to WHO (1997a), the hallmark of a sustainable health system is its emphasis on assessment. National and local systems of assessment for health are a prerequisite for development of effective, efficient, equitable and quality health systems.

The primary costs of an inadequate system for technology assessment are to human well-being – patients do not receive optimal care. But the worth of HT reaches beyond its warranty to the patient and its utility to the health professional. There are also economic costs if ineffective technologies are applied [IOM 1985, Fuchs 1993]. The results of assessment are therefore also needed by hospitals and other facilities that buy and apply technologies; by industry that develops technologies; by the professionals who disseminate information to health care practitioners; and by insurance companies, government agencies, corporate health schemes that pay for the use of technologies, and patients and their families who pay for health care services.

It is therefore important that strategies for assessing HT, especially in SSA, must take into account not only the methods of assessment but also the needs, demands, and objections of the participants and beneficiaries in the process.

The author believes that it is both possible and highly desirable to establish a coherent system for HTA in SSA. The challenge to this study is not only to devise one or more strategies for the planning, deployment, use, management and assessment of HT, built on current efforts, but also to strengthen and supplement them.

3.4 TECHNOLOGY AND HEALTH RESOURCES MANAGEMENT

Health technology has brought major changes to the practice of medicine and the organisation and management of health care services. Hospital doctors can not deliver technologically complex services without the assistance of a team of specially trained staff, nor can they dispense expensive services on their own authority [Jennett 1986, Foote 1992]. This is because the demand for such services exceeds the supply, and therefore some form of explicit or implicit rationing is inevitable.

The availability of high technology medicine is limited not only by cost but also because, even if money were not a constraint, there would not be enough skilled staff to satisfy the demand [Jennett 1986, Goodman 1991, ECRI 1989, Kachieng'a and Boonzaier 1999]. These limitations are not a peculiarity of Kenya and South Africa. Even in the most affluent of industrialized countries, it is not possible for practitioners to fully meet national demands, or for most patients as individuals to afford intensive care, renal dialysis or open-heart surgery [Jennett 1986, Rettig 1996].

To reduce health care expenditure, a number of countries have undertaken to rationalise investments in health care equipment. For example, the governments of Belgium, Canada, France, and Portugal directly control the acquisition of state-of-the art medical technologies by both the public and the private sectors [World Bank 1993a]. To alleviate some of the problems with equipment selection and procurement in developing countries, the World Bank and the World Health Organization have suggested equipment standardization for various levels of health facilities and the development of an essential equipment list along the lines of the essential drugs list which is already in use in many countries [WHO 1988a, World Bank 1993a]. These are just examples of the many explicit and implicit trade-offs that are made as public and private budgets are stretched to their limit.

In health resource allocations, budget limits and other financial mechanisms are best for setting the national objectives. They establish the general ground rules by determining the quantity of resources for health services. The way health care budgets are apportioned has implications not only for morbidity and mortality, but also for the character and quality of living and dying. Planning and regulation of health resources is a critical function in the allocation of resources to different uses. Health technology assessment makes these decisions more rational by providing information about the relative costs and outcomes of the different uses.

3.5 A REVIEW: HEALTH TECHNOLOGY UTILISATION IN SUB-SAHARAN AFRICA (SSA)

3.5.1 HISTORICAL BACKGROUND

Most developing countries in SSA were colonised, and the procurement, deployment, and management of technologies were naturally modelled on the health care systems of the colonising country. With the arrival of independence in the 1960s, colonial systems for procurement and maintenance were either discontinued or were no longer relevant under the new democratic dispensation [Prage 1987]. The newly independent countries of Africa were supported enthusiastically by the international donor community with various aid packages, including the building of new facilities, rehabilitation of existing ones, and supply of new or donated equipment.

As a result of these well-meaning but somewhat indiscriminate donations, the Sub-Saharan region is presently stocked with various models and types of equipment from many countries, most of it non-functional. The cost of maintenance of different types and models in various health facilities is so huge that it has become unbearable to most of these countries, and therefore health services are being compromised, in spite of increase in population in the region. The World Bank [1993a] and WHO [Issakov 1994] estimate that over 50% of HT in the region is non-functional, for various reasons, including scarcity of maintenance funds, trained clinical engineers and technicians, and spare parts. The lack of standardisation of equipment increases the investments required for obtaining spare parts and necessitates broad training of engineers and technicians to enable them to service the many diverse types and models. Such highly qualified personnel are usually not available in practice, or, if available, cannot be afforded by state hospitals [World Bank 1995a].

These observations are corroborated by the findings of Bloom and Temple-Bird [1988], whose study of health care problems in the region also identified the following causative factors: (i) insufficient funds being made available for purchase of equipment, spare parts and consumables; and (ii) inefficient use of what resources were available. The same study also revealed that, although there was a rise in spending on health care equipment in the mid 1970s and early 1980s, by 1985 expenditures in real terms (taking into account factors such as inflation and currency devaluation) had fallen back to the level of the mid 1970s [Mills 1991]. This was so in spite of the growth in population and the expansion in the health sector. The scenario has not changed [World Bank 1991d, 1995a].

In their report, entitled *Medical Equipment in Sub-Saharan Africa: A Frame for Policy Formulation*, Bloom and Temple-Bird (1988) highlighted the shortage of spare parts and consumables as the major reason why large quantities of expensive and sophisticated equipment were unusable. There were also numerous cases of redundancy due to minor faults which, in other circumstances could have been easily corrected, and in some cases equipment was being shipped abroad for minor repairs.

The factors giving rise to the serious problems in acquisition, utilisation and maintenance of health care technologies in SSA are discussed in depth in section 3.5.2.

3.5.2 HEALTH CARE EQUIPMENT PROBLEMS IN SSA REGION

The problem of non-functioning of health care equipment in SSA is recognised by the donor community as well as recipient governments as a major obstacle to the efficient delivery of health care services [Prage 1987, Issakov 1994, World Bank 1995a]. Evaluation reports carried out by, among others, the WHO [1986, 1987a, 1988a], UNDP [1983], EEC [1986] and World Bank [1993a, 1995a], conclude that most health facilities in the region have very little functioning equipment. Under-utilisation of equipment in developing countries has been further reported in several other studies [Banta 1986, Perry and Marx 1992, Serpa-Florez 1993, Kachieng'a 1998a, Kachieng'a and Boonzaier 1999].

While this is only one aspect of the broader crisis in the health sector in the SSA region, it nevertheless has a serious impact on the overall effectiveness of the delivery of health services. Furthermore, the importation of equipment, spare parts, consumables and reagents needed to keep health care services functional constitutes a significant expenditure of foreign exchange.

Another problem is inappropriate distribution of health care expenditure. In the case of Zambia, for example, an ILO Mission found that the health services in one province lacked virtually all essential drugs and equipment, but had a full complement of personnel [ILO 1987]. When funding of the health sector decreases, not all inputs are similarly decreased. The least vulnerable to cuts are the salaries, which normally account for about 70% of recurrent expenditure and in some countries have reached 85% [EEC 1986]. The present trend in industrialised countries to cut is reduction staff while enhancing technical efficiency by outsourcing non-core services.

A study by UNICEF [Bloom and Temple-Bird. 1988] showed that the greatest cuts in health sector expenditure due to financial constraints have been in capital expenditure followed by the purchase of spare parts and consumable goods. In fact, in a number of cases where total health expenditure fell between 1979 and 1983, as in Zambia, there was actually a rise in payments to employees [World Bank 1993a]. The consequence of this maldistribution of funds in the SSA region is that existing services have been seriously curtailed.

A number of studies have identified equipment maintenance as a serious problem in developing countries [Banta 1986, WHO 1985 & 1987, Perry and Chu 1988, Issakov 1994, World Bank 1995a]. Financial constraints and lack of policy for selection, procurement, utilisation and maintenance of health care equipment are the two major contributors to this situation [Abel-Smith 1986, Prage 1987, World Bank 1993a].

Developing countries are getting poor returns from those investments on equipment which have been made in spite of limited funds for health care in these countries. Furthermore, health care services are curtailed due to lack of functioning equipment. Trained personnel based in health facilities cannot be effective if there are no spare parts and consumables to maintain health care technologies. These countries are thus entangled in 'a double-loss circuit': high investments but poor returns on investment and also poor health outcomes.

The losses due to failure or under-use of equipment in developing countries amount to huge sums which should justify increased attention to the problems regarding the planning, procurement, deployment, utilisation and maintenance of health care equipment [Prage, 1987, Coe and Banta 1992, World Bank 1995a]. The economic realities are highlighted by a report that developing countries account for the expenditure of about $ 5 billion annually on health care equipment [World Bank, 1993a p 137]. It is estimated the countries in SSA account for more than 50% of this expenditure.

The main reasons for the 'equipment problem' vary from country to country, but the underlying factors can be summarised as follows:

- Lack of health technology policy [Issakov 1994, World Bank 1995a].
- Lack of policy on procurement, deployment and maintenance health care equipment - leading to poor selection of equipment [Issakov 1994].
- Lack of an essential equipment list [WHO 1991a, World Bank 1995a].
- Absence of technically skilled human resources [Banta 1986, Free 1992].
- Mismatch between technology requirements and health demands [Free 1992, Perry and Marx 1992, Coe and Banta 1992, Kachieng'a 1998a].
- Inadequate budgetary allocation for equipment maintenance and lack of equipment replacement planning [World Bank 1995a].
- Insufficient equipment maintenance budgets [Erinosho 1991, Issakov 1994, Kachieng'a and Boonzaier1999,].
- Lack of equipment assets management systems and insufficient infrastructural support (financial and technical) [Free 1992, World Bank 1995a, Kachieng'a 1998a].

Inadequate technical expertise in formulating equipment policy has led to unplanned equipment procurement, without systematic selection, and also ill-conceived deployment of equipment in the public sector. The fact that capital investments in equipment are not supported by adequate maintenance budgets has led to under-utilisation or even non-utilisation, and this has significantly affected the delivery of health care services in the region.

Economic considerations are playing an increasingly important role in HT decisions in all countries [Hermesse 1984, World Bank 1993a], especially in the SSA [World Bank 1995a, 1995b]. The current economic constraints in the region have caused significant cuts in spending on public health services, despite the presence of three types of funding [WHO 1987, World Bank 1995b]: direct financial resources for health provided by the national budgetary resources; monetary transfers from external sources in the form of international multilateral, bilateral and non-governmental assistance programmes; and individual spending on private health care, including traditional healers and private doctors.

Since, in most cases, economic conditions prevent decision makers from significantly increasing public resources for the provision of health care, increased attention must be given to the effective allocation of existing resources, including selection and procurement of new health care technologies. The use of health aid in the Sub-Saharan region is further discussed in chapter 5.

Furthermore, the absence of technical organizational infrastructure, such as maintenance workshops, equipment inventory management systems, and logistics for spare parts, as well as lack of trained engineers and technicians have compromised health care technical support services, with consequent drastic reduction in the efficiency of health care services.

Another factor contributing to equipment problems is the fact that public hospitals are 'administered', not managed. Critical technological decisions, such as the purchase of essential spare parts or equipment upgrades take time to be sanctioned, thus increasing equipment downtime and reducing service efficiency. Management of public hospitals is an issue that needs to be addressed if service efficiency is to be achieved in the public health sector.

3.6 COMMENTS AND DISCUSSION

Thousands of pieces of sophisticated equipment are being imported into the SSA region every day for use in the health sector. But according to Issakov [1994] the problem in the region is not lack of equipment but the presence of equipment which is non-functional or not used for various technical reasons. It is the unplanned purchase of health care equipment which has resulted in non-functionality and under-utilisation of equipment in the region. WHO emphasises that the rational use of equipment requires the formulation of a national policy, such as that for drugs [WHO 1988b, 1991a, Kachieng'a and Boonzaier 1999].

Inadequate maintenance of health care equipment has become a major stunting factor in the development of health services in Africa [World Bank 1993a]. There is virtually no correlation between capital investment on equipment and maintenance funds. Maintenance budgets are historically 'guesswork'. Most hospitals have no equipment inventory and do not know their total capital investment on equipment, and therefore they lack a logistical framework for calculation of maintenance budgets.

According to the World Bank, there is need for more equipment in the region, but appropriate arrangements, both financial and technical, need to be put in place before further investments are undertaken. Inadequate strategic planning of equipment purchase and deployment has led to situations where some hospital departments engage in over-procurement of equipment to cater for emergency situations, thus creating artificial shortages in equipment funds for other departments. Furthermore, the absence of an equipment inventory results in duplications of equipment purchases by different departments.

The training and deployment of clinical engineers and technicians lack long-term vision and continuity. A proper career development path for medical/clinical engineers and technicians does not exist in most countries due to the absence of a national scheme of service for clinical engineers and technicians in the public health sector. As a result health care technical services have not attracted or retained the best professionals, especially in South Africa. In Kenya, with the recent development of the National Scheme of Service for clinical engineers and technicians, the retention rate of engineering professionals in the Ministry of Health has improved.

Training programmes for medical/clinical technicians have been commenced in several countries in SSA, notably Swaziland, Botswana, Kenya, South Africa, Cameroon, Senegal and Zimbabwe [Issakov 1994, World Bank 1995a]. All the training is at technician and craft level, except in South Africa, where the University of Cape Town provides courses for postgraduate diplomas and degrees in Biomedical Engineering.

Apart from this training solution, no other solution has been offered or research undertaken to provide data for efficient and cost-effective planning and deployment of HT in Sub-Saharan Africa. No comprehensive strategy for matching health care technologies more closely to the health needs of the populations in African countries has yet been developed.

3.7 CONCLUSION

The problems with health care equipment in the public sector are multiple. In some areas it is possible to provide guidelines or policy options, but in others, there is need for further policy-oriented research. One particular difficulty in this field is the inter-sectoral nature of the health care equipment problem. Equipment is selected, procured, utilised, maintained and serviced within the health sector. However, the problems - for example shortages of funds for spare parts and consumables; lack of skilled engineers and technicians; the need to strengthen organizational infrastructure for technical services; the need for appropriate budget allocations for equipment maintenance, and the need for budgetary planning for equipment replacement - do not all fall under the health sector. The skills required to solve these problems require co-ordination with other sectors of the government.

The development of successful strategies for planning, deployment and rational use of health care equipment to a large extent mirrors similar initiatives throughout the national economy. Solutions developed in a sector as politically and socially important as health care can provide an impetus for badly needed economic development in the region.

High rates of disease and premature mortality in SSA are costing the region dearly. Poor health causes pain and suffering, reduces human energies, and leaves millions of Africans less able to cope with life, let alone enjoy it. The economic consequences are immense. As prosperity grows for a minority around the world, 600 million people who live in SSA are being left behind in both health care and economic development.

Health technology is now as much a part of health care as it is of life. There is no 'good' and 'bad' technology, for there is seldom a clear distinction between the useful and useless. Technology offers promises, but also threats [GCCHC 1992]. Few technologies live up to their initial promise and none is of value when used inappropriately. Most have some potential for harming patients, but many technologies are full of promise – they decrease the threat of death, reduce disability and dependence, and offer the possibility of improved quality of life.

The benefits, risks and burdens of health care technologies depend on a balance between many factors - technical, financial, clinical, economic and social. Not enough is known about these factors - we need knowledge and more data. This includes finding out more about the less tangible social aspects of any given technology. Assessing social factors is challenging enough; attaching value to them is even more difficult. Health care technology assessment brings hope, and hope brings challenge.

Note: For additional chapter-specific literature reviews see preambles of subsequent chapters.

CHAPTER 2

PURPOSE AND SCOPE OF THE RESEARCH

In Chapter 2 the specific research questions are formulated and the specific objectives of the thesis are stated. These are linked to the origins of health care problems and their association with technology.

Look beneath the surface: do not let a thing's intrinsic qualities or worth escape you.

Marcus Aurelius, 121-180

Meditations, Republished 1961

2.1 BROAD RESEARCH OBJECTIVES

The objective of the research presented in this thesis is to investigate problems and constraints with regard to utilisation of health technologies in Kenya and South Africa, the focus being on technology planning, deployment and management. Following identification of major constraints and obstacles to optimal technology utilisation, rational interventions directed at overcoming these problems will be recommended.

This thesis aims to bridge the gap between health policy and the effective utilisation of health technology (HT) in order to provide rational insight into technology planning, deployment, management and assessment, with a view to increasing the efficiency of national health care systems through cost containment, and reduction of waste in technology. It is the contention of this thesis that appropriate planning and deployment of technological innovations contribute to a general improvement in the quality of health care, and to increased access to the health care system for all population groups.

2.2 SIGNIFICANCE OF THIS RESEARCH

Of all the factors that will shape the health of humanity in the future, the one that most often captures the imagination is health technology [David 1993]. The rising investments in technology in the health sectors of both Kenya and South Africa demonstrate the perceived importance of and the benefits expected from deployment of technology in health care systems [Kachieng'a 1998a, Kachieng'a and Boonzaier 1999]. Similar growth of technology in health care has been recorded in both Europe and America [Fuchs 1993, Rettig 1996, Ziekenfodraad 1998].

The health care systems in both Kenya and South Africa are going through a transition that is being driven by three major driving forces: cost, social expectations and technology [Kachieng'a 1998a, Kachieng'a and Boonzaier 1999]. The impact of these forces may change from time to time, as does their relative significance. Nor is the human factor that interacts with these forces constant. The ability to forecast and manage this continual evolution and its implications has become a major component in all health care policy decisions. Both health care systems in this study are being subjected to mounting pressures: firstly a need to identify goals, secondly to prioritise these goals, and finally to allocate the limited resources with maximum effect.

The strategic planning, deployment and management of health technology is the only link between technical capabilities and clinical outcomes. It is therefore imperative to design a technology programme that:

1. Guides resource allocation;
2. Identifies and evaluates technological opportunities and/or threats;
3. Guides capital investment prioritisation, facility preparation and staff planning;
4. Maximises the value of investments in health technology;
5. Meets - and indeed exceeds - the necessary standard of care;
6. Reduces costs; and
7. Reduces risks.

Whereas patterns of management in other spheres, such as the business world, are well documented, the science of management of the health care delivery system in general and of HT in particular is still in its infancy [David 1993]. To manage their investments in technology objectively, many hospitals in Kenya and South Africa require pertinent information on how to plan for new equipment and reduce ownership costs of existing equipment.

This thesis therefore aims to generate data that would assist in technology planning, deployment and management, as well as cost containment. The aims are thus:

1. To accumulate pertinent information on health equipment.
2. To facilitate formulation of equipment replacement criteria.
3. To create an ongoing technology planning and assessment methodology.
4. To improve the equipment capital budget process by integrating the current technology position with long-term needs relative to health care equipment.

2.3 SPECIFIC RESEARCH OBJECTIVES

The specific objectives of this study are:

1. To review the literature on technology utilisation in health care for developing countries, with special reference to Sub-Saharan Africa (SSA), but with the focus on Kenya and South Africa.
2. To develop a logistical framework for planning, deployment, management and assessment of health technology (HT), with the focus on short-term and long-term technology transfer.
3. To carry out a survey of HT needs in small, medium and large hospitals in Kenya and South Africa, through questionnaires and field interviews.
4. To carry out a professional opinion survey, also through questionnaires and field interviews, of health care equipment maintenance experts (clinical engineers and technicians) on equipment problems in small, medium and large hospitals and regional maintenance workshops in Kenya and South Africa.
5. To promote the development of a Standard Essential Equipment List, through field audit and interviews with users, operators and clinical engineers and technicians in small, medium and large hospitals in Kenya and South Africa.
6. To propose a conceptual framework for HT policy that would meet the special needs of Kenya and South Africa, and could possibly be adaptable for application in other developing countries.

2.4 BENEFITS FROM THIS RESEARCH

In Kenya and South Africa there are no government or private institutions responsible for assessment of health technologies (HT), except the Medical Research Council (SA) which has a unit engaged in qualitative and quantitative measurements of health outcomes in relation to some technology [TBDG 1998]. Consequently, no single government unit or organization in the private sector has the responsibility for addressing broad policy issues such as assessment of existing health care technologies and adoption of new technologies. There is a need for information on which to base decisions regarding investment in HT and its rational use.

The research findings are expected to:

1. Highlight deficiencies in planning, deployment and use of existing health care technologies in public health facilities in Kenya and South Africa.
2. Improve understanding of the relationship between HT and health care systems in SSA.
3. Develop practicable methods for planning future health care systems in SSA.
4. Identify and document essential health care equipment in public health facilities in these two countries.
5. Develop a logistical framework for technology assessment in Kenya and South Africa.
6. Propose a health technology policy framework for the two countries under study.

Respective stakeholders in the health system will use the research as an information resource in the following areas:

Governments

- Prioritisation and allocation of national health resources;
- Formulation of an Standard Essential Equipment List (SEEL) for planning and budgeting and for equipping different categories of public health facilities;
- Design of equipment maintenance budgets;
- Planning of health facilities and services;
- Planning, deployment and management of health technology;
- Formulation of technology policy (short and long term);
- Planning and managing technology transfer;
- Restructuring and reforming health services;
- Equipment asset management systems;
- Formulation of health policy; and
- Selection of technologies for local manufacture.

Regional Governments (Sub-Saharan Africa)

- Development of a regional technology assessment database;
- As a basis for establishment of regional co-operation and collaboration in:
  - development and manufacture of health care equipment and other products,
  - technology assessment research, and
  - training of clinical engineers and technicians for the maintenance of health care equipment.

Bilateral & Multilateral Donor/ Non-Governmental Organisations

- Screening health care investment proposals from governments;
- Evaluation and assessment of ongoing health care projects;
- Impact analysis of investments in health technology; and
- Designing future health aid programmes.

Private Sector: Health Care Equipment Industry

- Quantification of "health market" demands for health equipment, devices, consumables and services; and
- Identification of manufacturing opportunities (national and regional) for health equipment, devices and consumables based on real local needs.

Scientific Community

The logistic model framework developed for strategic planning, deployment, development and management of HT and the proposed HT policy framework will open a new chapter in technology assessment research in Sub-Saharan Africa (SSA). No study on HT needs assessment has ever been done in the SSA region, and therefore this research represents a special initiative in finding the means to optimise the utilisation and management of HT in the region. With minor modifications the HT strategic planning and management model, and the proposed HT policy framework could be applied in other developing countries.

Broad Benefits

This is pioneering research. It was intended as a contribution towards better planning, deployment and management of health care technology. However because of its exploratory nature, all of the consequences – beneficial or otherwise – cannot yet be known, let alone quantified. Yet it is believed that the consequences will be largely beneficial. Further, it is hoped that there will be indirect benefits, such as stimulation of further research; or the establishment of institutions to co-ordinate HT management and assessment – nationally or regionally – or even simply inspiration to those who believed that health care problems in Africa were insurmountable.

CHAPTER 3

LITERATURE REVIEW

Chapter 3 provides a literature review on applications and use of health care technology in the public health sector in Sub-Saharan Africa, with the focus on Kenya and South Africa. The literature review covered the 1960 – 1999 period, and the tools used were Medicus Index, Medline, Dialogue and Citation Indices (social and science). Most arguments, discussion s, recommendations and conclusion were based on peer-reviewed sources. The primary data from surveys and information collected during hospital visits and face to face interviews were used to facilitate corroboration of facts and arguments, and to enhance recommendations.

Fools you are to say you learn by experience. I prefer to profit by others' mistakes and avoid the price of my own.

Otto van Bismarck-Schonhausen, 1815 – 1898

Bismarck, The Man and the Statesman 1898

AJ Butler (ed.) 1898.

3.1 WHAT IS HEALTH CARE TECHNOLOGY?

Technology may connote 'any tool or technique, any product or process, any physical equipment or method of doing or making by which human activity is extended' [Elliot and Elliot 1976]. Galbraith (1977) defined it as "the systematic application of scientific or other organised knowledge to practical tasks." Health technology refers to drugs, devices, medical and surgical procedures, support systems and organisational and administrative capacity [IOM 1985, OTA 1982].

Health technology, broadly construed, embraces innovations in medicine – new drugs, biologics, health care equipment and procedures, as well as existing therapeutic and diagnostic capabilities [Rettig 1996]. Health technology, viewed from the perspective of equipment, includes not only small simple devices such as thermometers and stethoscopes, but also highly sophisticated combinations of electrical, mechanical and electronic systems, for example, computerised ultrasonic tomography units and linear accelerators. In hospital environment, health technology also includes central information processing systems and health services management support systems [Hawkins 1992]. Modern health technology use computer-based techniques to enhance efficiency and productivity. In future, computer technology is bound to play a greater role in health service delivery and management.

For the present study the term "health technology" (HT) is defined as: *All devices, equipment, systems, software, pharmaceuticals, bio-technologies, and medical and surgical procedures used in health education, promotion, prevention, control, diagnosis/treatment, rehabilitation and public hygiene, and the organisational and supporting systems through which such care is* *provided* [David and Judd 1993]. This study focuses on the health care equipment products (devices, systems, hardware and software), rather than pharmaceuticals, bio-technologies or procedures.

More technological developments are expected in health care, not less, and projections into the future predict an even greater role for technology in medical practice, especially in the application of computer-aided equipment [Hellman and Vokes 1996]. "Laennec's stethoscope and Jenner's use of the cowpox virus to eliminate one of the world's greatest scourges, smallpox, were surely both high technology when they were introduced" [Mumford 1934, McGregor 1989]. Now, we expect the term high technology in medicine to signify CT scanners, MRI units, total physiological monitoring systems, surgical lasers, and gamma cameras.

3.2 APPLICATIONS OF TECHNOLOGY IN HEALTH CARE

Medical practice and health care services depend increasingly on technology to meet their large variety of needs [Reiser 1984]. They use technology to gather information necessary for appropriate diagnosis; to process this information and present it in comprehensive forms; to treat disorders effectively when diagnosed; to monitor treatment and evaluate its efficacy; and last, but not least, to prevent disease. There is practically no step in the sequence of medical actions and health care delivery services (Table 3:1) which is not dependent on technology [Anbar 1984, Kachieng'a 1998a]. Some medical specialities, such as surgery, orthopaedics, physiotherapy or ophthalmology, are more technology-intensive than others; however, even non-technological specialities such as psychiatry adopt technology wherever necessary (e.g., video cameras and tape recorders).

Health technology has changed all facets of modern medicine and health care services. The modern hospital is a wonderland of complicated equipment and thousands of people around the world depend upon artificial body parts for survival and to improve the quality of their lives - from artificial hips through intraocular lenses to heart pacemakers. Modern technology is exciting and expensive. In modern consulting offices physicians use lasers to remove cataracts without need of hospitalisation; ultrasound monitors take pictures of unborn babies. "The allure of health technology innovation is powerful, holding out the possibility of perfect outcome, an amelioration of pain, a delay in our inexorable decline toward death" [Foote 1992].

TABLE 3.1:
SEQUENCE OF ACTIONS OF MEDICAL PRACTICE

History and physical examination

↓

Selection of diagnostic tests

↓

Results of diagnostic tests

↓

Correlation with diagnostic tests

↓

Correlation with known pathology

↓

Diagnosis

↓

Selection of treatment

↓

Monitoring of treatment

↓

Evaluation of treatment

↓

Rehabilitation

Source: Modified from Anbar [1984] and Kachieng'a [1998a].

The compelling desire for good health and long life has led to excessive demands upon medicine and technology [Foote 1992]. In the words of the neurologist, Oliver Sacks, "medicine is asked to transcend the possible" [Sacks 1990]. The need for assessing technology and managing it efficiently is essential for a successful health care system.

Several parties with different motivations drive the forces behind technological innovations:

- Physicians seek technology that will enhance their ability as diagnosticians or therapists, or to make performance of their services easier or more efficient and thus increase their productivity.
- Clinical and biomedical engineers view medicine as an area of application for the products of their profession.
- Equipment manufacturers search for products that will have a profitable market or, more frequently, for profitable markets for existing products.
- Medical insurance companies, governments that pay for health care and hospital administrators look for technology to provide services less expensively or more expeditiously by substituting human labour with capital-intensive automatic equipment or devices.
- Patients (consumers) are always concerned about early diagnosis, less dangerous or uncomfortable diagnostic procedures, more favourable outcomes, and the affordability of services.
- Research institutions and organisations such as WHO are interested in qualitative and quantitative measurements of health outcomes analysis of technological interventions and service planning

The development of new health technologies is dominated by the USA, Japan and a few European countries [Hailey and Roseman 1990]. The majority of developing nations are net importers of health technologies. The size of the equipment industrial complex and market is in itself a powerful attraction for those preoccupied with political or financial gain, and it is unfortunate that factors of this nature, rather than the health and welfare of society, sometimes motivate the acquisition of technologies that may not be suitable for a particular country under current circumstances. For these reasons health technology assessment [HTA] can be a critical component in any policy developed to reconcile the interests of the various stakeholders in the health care sector of a country. This is further discussed in sections 3.3 and 3.4 of this chapter.

Innovations in HT – with life-saving promises, potential risks, and often high price tags – are deeply embedded in the broad debate about technology and health care policy [Banta 1986, Jennett 1986, Fuchs 1993]. The advances of medicine in the 1980s have been stupendous. The necessity for making an accurate diagnosis is more evident today than it has been at any other time in history. Much can be done to cure, to alleviate, to rehabilitate, and/or to comfort with conviction and understanding. Technology deserves a great deal of credit for these advances [Farber 1982, Reiser 1984].

Unfortunately many technologies are introduced without adequate assessment and without the necessary data to support the allocation of large portions of health budgets to the purchase of expensive health care equipment. Increasingly, governments have been called to regulate and control the developments of big ticket technologies [Foote 1992, Fuchs 1993].

3.3 WHAT IS HEALTH TECHNOLOGY ASSESSMENT?

In 1899, Charles H. Duell, Commissioner of the USA Office of patents, urged President McKinley to abolish the Patent Office by saying, "Everything that can be invented has been invented" [Tyson 1989]. Fortunately for the health industry, there have been more significant "medical inventions" in the 99 years following Duell's utterance than in all of recorded history preceding it.

Innovations in medicine are regarded by many as a primary guarantor of quality health care and the only pathway to finding new solutions to both old and new clinical problems [Rettig 1996]. Such innovations include developments in HT, which have been identified by many analysts as a major factor driving the relentless increase in national expenditures for health care services [Banta 1982, 1986, Bronzino 1995]. There is a deeply-rooted societal ambivalence toward HT - the wish to control health care costs, but not at the expense of innovation, quality, or clinical progress [Banta 1984a]. It is these two conflicting needs, coupled with the societal consequences of certain technologies such as artificial hearts [Kachieng'a 1982] and genetic screening [Hasset 1984], that have stimulated the need for health technology assessment.

The evaluation of the clinical efficacy, the cost-benefit and cost-effectiveness of HT is therefore a matter of substantial interest to health policy makers and planners, health care providers (public and private hospitals), medical insurance companies and patients. Health technology assessment (HTA) is the term applied to these technical, clinical and economic evaluation studies [Rettig 1996].

HTA is considered by some as the least controversial means of controlling health care costs. To others, it is an instrument of social policy, embracing issues beyond those of technical effectiveness and finance - such as unintended, indirect or delayed social impacts of a technology [Banta 1984b, Jennett 1986, Bronzino 1995]. Banta [1986] states that technology assessment is a comprehensive policy research that examines short - and long-term technical, economic and social consequences of applications of technology in health care.

According to Menon [1993], technology assessment is a research that is intended to deal with the development, acquisition and utilisation of HT. Health care professionals, such as physicians and clinical engineers, now recognise the need for assessment information in decision making. Technology assessment in recent years has broadened in scope, to encompass the measurement of effectiveness, consideration of quality of life and patients' preferences [Banta 1984a] and especially the costs and benefits [Jennett 1986,Goodman 1993, Menon 1993, Bronzino 1995]. Such kinds of extensive assessment - of both financial and social costs and benefits – now inform decisions about resources and have become an integral part of health policy and planning decisions in industrialized countries [Hawkins 1992, Rettig 1996].

Good health care technology must by definition be useful. It must be able to survive fierce buffeting by market forces, government policies, whims of medical fashions and all the vagaries of human nature and customs [Jennett 1986, Battista 1990]. Under ideal circumstances, new technology should make medical practice cost-effective and valuable for the patient [Tannenberger 1984]. Unfortunately, this is not always true. In his article, "When must a new approach to treatment be introduced?" in the *International Journal of*

Technology Assessment in Health Care, Stephan Tannenberger [1984] emphasises the need to assess new technology:

"Prior to nation-wide diffusion of a new technology, evidence must be assembled to demonstrate that a new technology is, in the terminology of WHO, appropriate. Not everything that is new in health care technology is good; not all that is good is needed".

In most developing countries, however, technology assessment research is non-existent [World Bank 1993a, Muller and Jaros 1994] and therefore health policy and planning are ultimately little more than a giant guessing game with potentially expensive outcomes. The tradition of policymakers in Kenya and South Africa has been to assume that technological innovations are efficacious and commit large amounts of resources on the basis of faith, rather than to seek out evidence of relative advantage in outcomes and costs [Jaros and Boonzaier 1993, Kachieng'a 1998a]. It is not often realised that what matters most is not how much is spent, but where it is spent and for what [Kachieng'a 1998a]. The *raison de'etre* of health technology assessment is therefore to provide information to aid health policy decision-making [Banta 1982, Muller and Jaros 1994].

The benefits, risks and burdens of technologies depend on a balance between many factors - technical, clinical, economic and social [Jennett 1986, Goodman 1993, David 1993]. Not enough is known about these factors - we need knowledge and more data to facilitate better equipment planning, procurement and deployment. In most African countries such data are at best inadequate and more often completely lacking. In health care, it is always easy to see the costs, but not benefits. The challenge is to track the benefits, quantify them and match them against costs. That is a function of health technology assessment.

In selecting a certain technological solution to a given medical problem, the benefit/cost ratio should always be maximised. The use made of HT depends much more on decisions made by doctors than on policies formulated by health authorities or professional organisations. However, doctors should not regard their clinical freedom as a licence to ignore all consideration of costs and resources. Many clinical decisions have strong economic components [Jennett 1986]. It is only through technology assessment that both promises and pitfalls of modern health care technologies can be brought to the attention of governments and all other health care providers. What is regarded as the most important contribution of the HTA studies is the ability to induce changes in *clinical practice behaviour* by sharing the evidence which has been accumulated with the medical profession and the public [DOH 1997]. Another major area of contribution of HTA is in informing reimbursement and investment decisions made by government agencies [Fuchs 1993].

According to WHO (1997a), the hallmark of a sustainable health system is its emphasis on assessment. National and local systems of assessment for health are a prerequisite for development of effective, efficient, equitable and quality health systems.

The primary costs of an inadequate system for technology assessment are to human well-being – patients do not receive optimal care. But the worth of HT reaches beyond its warranty to the patient and its utility to the health professional. There are also economic costs if ineffective technologies are applied [IOM 1985, Fuchs 1993]. The results of assessment are therefore also needed by hospitals and other facilities that buy and apply technologies; by industry that develops technologies; by the professionals who disseminate information to health care practitioners; and by insurance companies, government agencies, corporate health schemes that pay for the use of technologies, and patients and their families who pay for health care services.

It is therefore important that strategies for assessing HT, especially in SSA, must take into account not only the methods of assessment but also the needs, demands, and objections of the participants and beneficiaries in the process.

The author believes that it is both possible and highly desirable to establish a coherent system for HTA in SSA. The challenge to this study is not only to devise one or more strategies for the planning, deployment, use, management and assessment of HT, built on current efforts, but also to strengthen and supplement them.

3.4 TECHNOLOGY AND HEALTH RESOURCES MANAGEMENT

Health technology has brought major changes to the practice of medicine and the organisation and management of health care services. Hospital doctors can not deliver technologically complex services without the assistance of a team of specially trained staff, nor can they dispense expensive services on their own authority [Jennett 1986, Foote 1992]. This is because the demand for such services exceeds the supply, and therefore some form of explicit or implicit rationing is inevitable.

The availability of high technology medicine is limited not only by cost but also because, even if money were not a constraint, there would not be enough skilled staff to satisfy the demand [Jennett 1986, Goodman 1991, ECRI 1989, Kachieng'a and Boonzaier 1999]. These limitations are not a peculiarity of Kenya and South Africa. Even in the most affluent of industrialized countries, it is not possible for practitioners to fully meet national demands, or for most patients as individuals to afford intensive care, renal dialysis or open-heart surgery [Jennett 1986, Rettig 1996].

To reduce health care expenditure, a number of countries have undertaken to rationalise investments in health care equipment. For example, the governments of Belgium, Canada, France, and Portugal directly control the acquisition of state-of-the art medical technologies by both the public and the private sectors [World Bank 1993a]. To alleviate some of the problems with equipment selection and procurement in developing countries, the World Bank and the World Health Organization have suggested equipment standardization for various levels of health facilities and the development of an essential equipment list along the lines of the essential drugs list which is already in use in many countries [WHO 1988a, World Bank 1993a]. These are just examples of the many explicit and implicit trade-offs that are made as public and private budgets are stretched to their limit.

In health resource allocations, budget limits and other financial mechanisms are best for setting the national objectives. They establish the general ground rules by determining the quantity of resources for health services. The way health care budgets are apportioned has implications not only for morbidity and mortality, but also for the character and quality of living and dying. Planning and regulation of health resources is a critical function in the allocation of resources to different uses. Health technology assessment makes these decisions more rational by providing information about the relative costs and outcomes of the different uses.

3.5 A REVIEW: HEALTH TECHNOLOGY UTILISATION IN SUB-SAHARAN AFRICA (SSA)

3.5.1 HISTORICAL BACKGROUND

Most developing countries in SSA were colonised, and the procurement, deployment, and management of technologies were naturally modelled on the health care systems of the colonising country. With the arrival of independence in the 1960s, colonial systems for procurement and maintenance were either discontinued or were no longer relevant under the new democratic dispensation [Prage 1987]. The newly independent countries of Africa were supported enthusiastically by the international donor community with various aid packages, including the building of new facilities, rehabilitation of existing ones, and supply of new or donated equipment.

As a result of these well-meaning but somewhat indiscriminate donations, the Sub-Saharan region is presently stocked with various models and types of equipment from many countries, most of it non-functional. The cost of maintenance of different types and models in various health facilities is so huge that it has become unbearable to most of these countries, and therefore health services are being compromised, in spite of increase in population in the region. The World Bank [1993a] and WHO [Issakov 1994] estimate that over 50% of HT in the region is non-functional, for various reasons, including scarcity of maintenance funds, trained clinical engineers and technicians, and spare parts. The lack of standardisation of equipment increases the investments required for obtaining spare parts and necessitates broad training of engineers and technicians to enable them to service the many diverse types and models. Such highly qualified personnel are usually not available in practice, or, if available, cannot be afforded by state hospitals [World Bank 1995a].

These observations are corroborated by the findings of Bloom and Temple-Bird [1988], whose study of health care problems in the region also identified the following causative factors: (i) insufficient funds being made available for purchase of equipment, spare parts and consumables; and (ii) inefficient use of what resources were available. The same study also revealed that, although there was a rise in spending on health care equipment in the mid 1970s and early 1980s, by 1985 expenditures in real terms (taking into account factors such as inflation and currency devaluation) had fallen back to the level of the mid 1970s [Mills 1991]. This was so in spite of the growth in population and the expansion in the health sector. The scenario has not changed [World Bank 1991d, 1995a].

In their report, entitled *Medical Equipment in Sub-Saharan Africa: A Frame for Policy Formulation*, Bloom and Temple-Bird (1988) highlighted the shortage of spare parts and consumables as the major reason why large quantities of expensive and sophisticated equipment were unusable. There were also numerous cases of redundancy due to minor faults which, in other circumstances could have been easily corrected, and in some cases equipment was being shipped abroad for minor repairs.

The factors giving rise to the serious problems in acquisition, utilisation and maintenance of health care technologies in SSA are discussed in depth in section 3.5.2.

3.5.2 HEALTH CARE EQUIPMENT PROBLEMS IN SSA REGION

The problem of non-functioning of health care equipment in SSA is recognised by the donor community as well as recipient governments as a major obstacle to the efficient delivery of health care services [Prage 1987, Issakov 1994, World Bank 1995a]. Evaluation reports carried out by, among others, the WHO [1986, 1987a, 1988a], UNDP [1983], EEC [1986] and World Bank [1993a, 1995a], conclude that most health facilities in the region have very little functioning equipment. Under-utilisation of equipment in developing countries has been further reported in several other studies [Banta 1986, Perry and Marx 1992, Serpa-Florez 1993, Kachieng'a 1998a, Kachieng'a and Boonzaier 1999].

While this is only one aspect of the broader crisis in the health sector in the SSA region, it nevertheless has a serious impact on the overall effectiveness of the delivery of health services. Furthermore, the importation of equipment, spare parts, consumables and reagents needed to keep health care services functional constitutes a significant expenditure of foreign exchange.

Another problem is inappropriate distribution of health care expenditure. In the case of Zambia, for example, an ILO Mission found that the health services in one province lacked virtually all essential drugs and equipment, but had a full complement of personnel [ILO 1987]. When funding of the health sector decreases, not all inputs are similarly decreased. The least vulnerable to cuts are the salaries, which normally account for about 70% of recurrent expenditure and in some countries have reached 85% [EEC 1986]. The present trend in industrialised countries to cut is reduction staff while enhancing technical efficiency by outsourcing non-core services.

A study by UNICEF [Bloom and Temple-Bird. 1988] showed that the greatest cuts in health sector expenditure due to financial constraints have been in capital expenditure followed by the purchase of spare parts and consumable goods. In fact, in a number of cases where total health expenditure fell between 1979 and 1983, as in Zambia, there was actually a rise in payments to employees [World Bank 1993a]. The consequence of this maldistribution of funds in the SSA region is that existing services have been seriously curtailed.

A number of studies have identified equipment maintenance as a serious problem in developing countries [Banta 1986, WHO 1985 & 1987, Perry and Chu 1988, Issakov 1994, World Bank 1995a]. Financial constraints and lack of policy for selection, procurement, utilisation and maintenance of health care equipment are the two major contributors to this situation [Abel-Smith 1986, Prage 1987, World Bank 1993a].

Developing countries are getting poor returns from those investments on equipment which have been made in spite of limited funds for health care in these countries. Furthermore, health care services are curtailed due to lack of functioning equipment. Trained personnel based in health facilities cannot be effective if there are no spare parts and consumables to maintain health care technologies. These countries are thus entangled in 'a double-loss circuit': high investments but poor returns on investment and also poor health outcomes.

The losses due to failure or under-use of equipment in developing countries amount to huge sums which should justify increased attention to the problems regarding the planning, procurement, deployment, utilisation and maintenance of health care equipment [Prage, 1987, Coe and Banta 1992, World Bank 1995a]. The economic realities are highlighted by a report that developing countries account for the expenditure of about \$ 5 billion annually on health care equipment [World Bank, 1993a p 137]. It is estimated the countries in SSA account for more than 50% of this expenditure.

The main reasons for the 'equipment problem' vary from country to country, but the underlying factors can be summarised as follows:

- Lack of health technology policy [Issakov 1994, World Bank 1995a].
- Lack of policy on procurement, deployment and maintenance health care equipment - leading to poor selection of equipment [Issakov 1994].
- Lack of an essential equipment list [WHO 1991a, World Bank 1995a].
- Absence of technically skilled human resources [Banta 1986, Free 1992].
- Mismatch between technology requirements and health demands [Free 1992, Perry and Marx 1992, Coe and Banta 1992, Kachieng'a 1998a].
- Inadequate budgetary allocation for equipment maintenance and lack of equipment replacement planning [World Bank 1995a].
- Insufficient equipment maintenance budgets [Erinosho 1991, Issakov 1994, Kachieng'a and Boonzaier1999,].
- Lack of equipment assets management systems and insufficient infrastructural support (financial and technical) [Free 1992, World Bank 1995a, Kachieng'a 1998a].

Inadequate technical expertise in formulating equipment policy has led to unplanned equipment procurement, without systematic selection, and also ill-conceived deployment of equipment in the public sector. The fact that capital investments in equipment are not supported by adequate maintenance budgets has led to under-utilisation or even non-utilisation, and this has significantly affected the delivery of health care services in the region.

Economic considerations are playing an increasingly important role in HT decisions in all countries [Hermesse 1984, World Bank 1993a], especially in the SSA [World Bank 1995a, 1995b]. The current economic constraints in the region have caused significant cuts in spending on public health services, despite the presence of three types of funding [WHO 1987, World Bank 1995b]: direct financial resources for health provided by the national budgetary resources; monetary transfers from external sources in the form of international multilateral, bilateral and non-governmental assistance programmes; and individual spending on private health care, including traditional healers and private doctors.

Since, in most cases, economic conditions prevent decision makers from significantly increasing public resources for the provision of health care, increased attention must be given to the effective allocation of existing resources, including selection and procurement of new health care technologies. The use of health aid in the Sub-Saharan region is further discussed in chapter 5.

Furthermore, the absence of technical organizational infrastructure, such as maintenance workshops, equipment inventory management systems, and logistics for spare parts, as well as lack of trained engineers and technicians have compromised health care technical support services, with consequent drastic reduction in the efficiency of health care services.

Another factor contributing to equipment problems is the fact that public hospitals are 'administered', not managed. Critical technological decisions, such as the purchase of essential spare parts or equipment upgrades take time to be sanctioned, thus increasing equipment downtime and reducing service efficiency. Management of public hospitals is an issue that needs to be addressed if service efficiency is to be achieved in the public health sector.

3.6 COMMENTS AND DISCUSSION

Thousands of pieces of sophisticated equipment are being imported into the SSA region every day for use in the health sector. But according to Issakov [1994] the problem in the region is not lack of equipment but the presence of equipment which is non-functional or not used for various technical reasons. It is the unplanned purchase of health care equipment which has resulted in non-functionality and under-utilisation of equipment in the region. WHO emphasises that the rational use of equipment requires the formulation of a national policy, such as that for drugs [WHO 1988b, 1991a, Kachieng'a and Boonzaier 1999].

Inadequate maintenance of health care equipment has become a major stunting factor in the development of health services in Africa [World Bank 1993a]. There is virtually no correlation between capital investment on equipment and maintenance funds. Maintenance budgets are historically 'guesswork'. Most hospitals have no equipment inventory and do not know their total capital investment on equipment, and therefore they lack a logistical framework for calculation of maintenance budgets.

According to the World Bank, there is need for more equipment in the region, but appropriate arrangements, both financial and technical, need to be put in place before further investments are undertaken. Inadequate strategic planning of equipment purchase and deployment has led to situations where some hospital departments engage in over-procurement of equipment to cater for emergency situations, thus creating artificial shortages in equipment funds for other departments. Furthermore, the absence of an equipment inventory results in duplications of equipment purchases by different departments.

The training and deployment of clinical engineers and technicians lack long-term vision and continuity. A proper career development path for medical/clinical engineers and technicians does not exist in most countries due to the absence of a national scheme of service for clinical engineers and technicians in the public health sector. As a result health care technical services have not attracted or retained the best professionals, especially in South Africa. In Kenya, with the recent development of the National Scheme of Service for clinical engineers and technicians, the retention rate of engineering professionals in the Ministry of Health has improved.

Training programmes for medical/clinical technicians have been commenced in several countries in SSA, notably Swaziland, Botswana, Kenya, South Africa, Cameroon, Senegal and Zimbabwe [Issakov 1994, World Bank 1995a]. All the training is at technician and craft level, except in South Africa, where the University of Cape Town provides courses for postgraduate diplomas and degrees in Biomedical Engineering.

Apart from this training solution, no other solution has been offered or research undertaken to provide data for efficient and cost-effective planning and deployment of HT in Sub-Saharan Africa. No comprehensive strategy for matching health care technologies more closely to the health needs of the populations in African countries has yet been developed.

3.7 CONCLUSION

The problems with health care equipment in the public sector are multiple. In some areas it is possible to provide guidelines or policy options, but in others, there is need for further policy-oriented research. One particular difficulty in this field is the inter-sectoral nature of the health care equipment problem. Equipment is selected, procured, utilised, maintained and serviced within the health sector. However, the problems - for example shortages of funds for spare parts and consumables; lack of skilled engineers and technicians; the need to strengthen organizational infrastructure for technical services; the need for appropriate budget allocations for equipment maintenance, and the need for budgetary planning for equipment replacement - do not all fall under the health sector. The skills required to solve these problems require co-ordination with other sectors of the government.

The development of successful strategies for planning, deployment and rational use of health care equipment to a large extent mirrors similar initiatives throughout the national economy. Solutions developed in a sector as politically and socially important as health care can provide an impetus for badly needed economic development in the region.

High rates of disease and premature mortality in SSA are costing the region dearly. Poor health causes pain and suffering, reduces human energies, and leaves millions of Africans less able to cope with life, let alone enjoy it. The economic consequences are immense. As prosperity grows for a minority around the world, 600 million people who live in SSA are being left behind in both health care and economic development.

Health technology is now as much a part of health care as it is of life. There is no 'good' and 'bad' technology, for there is seldom a clear distinction between the useful and useless. Technology offers promises, but also threats [GCCHC 1992]. Few technologies live up to their initial promise and none is of value when used inappropriately. Most have some potential for harming patients, but many technologies are full of promise – they decrease the threat of death, reduce disability and dependence, and offer the possibility of improved quality of life.

The benefits, risks and burdens of health care technologies depend on a balance between many factors - technical, financial, clinical, economic and social. Not enough is known about these factors - we need knowledge and more data. This includes finding out more about the less tangible social aspects of any given technology. Assessing social factors is challenging enough; attaching value to them is even more difficult. Health care technology assessment brings hope, and hope brings challenge.

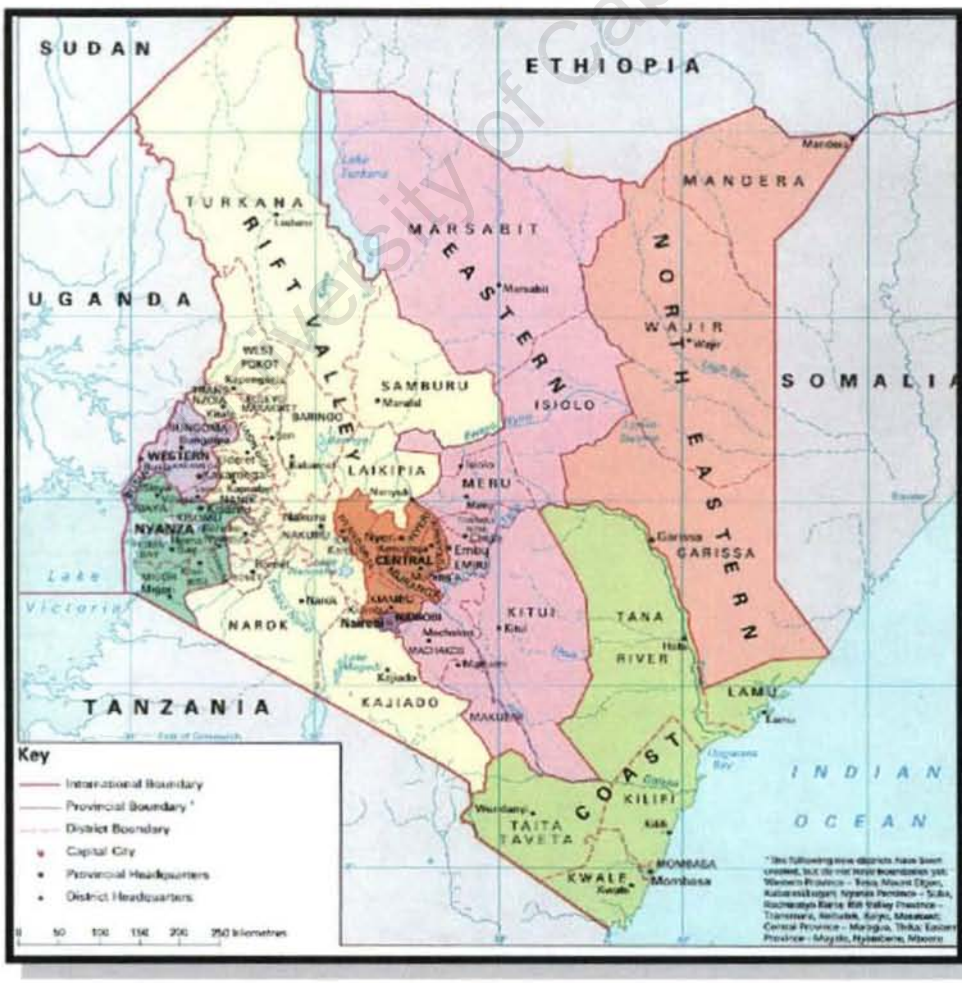
Note: For additional chapter-specific literature reviews see preambles of subsequent chapters.

CHAPTER 4

KENYA – A SITUATIONAL ANALYSIS

Chapter 4 examines Kenya's health care systems through analysis of public health care services, and includes pertinent information on population dynamics, health care financing, and the national economy.

Map of Kenya

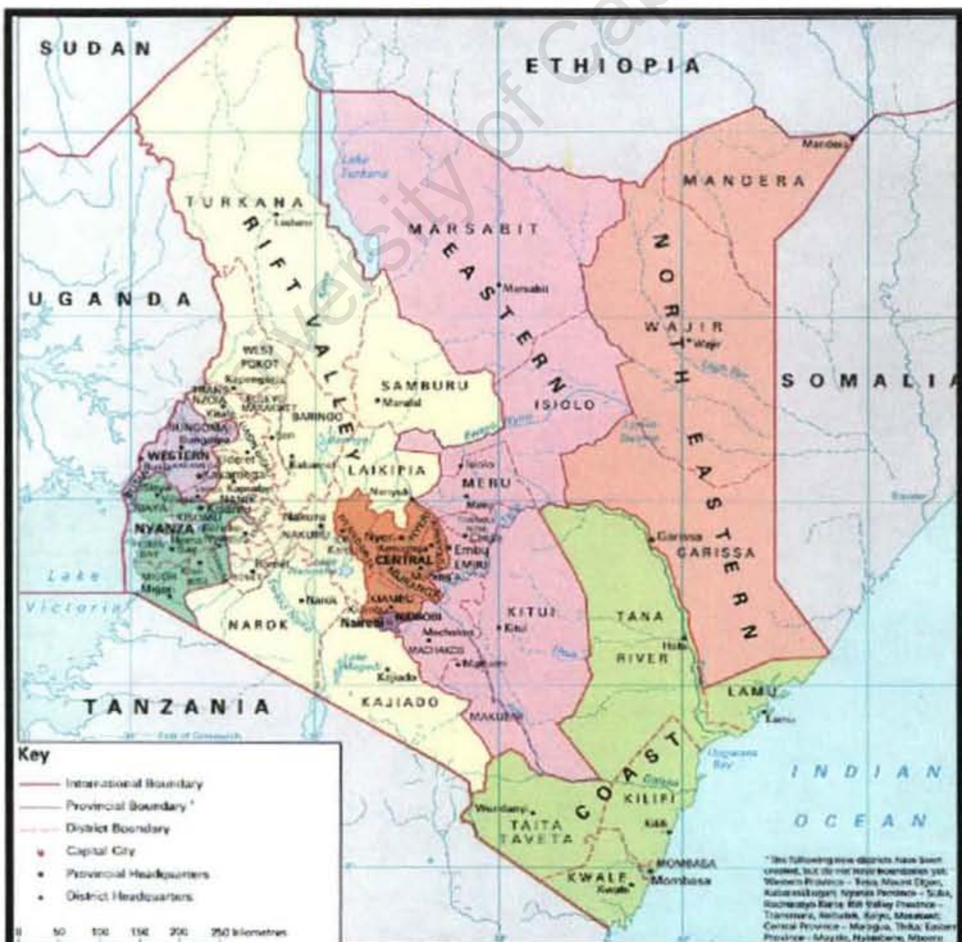


CHAPTER 4

KENYA – A SITUATIONAL ANALYSIS

Chapter 4 examines Kenya's health care systems through analysis of public health care services, and includes pertinent information on population dynamics, health care financing, and the national economy.

Map of Kenya



In the three preceding chapters, the background to the problems in health care in general and health technology (HT) in particular in Sub-Saharan Africa (SSA) has been presented, with special emphasis on the vital necessity for health technology assessment (HTA) as a policy tool. In order to develop such a strategy for application in Kenya and South Africa it is necessary to analyse in depth the situation regarding HT in these two countries. Such an analysis is presented in Chapter 4 for Kenya and in Chapter 6 for South Africa. In the case of Kenya an initiative undertaken jointly by the Kenyan and the German governments has begun to address some of the problems; this is discussed in Chapter 5.

4.1 GEOGRAPHIC PROFILE

The Republic of Kenya lies on the eastern coast of Africa, almost exactly astride the equator. It is bordered to the north by Ethiopia, to the north-west by Sudan, to the west by Uganda, to the south by Tanzania and to the east by Somalia. In the south-east it has about 1 000 kilometres of Indian Ocean coastline. Kenya is located approximately between latitudes 4.2° N and 4.3° S and between longitudes 34° E and 42° E.

Kenya has a total area of about 583 000 square kilometres of which more than 10 000 square kilometres are under water. The principal water body is Lake Victoria, a freshwater lake and the only one with an outlet, covering over 4 000 square kilometres of the territorial waters. Other water bodies are mainly to be found in the Rift Valley. Of these, Lake Turkana is the largest, with a territorial water area of 640 square kilometres. Without outlets, the Rift Valley lake levels and areas fluctuate; and all, barring lakes Naivasha and Baringo, are too salty for domestic consumption.

The rest of Kenya's landscape is one of great topographical diversity, rising from sea level to 5 200 metres at the summit of Mt Kenya, Africa's second highest peak, near the centre of Kenya. On the southern border with Tanzania stands Mt Kilimanjaro, Africa's highest point at 5 895 meters above sea level. The topographical environment of the country may also be expressed as follows: 38 percent of the country lies below 500m, 34.5 percent between 500 - 1 000m, 26 percent between 1 000 - 2 500m and 1.5 percent above 2 500m. Kenya possesses one of the most complicated and diversified physical environments found in any country, encompassing equatorial, tropical, savannah, aeolian, glacial and volcanic tectonic areas [Ojany and Ogendo 1986].

4.1.1 CLIMATE

Due to its proximity to the Equator and its altitude variations, Kenya has a wide range of climatic variation. The narrow coastal belt is classified as equatorial and the rest of the interior as tropical. This broad classification is modified by the great variations in topography, the localised influences of Lake Victoria and the relatively low rainfall totals in the country. The topography of the country falls into two distinct physical regions, Lowland and Highland Kenya. Much of Lowland Kenya has a fragile environment which offers development challenges, while Highland Kenya is regarded as the backbone of the Kenyan economy.

In Kenya the most important element of the climate, which has a major influence on the use of land, is rainfall. As is to be expected there are extreme variations in rainfall and temperature, as well as humidity. Humidity is, on the whole, not unduly high except at the coastal belt, where sea breezes combine with high temperatures. Atmospheric pressure, which is closely related to altitude and rainfall, is important for its influence on health.

An important characteristic of Kenya's rainfall is its unreliability, both in amount and expected time of arrival. This makes reliance on agriculture unsafe, not only in terms of type of crop, but also in that poor harvests are a common feature of farming.

4.2 NATIONAL ECONOMIC PROFILE

The Kenyan economy has undergone mixed experiences since independence in 1963. The growth in Gross Domestic Product (GDP) averaged 6.5% over the period 1964 to 1970; however, the first oil crisis of 1972 brought an abrupt halt to this level of achievement. Consequently the growth rate decelerated to below 4% for much of the early 1970s until the unexpected "coffee boom" of 1976 and 1977, when the growth rate in GDP averaged 8.2% [GOK 1986, MOH 1994a, 1994b]. However the situation worsened when the price of crude petroleum doubled from US$13 per barrel in 1978 to US$27 in 1979, pushing up the inflation rate and the cost of imported goods and raw materials and considerably slowing the country's economic growth rate.

During the early 1980s the GDP's growth rate remained below 5%, falling below 1% in 1984 for the first time in Kenya's history. This was largely attributed to the severe drought of that year. Favourable weather conditions coupled with government budgetary discipline and improved management enabled Kenya to achieve significant 4.8% and 5.5% growth rates in 1985 and 1986 respectively [CBS 1994]. Since 1990, however, the rate of growth in GDP has remained below 4%, with a dramatic fall in 1992 to a mere 0.4%, the lowest since independence. The slowdown in GDP growth since 1991 could be explained in terms of the actual decline in real output and value added in agriculture due to below average rainfall, as well as to the suspension of donor aid in the 1994 – 1996 period.

The contribution of the agricultural sector has steadily declined from over 45% of GDP in 1963 to about 28% in 1992. The implication is that the contributions to GDP from manufacturing and government services have steadily expanded (CBS 1994, CBS 1996).

Unstable economic growth has become the primary constraint to social improvement in Kenya. In particular, economic growth has not been sufficient to generate productive employment opportunities to absorb the rapidly growing labour force. Unemployment in urban areas is currently around 25% and about half of the rural population is living in poverty, with no access to the minimum requirements of food and essential non-food commodities [CBS 1996].

Kenya faces a major challenge in reducing unemployment and poverty. The number of people unemployed is currently more than 2 million and at least 10 million people are living in poverty. In addition, around 500 000 people will enter the labour force each year over the next decade [GOK/IMF/World Bank 1996]. The World Bank estimates that, in order to achieve significant reductions in unemployment and poverty, the economy will have to grow by an average of over 6 percent a year for several years. It will also be imperative that the Kenyan government place increased emphasis on social services and adequately targeted intervention in favour of the poor.

4.3 POPULATION DYNAMICS

Kenya has been pursuing an active population management policy. While there has been remarkable success in reducing fertility over the last decade, the population of Kenya is still growing at 3% per annum [GOK/IMF/WORLD BANK 1996]. Projections put the population of Kenya at 27.5 million in 1995 compared to 23.2 million (adjusted) in 1989, implying a population growth rate of 2.7% per annum. Average population density has continued to increase over the years - from 26 to 37 persons per square kilometre, in 1979 and 1989 respectively - although some districts have population density much higher than the average. Kenya has a youthful population, on average, with 48.9% being under 15 years and 60 percent under 20 years of age [CBS 1996].

Mortality levels have maintained a downward trend with the death rate of children under five declining from 190 to 157 to 113 per thousand according to the 1969, 1979 and 1989 censuses, respectively [NASCOP 1996]. However, if the AIDS pandemic persists the mortality levels will begin to rise again.

Table 4:1 provides a brief summary of the major demographic indicators for the period 1963 and 1993. According to the Statistical Abstract of 1995 and Economic Survey of 1996 [CBS 1996], the crude birth rate decreased from 52/1 000 in 1963 to 46/1 000 in 1993 whereas the crude death rate declined from 20/1 000 to 12/1 000 over the same period. The infant mortality rate also declined from 120/1 000 in 1963 to 67/1 000 in 1993. As a result of these trends almost 50% of Kenya's population is currently under 15 years of age and only 10 percent above 50 years. There appears to be a tremendous demographic momentum in Kenya, with a large pool of sexually active individuals in the 15 to 49 years age group. Furthermore, population growth rate in urban areas is over 7 percent, which is largely attributable to migration from the rural areas (see section 4.3.1)

Predictions of population growth in Kenya must take into account these trends in fertility and mortality, as well as the potential effect of the AIDS epidemic (see section 4.2.2) and migration into urban areas (see section 4.3.1). The population of Kenya is expected to grow to between 34 and 38 million over the next decade and this will put increasing pressure upon the government to provide adequate levels of health care coverage to a young population [NASCOP 1996].

4.3.1 URBANISATION TRENDS

The growth of urban centres in the country has increased rapidly since independence. According to the 1948 population census there were only 17 towns with an aggregate population of 276 000 people. By 1969 the population census showed that the number of urban centres had increased to 48 towns, with a total urban population of 1.08 million. As shown in Table 4.2 the trend of rural to urban migration has increased steadily since then. Between the 1969 and 1979 population census the number of urban centres had increased further to 67 towns, with a total urban population of over 2.3 million. The population for urban centres was 3.8 million in 1989, giving an inter-censual growth rate of 4.8% and a 19% share of the population compared to 15% in 1979. The number of urban centres reporting a population size of 10 000 and above increased from 25 in 1979 to 45 in 1989 [MOH 1990a].

Between 1980 and 1990 the urban population increased at an annual rate of 5.0%, almost doubling from 2.48 million in 1980 to 4.03 million in 1990. It constituted 15.5% and 17.7% of the total population in 1980 and 1990 respectively. Urban population is projected to increase to 6.95 million and 11.11 million by the years 2000 and 2010 respectively. The urban population growth rate between 1990 - 2000 is expected to be 5.6% - as opposed to the national growth rate of 2.7% - and it is projected that the urban population will constitute 23.4% of the total by the year 2000 and 30.4% in 2010. It is expected that by 2010 over half the annual national population growth will be occurring in urban areas [GOK 1994a].

TABLE 4.2:

RURAL AND URBAN POPULATION FROM 1980 - 2010 (MILLIONS)

Year	1980	1990	1992	2000	2010
Total Population	16.67	22.75	24.18	29.71	36.90
Urban Population Share (%)	2.50 (15)	4.03 (17.7)	4.50 (18.6)	6.95 (23.4)	11.11 (30.4)
Rural Population Share (%)	14.17 (85)	18.72 (82.3)	19.68 (81.4)	22.76 (76.6)	25.68 (69.6)

Source: Sessional Paper No. 1 of 1994 on Recovery and Sustainable Development to the Year 2010, GOK [1994a].

4.4 HEALTH SECTOR PROFILE

Over the past 35 years since independence in 1963, Kenya has made substantial progress in improving the overall health of its population. Health indicators have progressed steadily and are considerably better than those of most countries at similar levels of development, in large part due to the rapid expansion of government-financed programmes during the 1960s and 1970s [World Bank 1990]. Table 4.3: shows comparative health indicators for Kenya and countries at similar development levels.

The Ministry of Health (MOH) was established in 1965, and took over rural services from county councils in 1970. In the 1970s the government adopted a policy of decentralised management of health services which was reinforced in 1985 as part of its overall district focus strategy for development.

TABLE 4.3:
COMPARATIVE HEALTH INDICATORS

Country	Life Expectancy		Mortality		Population per	
	Male	Female	Infant	Maternal	Doctor	Nurse
Kenya	**57**	**61**	**70**	**510**	**9 970**	**950**
Ethiopia	46	49	35	2 000	78 970	5 500
Malawi	47	48	49	250	11 330	3 100
Zambia	52	55	78	110	7 150	740
Zimbabwe	61	65	49	150	6 700	1 000
Mauritius	63	70	22	99	1 900	580
Ghana	52	56	38	1 070	14 890	640
Low-income (exc. India and China)	53	56	98	–	13 910	3 250
Lower middle-income	62	67	57	–	3 030	1 090
Sub-Saharan Africa	**49**	**52**	**108**	**–**	**23 850**	**2 460**

Source: World Development Report 1990, World Bank [1990].

Infant mortality per 1 000 live births, maternal per 100 000 live births.

Life expectancy and infant mortality figures refer to 1987, maternal mortality to 1990; population per doctor and nurse to 1984.

By the early 1980s one of the two outstanding problems in the sector, which the overall indicators concealed, was the wide variation in health status among districts, largely reflecting variations in the distribution of health facilities and poverty levels. The other problem was that a high proportion of health care equipment was non-functional due to lack of maintenance. Health care was compromised due to lack of functioning equipment.

4.4.1 DISEASE BURDEN

Since independence in 1963, life expectancy at birth has risen from 42 to 58 years, the crude death rate has declined from 20 to 11 per thousand, infant mortality has fallen from 120 to 70 per thousand live births and under-five mortality has almost halved from over 200 to 110 per thousand live births [World Bank 1991a] (see also Table 4.1).

Kenya Demographic and Health Survey (KDHS) of 1990-92 indicates, however, that these impressive overall figures conceal severe regional disparities, with infant mortality varying from 107 per thousand in Coast Province to as little as 35 in the Rift Valley Province [CBS 1994].

Kenya's disease pattern can be grouped into seven broad categories [MOH 1994a]:

1. Respiratory, including pneumonia, tuberculosis, bronchitis and whooping cough, which are found mainly in high altitude areas;
2. Parasitic and infectious, including malaria, which is widespread in the warm lowlands around Lake Victoria and the coastal region, and schistosomiasis, usually found in irrigated areas with other vector-borne diseases such as sleeping sickness and filariasis;
3. Sanitation-related, including amoebiasis, enteritis, the dysenteries and other intestinal parasitic diseases;

4. Measles, among infants and children;
5. Maternity-related, including haemorrhage, tetanus, hypertension and uterine rupture;
6. Sexually-transmitted diseases, including AIDS, gonorrhoea and syphilis; and
7. Skin diseases.

Together the first three disease groups accounted for 70% of all deaths reported in 1980, and for over 60% of the reported morbidity. Measles was responsible for about 15% of deaths among children under five, only just behind acute respiratory infections, 20%, and gastro-intestinal infections, 20%. Maternal mortality has remained a major concern for years; maternal morbidity has only been partially surveyed and trends are largely unknown.

The burden of disease in Kenya is not well quantified and much needs to be done to improve the availability and reliability of available information, most of which is derived from reported disease statistics. It is known that there are marked regional variations in epidemiological patterns but, in general, preventable, vector-borne diseases and respiratory diseases are the highest contributors to morbidity [MOH 1994a, ADB 1993]. The leading causes of morbidity in Kenya are presented in Figure 4.1.

In the three preceding chapters, the background to the problems in health care in general and health technology (HT) in particular in Sub-Saharan Africa (SSA) has been presented, with special emphasis on the vital necessity for health technology assessment (HTA) as a policy tool. In order to develop such a strategy for application in Kenya and South Africa it is necessary to analyse in depth the situation regarding HT in these two countries. Such an analysis is presented in Chapter 4 for Kenya and in Chapter 6 for South Africa. In the case of Kenya an initiative undertaken jointly by the Kenyan and the German governments has begun to address some of the problems; this is discussed in Chapter 5.

4.1 GEOGRAPHIC PROFILE

The Republic of Kenya lies on the eastern coast of Africa, almost exactly astride the equator. It is bordered to the north by Ethiopia, to the north-west by Sudan, to the west by Uganda, to the south by Tanzania and to the east by Somalia. In the south-east it has about 1 000 kilometres of Indian Ocean coastline. Kenya is located approximately between latitudes 4.2° N and 4.3° S and between longitudes 34° E and 42° E.

Kenya has a total area of about 583 000 square kilometres of which more than 10 000 square kilometres are under water. The principal water body is Lake Victoria, a freshwater lake and the only one with an outlet, covering over 4 000 square kilometres of the territorial waters. Other water bodies are mainly to be found in the Rift Valley. Of these, Lake Turkana is the largest, with a territorial water area of 640 square kilometres. Without outlets, the Rift Valley lake levels and areas fluctuate; and all, barring lakes Naivasha and Baringo, are too salty for domestic consumption.

The rest of Kenya's landscape is one of great topographical diversity, rising from sea level to 5 200 metres at the summit of Mt Kenya, Africa's second highest peak, near the centre of Kenya. On the southern border with Tanzania stands Mt Kilimanjaro, Africa's highest point at 5 895 meters above sea level. The topographical environment of the country may also be expressed as follows: 38 percent of the country lies below 500m, 34.5 percent between 500 - 1 000m, 26 percent between 1 000 - 2 500m and 1.5 percent above 2 500m. Kenya possesses one of the most complicated and diversified physical environments found in any country, encompassing equatorial, tropical, savannah, aeolian, glacial and volcanic tectonic areas [Ojany and Ogendo 1986].

4.1.1 CLIMATE

Due to its proximity to the Equator and its altitude variations, Kenya has a wide range of climatic variation. The narrow coastal belt is classified as equatorial and the rest of the interior as tropical. This broad classification is modified by the great variations in topography, the localised influences of Lake Victoria and the relatively low rainfall totals in the country. The topography of the country falls into two distinct physical regions, Lowland and Highland Kenya. Much of Lowland Kenya has a fragile environment which offers development challenges, while Highland Kenya is regarded as the backbone of the Kenyan economy.

In Kenya the most important element of the climate, which has a major influence on the use of land, is rainfall. As is to be expected there are extreme variations in rainfall and temperature, as well as humidity. Humidity is, on the whole, not unduly high except at the coastal belt, where sea breezes combine with high temperatures. Atmospheric pressure, which is closely related to altitude and rainfall, is important for its influence on health.

An important characteristic of Kenya's rainfall is its unreliability, both in amount and expected time of arrival. This makes reliance on agriculture unsafe, not only in terms of type of crop, but also in that poor harvests are a common feature of farming.

4.2 NATIONAL ECONOMIC PROFILE

The Kenyan economy has undergone mixed experiences since independence in 1963. The growth in Gross Domestic Product (GDP) averaged 6.5% over the period 1964 to 1970; however, the first oil crisis of 1972 brought an abrupt halt to this level of achievement. Consequently the growth rate decelerated to below 4% for much of the early 1970s until the unexpected "coffee boom" of 1976 and 1977, when the growth rate in GDP averaged 8.2% [GOK 1986, MOH 1994a, 1994b]. However the situation worsened when the price of crude petroleum doubled from US$13 per barrel in 1978 to US$27 in 1979, pushing up the inflation rate and the cost of imported goods and raw materials and considerably slowing the country's economic growth rate.

During the early 1980s the GDP's growth rate remained below 5%, falling below 1% in 1984 for the first time in Kenya's history. This was largely attributed to the severe drought of that year. Favourable weather conditions coupled with government budgetary discipline and improved management enabled Kenya to achieve significant 4.8% and 5.5% growth rates in 1985 and 1986 respectively [CBS 1994]. Since 1990, however, the rate of growth in GDP has remained below 4%, with a dramatic fall in 1992 to a mere 0.4%, the lowest since independence. The slowdown in GDP growth since 1991 could be explained in terms of the actual decline in real output and value added in agriculture due to below average rainfall, as well as to the suspension of donor aid in the 1994 – 1996 period.

The contribution of the agricultural sector has steadily declined from over 45% of GDP in 1963 to about 28% in 1992. The implication is that the contributions to GDP from manufacturing and government services have steadily expanded (CBS 1994, CBS 1996).

Unstable economic growth has become the primary constraint to social improvement in Kenya. In particular, economic growth has not been sufficient to generate productive employment opportunities to absorb the rapidly growing labour force. Unemployment in urban areas is currently around 25% and about half of the rural population is living in poverty, with no access to the minimum requirements of food and essential non-food commodities [CBS 1996].

Kenya faces a major challenge in reducing unemployment and poverty. The number of people unemployed is currently more than 2 million and at least 10 million people are living in poverty. In addition, around 500 000 people will enter the labour force each year over the next decade [GOK/IMF/World Bank 1996]. The World Bank estimates that, in order to achieve significant reductions in unemployment and poverty, the economy will have to grow by an average of over 6 percent a year for several years. It will also be imperative that the Kenyan government place increased emphasis on social services and adequately targeted intervention in favour of the poor.

4.3 POPULATION DYNAMICS

Kenya has been pursuing an active population management policy. While there has been remarkable success in reducing fertility over the last decade, the population of Kenya is still growing at 3% per annum [GOK/IMF/WORLD BANK 1996]. Projections put the population of Kenya at 27.5 million in 1995 compared to 23.2 million (adjusted) in 1989, implying a population growth rate of 2.7% per annum. Average population density has continued to increase over the years - from 26 to 37 persons per square kilometre, in 1979 and 1989 respectively - although some districts have population density much higher than the average. Kenya has a youthful population, on average, with 48.9% being under 15 years and 60 percent under 20 years of age [CBS 1996].

Mortality levels have maintained a downward trend with the death rate of children under five declining from 190 to 157 to 113 per thousand according to the 1969, 1979 and 1989 censuses, respectively [NASCOP 1996]. However, if the AIDS pandemic persists the mortality levels will begin to rise again.

Table 4:1 provides a brief summary of the major demographic indicators for the period 1963 and 1993. According to the Statistical Abstract of 1995 and Economic Survey of 1996 [CBS 1996], the crude birth rate decreased from 52/1 000 in 1963 to 46/1 000 in 1993 whereas the crude death rate declined from 20/1 000 to 12/1 000 over the same period. The infant mortality rate also declined from 120/1 000 in 1963 to 67/1 000 in 1993. As a result of these trends almost 50% of Kenya's population is currently under 15 years of age and only 10 percent above 50 years. There appears to be a tremendous demographic momentum in Kenya, with a large pool of sexually active individuals in the 15 to 49 years age group. Furthermore, population growth rate in urban areas is over 7 percent, which is largely attributable to migration from the rural areas (see section 4.3.1)

Predictions of population growth in Kenya must take into account these trends in fertility and mortality, as well as the potential effect of the AIDS epidemic (see section 4.2.2) and migration into urban areas (see section 4.3.1). The population of Kenya is expected to grow to between 34 and 38 million over the next decade and this will put increasing pressure upon the government to provide adequate levels of health care coverage to a young population [NASCOP 1996].

4.3.1 URBANISATION TRENDS

The growth of urban centres in the country has increased rapidly since independence. According to the 1948 population census there were only 17 towns with an aggregate population of 276 000 people. By 1969 the population census showed that the number of urban centres had increased to 48 towns, with a total urban population of 1.08 million. As shown in Table 4.2 the trend of rural to urban migration has increased steadily since then. Between the 1969 and 1979 population census the number of urban centres had increased further to 67 towns, with a total urban population of over 2.3 million. The population for urban centres was 3.8 million in 1989, giving an inter-censual growth rate of 4.8% and a 19% share of the population compared to 15% in 1979. The number of urban centres reporting a population size of 10 000 and above increased from 25 in 1979 to 45 in 1989 [MOH 1990a].

Between 1980 and 1990 the urban population increased at an annual rate of 5.0%, almost doubling from 2.48 million in 1980 to 4.03 million in 1990. It constituted 15.5% and 17.7% of the total population in 1980 and 1990 respectively. Urban population is projected to increase to 6.95 million and 11.11 million by the years 2000 and 2010 respectively. The urban population growth rate between 1990 - 2000 is expected to be 5.6% - as opposed to the national growth rate of 2.7% - and it is projected that the urban population will constitute 23.4% of the total by the year 2000 and 30.4% in 2010. It is expected that by 2010 over half the annual national population growth will be occurring in urban areas [GOK 1994a].

TABLE 4.2:

RURAL AND URBAN POPULATION FROM 1980 - 2010 (MILLIONS)

Year	1980	1990	1992	2000	2010
Total Population	16.67	22.75	24.18	29.71	36.90
Urban Population Share (%)	2.50 (15)	4.03 (17.7)	4.50 (18.6)	6.95 (23.4)	11.11 (30.4)
Rural Population Share (%)	14.17 (85)	18.72 (82.3)	19.68 (81.4)	22.76 (76.6)	25.68 (69.6)

Source: Sessional Paper No. 1 of 1994 on Recovery and Sustainable Development to the Year 2010, GOK [1994a].

4.4 HEALTH SECTOR PROFILE

Over the past 35 years since independence in 1963, Kenya has made substantial progress in improving the overall health of its population. Health indicators have progressed steadily and are considerably better than those of most countries at similar levels of development, in large part due to the rapid expansion of government-financed programmes during the 1960s and 1970s [World Bank 1990]. Table 4.3: shows comparative health indicators for Kenya and countries at similar development levels.

The Ministry of Health (MOH) was established in 1965, and took over rural services from county councils in 1970. In the 1970s the government adopted a policy of decentralised management of health services which was reinforced in 1985 as part of its overall district focus strategy for development.

TABLE 4.3:

COMPARATIVE HEALTH INDICATORS

Country	Life Expectancy		Mortality		Population per	
	Male	Female	Infant	Maternal	Doctor	Nurse
Kenya	**57**	**61**	**70**	**510**	**9 970**	**950**
Ethiopia	46	49	35	2 000	78 970	5 500
Malawi	47	48	49	250	11 330	3 100
Zambia	52	55	78	110	7 150	740
Zimbabwe	61	65	49	150	6 700	1 000
Mauritius	63	70	22	99	1 900	580
Ghana	52	56	38	1 070	14 890	640
Low-income (exc. India and China)	53	56	98	–	13 910	3 250
Lower middle-income	62	67	57	–	3 030	1 090
Sub-Saharan Africa	**49**	**52**	**108**	**–**	**23 850**	**2 460**

Source: World Development Report 1990, World Bank [1990].

Infant mortality per 1 000 live births, maternal per 100 000 live births.

Life expectancy and infant mortality figures refer to 1987, maternal mortality to 1990; population per doctor and nurse to 1984.

By the early 1980s one of the two outstanding problems in the sector, which the overall indicators concealed, was the wide variation in health status among districts, largely reflecting variations in the distribution of health facilities and poverty levels. The other problem was that a high proportion of health care equipment was non-functional due to lack of maintenance. Health care was compromised due to lack of functioning equipment.

4.4.1 DISEASE BURDEN

Since independence in 1963, life expectancy at birth has risen from 42 to 58 years, the crude death rate has declined from 20 to 11 per thousand, infant mortality has fallen from 120 to 70 per thousand live births and under-five mortality has almost halved from over 200 to 110 per thousand live births [World Bank 1991a] (see also Table 4.1).

Kenya Demographic and Health Survey (KDHS) of 1990-92 indicates, however, that these impressive overall figures conceal severe regional disparities, with infant mortality varying from 107 per thousand in Coast Province to as little as 35 in the Rift Valley Province [CBS 1994].

Kenya's disease pattern can be grouped into seven broad categories [MOH 1994a]:

1. Respiratory, including pneumonia, tuberculosis, bronchitis and whooping cough, which are found mainly in high altitude areas;
2. Parasitic and infectious, including malaria, which is widespread in the warm lowlands around Lake Victoria and the coastal region, and schistosomiasis, usually found in irrigated areas with other vector-borne diseases such as sleeping sickness and filariasis;
3. Sanitation-related, including amoebiasis, enteritis, the dysenteries and other intestinal parasitic diseases;

4. Measles, among infants and children;
5. Maternity-related, including haemorrhage, tetanus, hypertension and uterine rupture;
6. Sexually-transmitted diseases, including AIDS, gonorrhoea and syphilis; and
7. Skin diseases.

Together the first three disease groups accounted for 70% of all deaths reported in 1980, and for over 60% of the reported morbidity. Measles was responsible for about 15% of deaths among children under five, only just behind acute respiratory infections, 20%, and gastro-intestinal infections, 20%. Maternal mortality has remained a major concern for years; maternal morbidity has only been partially surveyed and trends are largely unknown.

The burden of disease in Kenya is not well quantified and much needs to be done to improve the availability and reliability of available information, most of which is derived from reported disease statistics. It is known that there are marked regional variations in epidemiological patterns but, in general, preventable, vector-borne diseases and respiratory diseases are the highest contributors to morbidity [MOH 1994a, ADB 1993]. The leading causes of morbidity in Kenya are presented in Figure 4.1.

TABLE 4.1:

DEMOGRAPHIC INDICATORS 1963-1993

Indicator	1963	1979	1984	1989/90	1993
Estimated Population (million)	8.90	15.30	18.40	21.40	24.50
Population Growth Rate (%)	3.00	3.80	3.70	3.00	3.40
Fertility Rate (%)	6.80	7.90	7.70	6.70	5.40
Population under 15 years (%)	48.00	48.00	48.00	47.00	47.00
Females 15-49 years (%)	27.00	21.00	22.00	22.00	22.00
Population 15-49 years (%)	42.00	43.00	43.00	43.00	43.00
Population 50 years and above (%)	10.00	9.00	9.00	10.00	10.00
Crude Death Rate*	20/ 1 000	14/ 1 000	13/ 1 000	12/ 1 000	12/ 1 000
Crude Birth Rate**	52/1 000	50/ 1 000	50/ 1 000	49/ 1 000	46/ 1 000
Life Expectancy at Birth (years)	44	54	56	58	60
Infant Mortality Rate	120/ 1 000	104/ 1 000	87/ 1 000	74/ 1 000	67/ 1 000
Child Mortality Rate	156/ 1 000	Na	Na	Na	Na

Source: Expenditure and Financing of the Health Sector in Kenya, MOH [1996].

* *Crude death rate: The number of deaths occurring per thousand population in a year.*

** *Crude birth rate: The number of live births occurring per thousand population in a year.*

TABLE 4.1:

DEMOGRAPHIC INDICATORS 1963-1993

Indicator	1963	1979	1984	1989/90	1993
Estimated Population (million)	8.90	15.30	18.40	21.40	24.50
Population Growth Rate (%)	3.00	3.80	3.70	3.00	3.40
Fertility Rate (%)	6.80	7.90	7.70	6.70	5.40
Population under 15 years (%)	48.00	48.00	48.00	47.00	47.00
Females 15-49 years (%)	27.00	21.00	22.00	22.00	22.00
Population 15-49 years (%)	42.00	43.00	43.00	43.00	43.00
Population 50 years and above (%)	10.00	9.00	9.00	10.00	10.00
Crude Death Rate*	20/ 1 000	14/ 1 000	13/ 1 000	12/ 1 000	12/ 1 000
Crude Birth Rate**	52/1 000	50/ 1 000	50/ 1 000	49/ 1 000	46/ 1 000
Life Expectancy at Birth (years)	44	54	56	58	60
Infant Mortality Rate	120/ 1 000	104/ 1 000	87/ 1 000	74/ 1 000	67/ 1 000
Child Mortality Rate	156/ 1 000	Na	Na	Na	Na

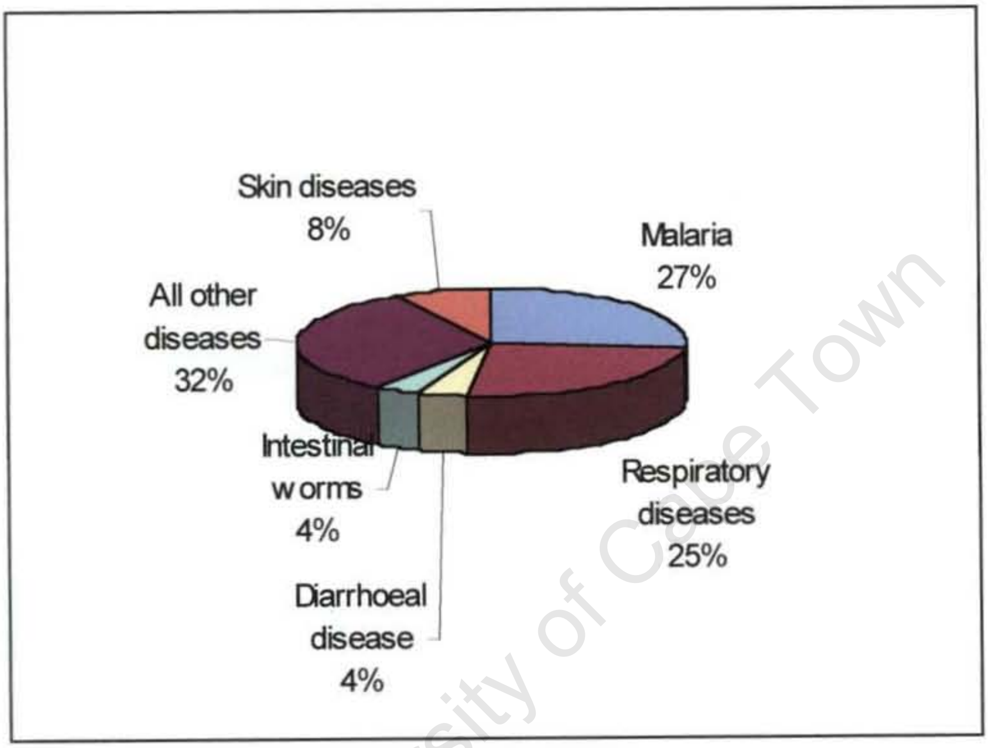
Source: Expenditure and Financing of the Health Sector in Kenya, MOH [1996].

* *Crude death rate: The number of deaths occurring per thousand population in a year.*

** *Crude birth rate: The number of live births occurring per thousand population in a year.*

Figure 4.1:

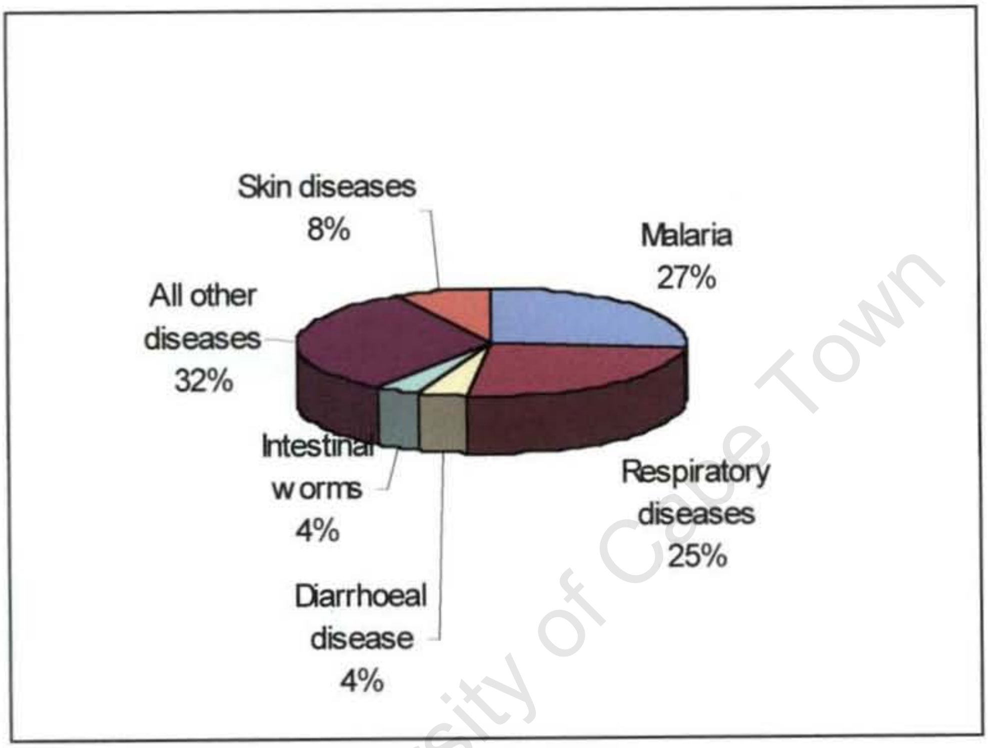
Five leading causes of morbidity in Kenya



Source: Health Information Systems, MOH [1994a] and ADB [1993].

Figure 4.1:

Five leading causes of morbidity in Kenya



Source: Health Information Systems, MOH [1994a] and ADB [1993].

Though not yet fully reflected in the mortality and morbidity statistics, a significant new public health problem that arose in the 1980s is Acquired Immuno-Deficiency Syndrome (AIDS), caused by the Human Immuno-Deficiency Virus (HIV) [NASCOP 1996]. The HIV and AIDS epidemic now poses a serious health problem. The National AIDS Control Programme (NACP) had reported 39 000 cases of AIDS by August 1993, when it was believed there were about 110 000 people in the country who had contracted the AIDS virus. It is estimated that some 841 700 people were HIV positive in 1993, of whom 30 000 were children [NASCOP 1996]. Table 4.4 presents HIV positive population and AIDS related deaths in Kenya between 1990-1996.

In Kenya there are three significant modes of transmission of the HIV virus. These are heterosexual transmission, which accounts for about 75%; perinatal transmission, which accounts for about 20%; and blood transmission, which historically accounted for 5%, but which is expected to decline with improved blood screening [NASCOP 1996].

Though not yet fully reflected in the mortality and morbidity statistics, a significant new public health problem that arose in the 1980s is Acquired Immuno-Deficiency Syndrome (AIDS), caused by the Human Immuno-Deficiency Virus (HIV) [NASCOP 1996]. The HIV and AIDS epidemic now poses a serious health problem. The National AIDS Control Programme (NACP) had reported 39 000 cases of AIDS by August 1993, when it was believed there were about 110 000 people in the country who had contracted the AIDS virus. It is estimated that some 841 700 people were HIV positive in 1993, of whom 30 000 were children [NASCOP 1996]. Table 4.4 presents HIV positive population and AIDS related deaths in Kenya between 1990-1996.

In Kenya there are three significant modes of transmission of the HIV virus. These are heterosexual transmission, which accounts for about 75%; perinatal transmission, which accounts for about 20%; and blood transmission, which historically accounted for 5%, but which is expected to decline with improved blood screening [NASCOP 1996].

TABLE 4.4:

HIV POSITIVE POPULATION AND AIDS RELATED DEATHS BY AGE, SEX AND RURAL /URBAN LOCATION

	1990	1993	1994	1995	1996
HIV-positive populations ('000)					
Rural	151	284	334	383	428
Urban	298	558	665	752	842
Male	244	457	537	617	689
Female	205	384	452	518	581
Total	**449**	**841**	**989**	**1 135**	**1 270**
HIV-related Deaths ('000)					
Rural	7	15	19	25	30
Urban	13	29	37	46	56
Male	11	24	30	38	56
Female	9	20	26	33	40
Total	**20**	**44**	**56**	**71**	**96**

Source: Republic of Kenya. National Development Plan, 1994 - 1996, pp. 261, GOK [1994b].

TABLE 4.4:

HIV POSITIVE POPULATION AND AIDS RELATED DEATHS BY AGE, SEX AND RURAL /URBAN LOCATION

	1990	1993	1994	1995	1996
HIV-positive populations ('000)					
Rural	151	284	334	383	428
Urban	298	558	665	752	842
Male	244	457	537	617	689
Female	205	384	452	518	581
Total	**449**	**841**	**989**	**1 135**	**1 270**
HIV-related Deaths ('000)					
Rural	7	15	19	25	30
Urban	13	29	37	46	56
Male	11	24	30	38	56
Female	9	20	26	33	40
Total	**20**	**44**	**56**	**71**	**96**

Source: Republic of Kenya. National Development Plan, 1994 - 1996, pp. 261, GOK [1994b].

4.4.2 DEVELOPMENT ISSUES RELATING TO HIV/AIDS

The spread of AIDS will have significant effects not only on the demographic composition of the Kenyan population, but also on the social and economic structure of the country.

First, HIV/AIDS is likely to make an important difference to demographic variables for Kenya, including mortality, life expectancy and infant survival. There will be a reduction in some of the gains made in increased child survival and life expectancy. Overall life expectancy could be reduced by up to 17 years by the year 2000 [NASCOP 1996]. The impact on child survival will be severe because it will be affected both directly through prenatal infection and indirectly through increased numbers of orphans, which will put severe stresses on communities' ability to maintain them. At present there are estimated to be 150 000 such orphans, increasing to 600 000 by the year 2 000 [NASCOP 1996].

Secondly, the costs of caring for AIDS patients could be equivalent to the entire 1993/94 recurrent budget of the Ministry of Health by the year 2000. It is predicted that the total direct and indirect costs of AIDS to Kenya could reach 15% of the GDP by the year 2000, compared to the cost estimated for 1991, which stood between 2 and 4% of the GDP [CBS 1994].

Thirdly, since the prevalence of HIV among Kenyans working in the "modern" sector is approximately twice as high as that among those working in the small farm sector, the obvious implication is that those with a higher socio-economic status are more likely to be infected than those in subsistence farming. Moreover, the epidemic imposes a double burden on women. Already more vulnerable to HIV infection, women are also affected by the AIDS epidemic in their role as caregivers in the family and community [NASCOP 1996].

4.4.3 MAIN STAKEHOLDERS IN KENYA'S HEALTH SECTOR

Kenya has three major health sub-sectors: public, voluntary and private. The public sector comprises both central government and municipal health services, as well as the national referral hospital, Kenyatta National Hospital (KNH), which is a teaching hospital located in Nairobi. The voluntary sub-sector consists of church-related health services and the health activities of other NGOs. The private sub-sector consists mainly of curative care provided through the market by private, profit-orientated institutions (hospitals, nursing and maternity homes), doctors and pharmacies. It also includes medical services provided directly to employees by private companies. Both the voluntary and private sub-sectors have always charged for their services. The public sector also began to charge for services in December 1989.

The public sector provides about 70% of Kenya's hospital beds, 62% of them in public health facilities and 8% at KNH. The Ministry of Health employs just under one half of all doctors, the vast majority of clinical workers and about two-thirds of registered nurses. The voluntary sub-sector provides about one fifth of all hospital beds and the private sub-sector about one tenth. Similarly, 71% of health centres and dispensaries are operated by the Ministry of Health, 14% are run by NGOs and the remainder are split among various other government entities, notably municipalities such as the Nairobi City Commission under the Ministry of Local Government, and private health care providers. Table 4:5 shows the distribution of national bed capacity.

4.4.2 DEVELOPMENT ISSUES RELATING TO HIV/AIDS

The spread of AIDS will have significant effects not only on the demographic composition of the Kenyan population, but also on the social and economic structure of the country.

First, HIV/AIDS is likely to make an important difference to demographic variables for Kenya, including mortality, life expectancy and infant survival. There will be a reduction in some of the gains made in increased child survival and life expectancy. Overall life expectancy could be reduced by up to 17 years by the year 2000 [NASCOP 1996]. The impact on child survival will be severe because it will be affected both directly through prenatal infection and indirectly through increased numbers of orphans, which will put severe stresses on communities' ability to maintain them. At present there are estimated to be 150 000 such orphans, increasing to 600 000 by the year 2 000 [NASCOP 1996].

Secondly, the costs of caring for AIDS patients could be equivalent to the entire 1993/94 recurrent budget of the Ministry of Health by the year 2000. It is predicted that the total direct and indirect costs of AIDS to Kenya could reach 15% of the GDP by the year 2000, compared to the cost estimated for 1991, which stood between 2 and 4% of the GDP [CBS 1994].

Thirdly, since the prevalence of HIV among Kenyans working in the "modern" sector is approximately twice as high as that among those working in the small farm sector, the obvious implication is that those with a higher socio-economic status are more likely to be infected than those in subsistence farming. Moreover, the epidemic imposes a double burden on women. Already more vulnerable to HIV infection, women are also affected by the AIDS epidemic in their role as caregivers in the family and community [NASCOP 1996].

4.4.3 MAIN STAKEHOLDERS IN KENYA'S HEALTH SECTOR

Kenya has three major health sub-sectors: public, voluntary and private. The public sector comprises both central government and municipal health services, as well as the national referral hospital, Kenyatta National Hospital (KNH), which is a teaching hospital located in Nairobi. The voluntary sub-sector consists of church-related health services and the health activities of other NGOs. The private sub-sector consists mainly of curative care provided through the market by private, profit-orientated institutions (hospitals, nursing and maternity homes), doctors and pharmacies. It also includes medical services provided directly to employees by private companies. Both the voluntary and private sub-sectors have always charged for their services. The public sector also began to charge for services in December 1989.

The public sector provides about 70% of Kenya's hospital beds, 62% of them in public health facilities and 8% at KNH. The Ministry of Health employs just under one half of all doctors, the vast majority of clinical workers and about two-thirds of registered nurses. The voluntary sub-sector provides about one fifth of all hospital beds and the private sub-sector about one tenth. Similarly, 71% of health centres and dispensaries are operated by the Ministry of Health, 14% are run by NGOs and the remainder are split among various other government entities, notably municipalities such as the Nairobi City Commission under the Ministry of Local Government, and private health care providers. Table 4:5 shows the distribution of national bed capacity.

TABLE 4.5:

NATIONAL BED CAPACITY – GENERAL, MATERNITY AND COTS

	General	Maternity	Cots	Total
Ministry of Health	18 278	6 050	2 668	26 996
Private/ NGOs	19 809	2 614	1 537	23 960
Combined	36 6087	8 664	4 205	50 956

Source: Health Information System, MOH [1994a].

4.4.4 HEALTH FACILITIES AND HUMAN RESOURCES

Kenya's health care system has expanded rapidly over the past three decades and especially in the 1990s. Table 4:6 shows the breakdown of health institutions by province in 1995. The total number of facilities increased by a marginal 2.4% from 3 714 in 1994 to 3 802 in 1995. However, hospitals increased considerably by 6.8 percent to reach 346 in 1995 from 324 in 1994, resulting in a marked 26.7% rise in the number of hospital beds and cots. Bed-population ratio also increased significantly by 22.4% from 147 in 1994 to a record 180 in 1995 [CBS 1996].

TABLE 4.6:

HOSPITALS AND HOSPITAL BEDS AND COTS BY PROVINCE (1995)

	Hospitals	Hospital Beds & Cots	
Province		**No Beds & Cots**	**No. Per 100 000**
Nairobi	43	6 225	354
Coast	39	3 818	173
Eastern	39	5 724	126
North-Eastern	3	1 447	391
Central	41	6 400	174
Rift Valley	72	9 878	157
Nyanza	72	8 947	214
Western	37	4 775	155
Total 1995	**346**	**47 214**	**180**
Total 1994	324	37 271	147

Source: Economic Survey 1996, CBS [1996].

According to the 1996 economic survey, the number of registered medical personnel in all categories rose parallel to the increase in enrolment to the training, as shown in Table 4.7. The total number increased to 43 264 in 1994/95 from 40 650 in 1993/ 94, a 6.4% rise. The ratio of medical personnel to population improved in most of the categories in 1995, except that of doctors, registered nurses and public health officers. The doctor-population ratio dropped by 3.3% points to register 14.7 doctors per 100 000 people. In general, the ratio of enrolled nurses to the population (85.4) was the highest, followed by that of registered nurses. The ratio of public health officers to the population was lowest at 1.8% in the reference year. Clinical engineers and clinical engineering technicians were not covered in the personnel survey. Staff records at the Ministry of Health show that there were about 341 clinical engineering technicians and two clinical engineers in the public service in 1996.

TABLE 4.7:

HEALTH HUMAN RESOURCES 1994 – 1995

	1994		1995	
Human Resource	**Number**	**No. Per 100 000 Population**	**Number**	**No. Per 100 000 Population**
Doctors	4 558	18.0	3 855	14.7
Dentists	630	2.5	655	2.6
Pharmacists	1 260	5.0	1 357	5.2
Pharmaceutical Technologist	660	2.6	885	3.4
Registered Nurses	6 719	26.5	6 920	26.4
Enrolled Nurses	21 147	83.4	22 347	85.4
Clinical Officers	1 644	6.5	2 950	11.3
Public Health Officers	465	1.8	480	1.8
Public Health Technicians	3 567	14.1	3 815	14.6
Clinical Engineers*	n/a	n/a	n/a	n/a
Clinical Eng. Technicians**	n/a	n/a	n/a	n/a
Total	**40 650**		**43 264**	

Source: Economic survey 1996, CBS [1996].

* 2 Clinical engineers in public health sector (MOH, Staff Records, 1997)

** 341 Clinical engineering technicians in public health sector (MOH, Staff Records, 1997).

In the absence of workload data, Table 4.8 presents a simplified comparison of the percentages of total health sector expenditure; numbers of fixed facilities, and personnel attributable to the Ministry of Health and all other providers. It can be seen that the Ministry of Health has the lowest percentage of total expenditure but this is not reflected in its infrastructure or staff component.

TABLE 4.8:
PROVIDERS OF HEALTH SERVICES BY EXPENDITURE, FACILITY AND PERSONNEL

Provider	Expenditure	Facilities	Personnel
Ministry of Health Total	43%	55%	70%
All Others Total	57%	45%	30%
Total	100%	100%	100%

Source: Health Information System, MOH [1994a].

4.4.5 THE PUBLIC SECTOR

The Ministry of Health is responsible for the national health policy and is also the main stakeholder in Kenya's health system. The Ministry of Health consists of an administrative and a professional branch (medical and technical). The former is responsible for budgeting, planning and development, while medical professionals are in charge of hospitals, development of rural services, training and medical research. Technical professionals are in charge of all health care technical support services, including the maintenance of facilities and health care equipment.

The public sector is essentially three-tiered. At the apex is Kenyatta National Hospital (KNH), a teaching hospital, followed by the provincial hospitals, which deliver tertiary care and serve as referral points. At the secondary level, the district and provincial hospitals are referral points (for difficult or specialised cases) for primary level, rural clinics and municipal health centres and dispensaries. In some areas services have been extended to community level through the training and deployment of village health workers. In addition to general wards, district and provincial hospitals and KNH have "amenity wards" or private wards. Family planning and other health services are integrated through the system [MOH 1990b].

Fiscal stringency and the growth in demand for health services have reduced the quality of care provided by the public health sector. Rural health facilities often lack adequately trained staff, equipment, drugs and consumables. Patients often have to procure drugs in the market, as shortages in public institutions are common [GOK/IMF/World Bank1996, Kachieng'a 1998a]. The physical condition of health facilities has also deteriorated due to lack of funds for repairs and maintenance.

4.4.6 HEALTH CARE SERVICES

The health care system in Kenya has been perceived as being divided into two major divisions, curative services and preventive services, and this has been reflected in patterns of finance. In fact, both should be regarded as elements of the essential integrated health care services to which all Kenyans should have access.

Curative Services: In Kenya these are provided by the government and private sectors. Government services are organised in a hierarchical system from the smallest and simplest facility (dispensary) to the most complicated and sophisticated (national and teaching hospital). In between these fall health centres, district hospitals and provincial hospitals. The private sector runs hospitals, surgeries and clinics. There has been a bias in the distribution of these services, which has tended to favour the urban areas, and this inequality needs to be addressed [Reach 1988a, 1988b].

Preventive and promotive services: A large proportion of patients seen in health institutions in Kenya suffer from communicable diseases which can be prevented through simple public health interventions [MOH 1994a]. As a result, preventive and promotive health services have formed the major emphasis of Kenya's health policy as a means to reduce the burden of disease. However, this policy is yet to be translated into concrete actions. As will be shown in section 4.5 (Table 4.9), in terms of resource allocation, preventive and promotive services only receive approximately 20% of the recurrent health budget.

Preventive/primary health care services, which have been conducted by government, NGOs, mission facilities and to a lesser extent private initiatives, will need to be integrated, intensified and expanded. These services have been, and still are, largely dependent on financial and material support from international donors and do not yet cover the whole country.

The public health interventions that are currently taking place need to be greatly expanded. These interventions include immunisation, provision of safe water and sanitation, adequate and proper nutrition and public health education on health promotion and disease prevention. Special attention should be paid to the major causes of morbidity, mortality and disability, such as malaria, respiratory infections, diarrhoeal diseases, AIDS and sexually transmitted diseases. Preventive health care services have been heavily compromised because of inadequate essential equipment, drugs, and medical personnel. As in the case of curative services the current distribution pattern of the public health personnel exhibits a bias towards services in urban areas. There is need for equity in health services delivery to rural areas and urban centres.

4.5. HEALTH CARE FINANCING

The most crucial factor influencing both quantity and quality of health care services is the planning of health facilities and the types of services to be offered [CBS 1996]. Capital investments in new public facilities, or in the rehabilitation of old ones, have substantial long-term repercussions upon the recurrent budget of the Ministry of Health. Currently, over 70% of that recurrent budget is devoted to the payment of staff salaries and benefits, to the detriment of expenditures on other essential items, particularly medicines and equipment [MOH 1995, MOH 1996].

4.5.1 MINISTRY OF HEALTH CURRENT EXPENDITURE TRENDS

(*Expenditure in constant terms*)

Ministry of Health expenditure has shown significant decline over the years (Table 4:9). Although Ministry of Health local currency expenditures have risen steadily - from about K£43 million in 1979/80 to over K£147 million in 1991/92, and then to over K£350 million by 1996/97 - in real terms the trend is one of decline. Per capita expenditures on health were US$9.55 in 1980/81, dropping to about US$4.50 in 1991/92, further to US$ 3.09 in 1996/97 (Figure 4.2). Although there is expectation of positive economic growth in 1997/98, it is unlikely that per capita expenditures will rise above US$ 3.50, unless the economy makes a dramatic recovery [GOK/IMF/WORLD BANK 1996, MOH 1996, CBS 1996].

Figure 4.2 shows recurrent expenditures from 1979 to 1997.

According to the 1996 economic survey, the number of registered medical personnel in all categories rose parallel to the increase in enrolment to the training, as shown in Table 4.7. The total number increased to 43 264 in 1994/95 from 40 650 in 1993/ 94, a 6.4% rise. The ratio of medical personnel to population improved in most of the categories in 1995, except that of doctors, registered nurses and public health officers. The doctor-population ratio dropped by 3.3% points to register 14.7 doctors per 100 000 people. In general, the ratio of enrolled nurses to the population (85.4) was the highest, followed by that of registered nurses. The ratio of public health officers to the population was lowest at 1.8% in the reference year. Clinical engineers and clinical engineering technicians were not covered in the personnel survey. Staff records at the Ministry of Health show that there were about 341 clinical engineering technicians and two clinical engineers in the public service in 1996.

TABLE 4.7:
HEALTH HUMAN RESOURCES 1994 – 1995

	1994		1995	
Human Resource	**Number**	**No. Per 100 000 Population**	**Number**	**No. Per 100 000 Population**
Doctors	4 558	18.0	3 855	14.7
Dentists	630	2.5	655	2.6
Pharmacists	1 260	5.0	1 357	5.2
Pharmaceutical Technologist	660	2.6	885	3.4
Registered Nurses	6 719	26.5	6 920	26.4
Enrolled Nurses	21 147	83.4	22 347	85.4
Clinical Officers	1 644	6.5	2 950	11.3
Public Health Officers	465	1.8	480	1.8
Public Health Technicians	3 567	14.1	3 815	14.6
Clinical Engineers*	n/a	n/a	n/a	n/a
Clinical Eng. Technicians**	n/a	n/a	n/a	n/a
Total	**40 650**		**43 264**	

Source: Economic survey 1996, CBS [1996].

* 2 Clinical engineers in public health sector (MOH, Staff Records, 1997)

** 341 Clinical engineering technicians in public health sector (MOH, Staff Records, 1997).

In the absence of workload data, Table 4.8 presents a simplified comparison of the percentages of total health sector expenditure; numbers of fixed facilities, and personnel attributable to the Ministry of Health and all other providers. It can be seen that the Ministry of Health has the lowest percentage of total expenditure but this is not reflected in its infrastructure or staff component.

TABLE 4.8:

PROVIDERS OF HEALTH SERVICES BY EXPENDITURE, FACILITY AND PERSONNEL

Provider	Expenditure	Facilities	Personnel
Ministry of Health Total	43%	55%	70%
All Others Total	57%	45%	30%
Total	100%	100%	100%

Source: Health Information System, MOH [1994a].

4.4.5 THE PUBLIC SECTOR

The Ministry of Health is responsible for the national health policy and is also the main stakeholder in Kenya's health system. The Ministry of Health consists of an administrative and a professional branch (medical and technical). The former is responsible for budgeting, planning and development, while medical professionals are in charge of hospitals, development of rural services, training and medical research. Technical professionals are in charge of all health care technical support services, including the maintenance of facilities and health care equipment.

The public sector is essentially three-tiered. At the apex is Kenyatta National Hospital (KNH), a teaching hospital, followed by the provincial hospitals, which deliver tertiary care and serve as referral points. At the secondary level, the district and provincial hospitals are referral points (for difficult or specialised cases) for primary level, rural clinics and municipal health centres and dispensaries. In some areas services have been extended to community level through the training and deployment of village health workers. In addition to general wards, district and provincial hospitals and KNH have "amenity wards" or private wards. Family planning and other health services are integrated through the system [MOH 1990b].

Fiscal stringency and the growth in demand for health services have reduced the quality of care provided by the public health sector. Rural health facilities often lack adequately trained staff, equipment, drugs and consumables. Patients often have to procure drugs in the market, as shortages in public institutions are common [GOK/IMF/World Bank1996, Kachieng'a 1998a]. The physical condition of health facilities has also deteriorated due to lack of funds for repairs and maintenance.

4.4.6 HEALTH CARE SERVICES

The health care system in Kenya has been perceived as being divided into two major divisions, curative services and preventive services, and this has been reflected in patterns of finance. In fact, both should be regarded as elements of the essential integrated health care services to which all Kenyans should have access.

Curative Services: In Kenya these are provided by the government and private sectors. Government services are organised in a hierarchical system from the smallest and simplest facility (dispensary) to the most complicated and sophisticated (national and teaching hospital). In between these fall health centres, district hospitals and provincial hospitals. The private sector runs hospitals, surgeries and clinics. There has been a bias in the distribution of these services, which has tended to favour the urban areas, and this inequality needs to be addressed [Reach 1988a, 1988b].

Preventive and promotive services: A large proportion of patients seen in health institutions in Kenya suffer from communicable diseases which can be prevented through simple public health interventions [MOH 1994a]. As a result, preventive and promotive health services have formed the major emphasis of Kenya's health policy as a means to reduce the burden of disease. However, this policy is yet to be translated into concrete actions. As will be shown in section 4.5 (Table 4.9), in terms of resource allocation, preventive and promotive services only receive approximately 20% of the recurrent health budget.

Preventive/primary health care services, which have been conducted by government, NGOs, mission facilities and to a lesser extent private initiatives, will need to be integrated, intensified and expanded. These services have been, and still are, largely dependent on financial and material support from international donors and do not yet cover the whole country.

The public health interventions that are currently taking place need to be greatly expanded. These interventions include immunisation, provision of safe water and sanitation, adequate and proper nutrition and public health education on health promotion and disease prevention. Special attention should be paid to the major causes of morbidity, mortality and disability, such as malaria, respiratory infections, diarrhoeal diseases, AIDS and sexually transmitted diseases. Preventive health care services have been heavily compromised because of inadequate essential equipment, drugs, and medical personnel. As in the case of curative services the current distribution pattern of the public health personnel exhibits a bias towards services in urban areas. There is need for equity in health services delivery to rural areas and urban centres.

4.5. HEALTH CARE FINANCING

The most crucial factor influencing both quantity and quality of health care services is the planning of health facilities and the types of services to be offered [CBS 1996]. Capital investments in new public facilities, or in the rehabilitation of old ones, have substantial long-term repercussions upon the recurrent budget of the Ministry of Health. Currently, over 70% of that recurrent budget is devoted to the payment of staff salaries and benefits, to the detriment of expenditures on other essential items, particularly medicines and equipment [MOH 1995, MOH 1996].

4.5.1 MINISTRY OF HEALTH CURRENT EXPENDITURE TRENDS

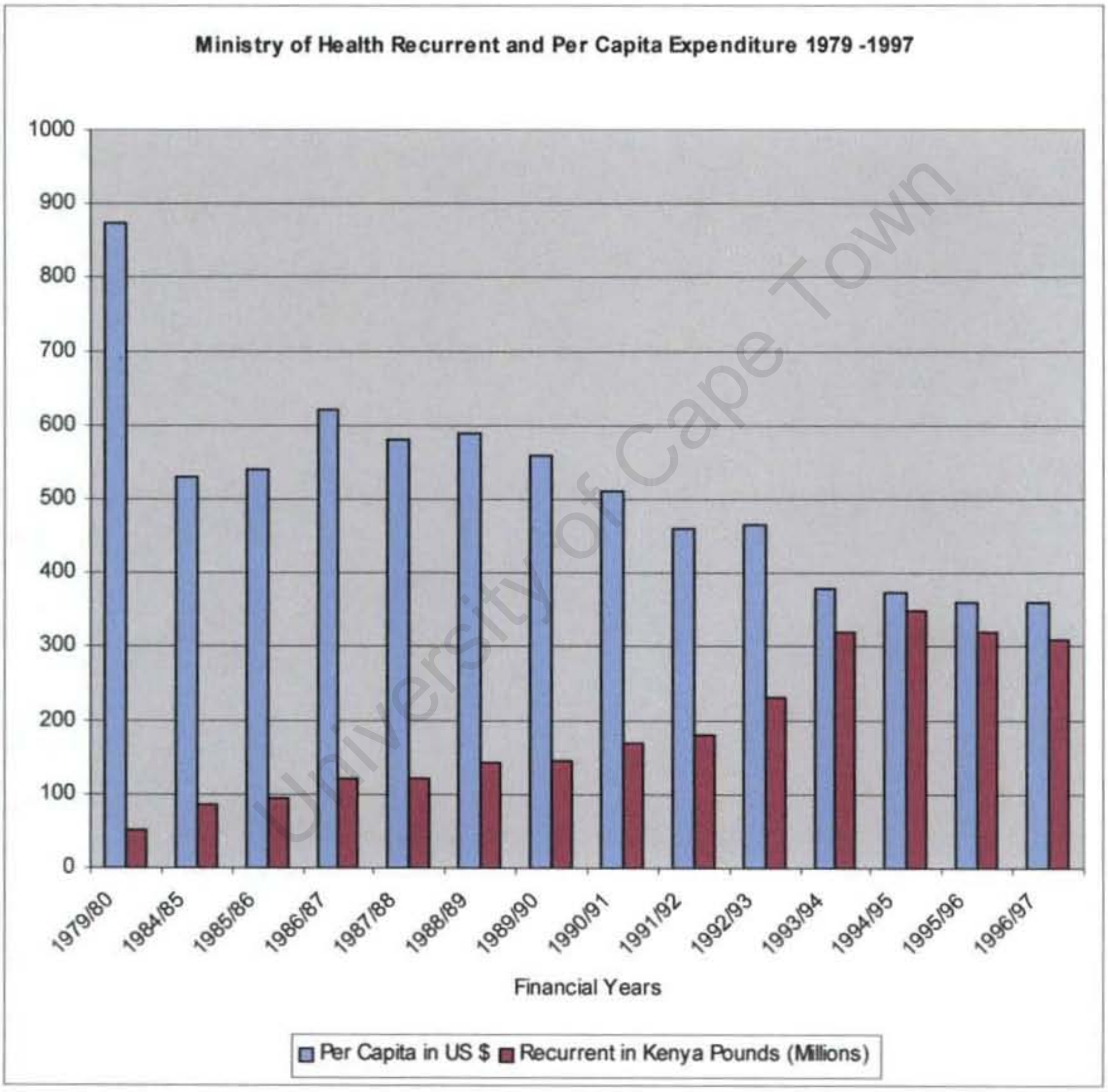
(*Expenditure in constant terms*)

Ministry of Health expenditure has shown significant decline over the years (Table 4:9). Although Ministry of Health local currency expenditures have risen steadily - from about K£43 million in 1979/80 to over K£147 million in 1991/92, and then to over K£350 million by 1996/97 - in real terms the trend is one of decline. Per capita expenditures on health were US$9.55 in 1980/81, dropping to about US$4.50 in 1991/92, further to US$ 3.09 in 1996/97 (Figure 4.2). Although there is expectation of positive economic growth in 1997/98, it is unlikely that per capita expenditures will rise above US$ 3.50, unless the economy makes a dramatic recovery [GOK/IMF/WORLD BANK 1996, MOH 1996, CBS 1996].

Figure 4.2 shows recurrent expenditures from 1979 to 1997.

Figure 4.2:

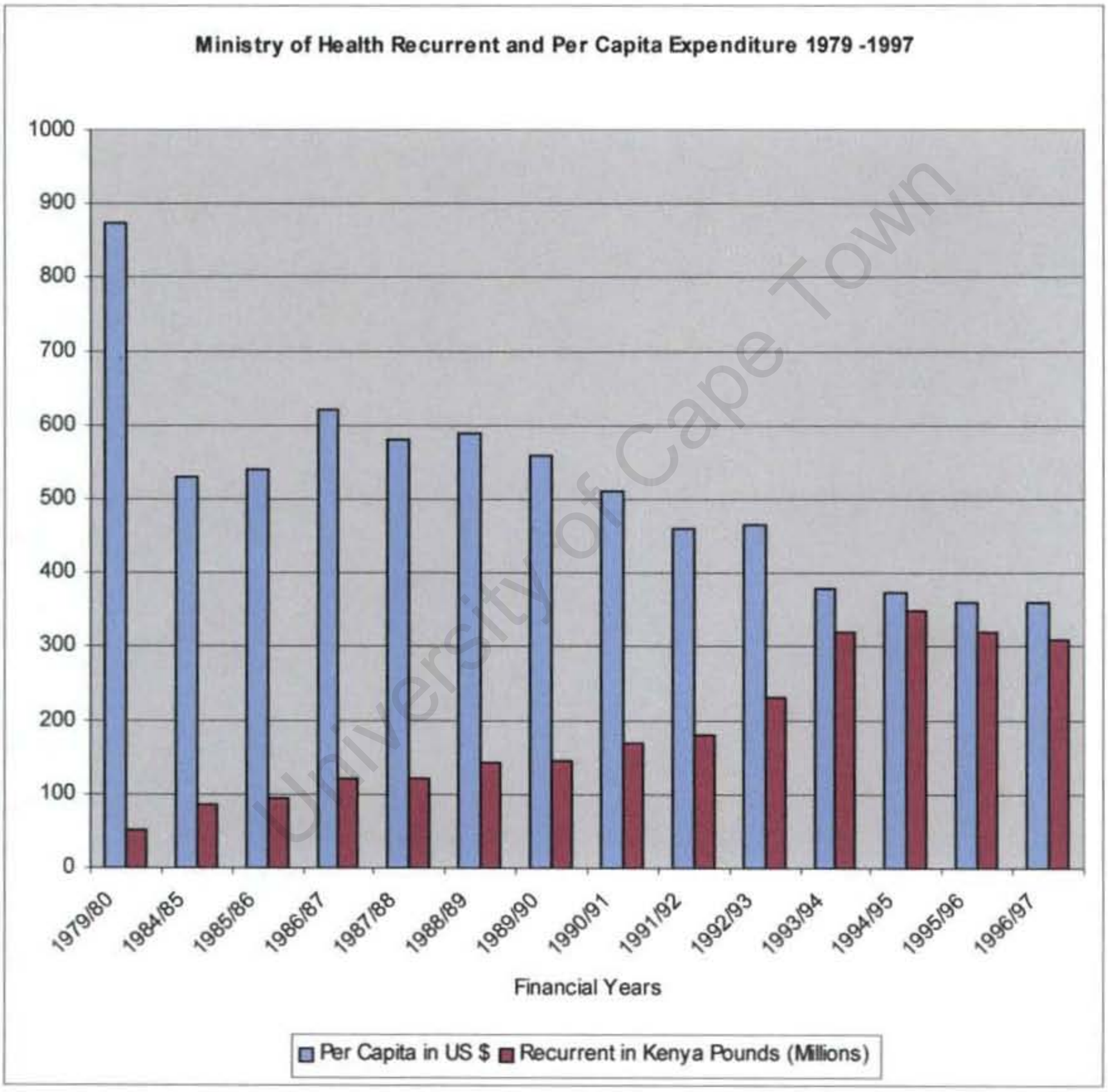
Ministry of Health recurrent and per capita expenditures 1979 - 1997



Source: Expenditure and Financing of the Health Sector in Kenya, MOH [1996].

Figure 4.2:

Ministry of Health recurrent and per capita expenditures 1979 - 1997



Source: Expenditure and Financing of the Health Sector in Kenya, MOH [1996].

In 1979/80 Ministry of Health recurrent expenditures accounted for 9.26% of the government total for that year. From 1986/87 onwards, this percentage began dropping, and by 1991/92 it was only 8.51% of total government expenditure. This was expected to fall by almost one percentage point to 7.61% in 1996/97 [MOH 1993b, 1993c, CBS 1996]. Further changes cannot yet be confirmed as the 1997/98 budgetary allocations and expenditures have not yet been published.

4.5.2 MINISTRY OF HEALTH INTERNAL ALLOCATIONS OF RECURRENT EXPENDITURES

The internal allocations of Ministry of Health recurrent budgets, as shown in Table 4.9, continue to favour curative care in hospitals. Since 1979/80 the percentage of Ministry of Health recurrent expenditure attributable to the provision of curative services has remained at approximately 70% of the total, although within hospitals a greater share of their expenditure has been on preventive services carried out in outpatient clinics. Increases to the direct funding of primary and preventive health care from 15% in 1979/80 to about 21% in 1991/92 have occurred at the expense of expenditure on administration and training [CBS 1997]. Thereafter the budgetary allocations to primary health care showed a slight increase in real terms.

TABLE 4.9:

MINISTRY OF HEALTH (MOH) RECURRENT BUDGET EXPENDITURES (INTERNAL ALLOCATIONS AS PERCENTAGE OF GOVERNMENT TOTAL AND US$ PER CAPITA)

Period	Total K£	Curative	Rural & P/PHC	Admin & Training	Non-drug Supplies & Research	US$ Per Capita
1979/80	42 943 415	66.69	15.13	11.70	6.48	8.65
1980/81	52 868 619	68.36	15.74	11.43	4.47	9.55
1981/82	59 075 879	72.33	12.75	11.98	2.94	7.60
1982/83	61 306 323	72.41	13.84	12.44	1.31	6.00
1983/84	61 765 853	72.39	11.55	14.57	1.49	5.36
1984/85	73 007 033	66.52	9.71	10.88	12.89	5.24
1985/86	79 653 593	71.83	12.88	10.10	5.19	5.35
1986/87	96 546 022	72.14	10.82	12.14	4.90	6.16
1987/88	101 014 500	78.18	10.50	9.56	1.77	5.76
1988/89	113 686 327	72.24	16.84	9.63	1.65	5.85
1989/90	115 032 567	69.39	18.92	10.58	1.11	5.54
1990/91	128 807 254	69.76	19.87	9.17	119	5.08
1991/92	147 833 073	67.77	21.62	9.28	1.32	4.50
1992/93	169 489 868	68.72	22.02	8.65	0.61	4.60
1993/94	209 125 600	62.74	25,49	9.17	2.60	2.99
1994/95	299 529 639	67.23	20.95	9.65	2.16	3.44
1995/96	315 133 200	67.11	21.38	9.28	2.22	3.22
1996/97	350 586 292	66.86	21.39	9.58	2.17	3.09

Source: Expenditure and Financing of the Health Sector in Kenya, MOH [1996].

4.5.3 MINISTRY OF HEALTH DEVELOPMENT EXPENDITURES

Development expenditures represent approximately 25% of total Ministry of Health expenditure [MOH 1996]. Despite considerable increases in total donor inputs to the health sector since the 1980s, these inputs still represent less than 30% of total Ministry of Health expenditures, making the Ministry of Health the single most important source of health care financing today (see Table 4.10). Nevertheless, donor contributions represent approximately 80% of the Development Budget alone, as shown in Table A.1 (Appendix A) and there exists a tendency for approximately 40% of development expenditures provided by donor agencies to be a form of recurrent budget support [MOH 1996].

In Table A.2 (Appendix A), it is important to note that although development expenditure on equipment and plant constituted 25.65% of the Ministry's budget in 1993/94, maintenance allocation was only 2.18%. Maintenance budgets cannot adequately support equipment capital investments.

TABLE 4.10:

COMBINED RECURRENT AND DEVELOPMENT BUDGETS BY SOURCE

Year	Total (K£)	GOK	Donors	GOK%
1992/93	286 494 589	200 299 263	86 195 326	69.91
1993/94	310 947 827	223 946 610	87 001 217	72.02
1994/95	343 916 500	255 364 811	88 551 689	74.25
1995/96	375 833 659	269 227 550	106 606 109	71.63

Source: Expenditure and Financing of the Health Sector in Kenya, February 1996, MOH [1996].

The decline in overall economic performance in Kenya has had an adverse effect on all social sectors of the economy, not least the health sector. As a result, the Ministry of Health's real allocations per capita have declined significantly, resulting in shortages of the inputs required to maintain adequate standards of care [MOH 1993a, Mwangi 1996, MOF 1996]. This is particularly true for certain categories of essential drugs and equipment spare parts [MOH 1997]. The Ministry of Health is today faced with a crisis where available resources cannot match the demand for services. This has caused shortages and under-utilisation of existing health personnel and health care equipment. This situation has been aggravated still further because over 70 percent of the funds actually allocated to the Ministry's recurrent budget are used first and foremost to pay staff salaries and allowances [Mwangi 1996, MOH 1996]. This leaves insufficient resources for operational expenses and in particular the purchase of essential spare parts for equipment maintenance services.

4.6 HEALTH TECHNOLOGY PROFILE

Historically, major health care equipment has been procured in Kenya through bilateral or multilateral aid agreements. Over the years, procurements of health care equipment were done haphazardly without assessment of health needs, and without evaluating national technical capacity to maintain and repair the various types of equipment. Kenya's health sector has been flooded with an assortment of health care equipment sourced from several countries. This has created an equipment maintenance bottleneck because, to achieve sufficient maintenance, a large amount of capital must be invested in spare parts to support different types and models of equipment. The present equipment maintenance budgets cannot adequately support the existing equipment stock [Bunge *et al.* 1992,MOF 1996, MOH 1996, Kachieng'a 1998a]. The management of equipment procurement and maintenance has become a critical policy issue in Kenya [MOH 1997].

4.6.1 HEALTH CARE EQUIPMENT PROBLEMS

The problems of health care equipment maintenance were first discussed in the 1979 - 1983 Development Plan [MOH 1997]. Thereafter, the Kenyan government began negotiations for technical aid with several foreign countries and donor organisations to alleviate the equipment maintenance problems, which were already affecting the delivery of health care services.

Through a bilateral technical aid agreement between the Kenyan and the German governments, the Health Facility Maintenance Management Project, generally known as MOH/GTZ Project, was born in the mid 1980s. The Ministry of Health and the German Project Implementation Organisation (GTZ) became the joint project co-ordinators. The project has made a major effort to improve equipment maintenance in the country. The Health Facility Maintenance Improvement Management Programs cover construction of equipment maintenance workshops, sourcing of spare parts and the training of clinical (medical) engineering technicians (Paton and Nyamu 1996, MOH 1997), and have achieved considerable success. A survey carried out by international evaluators in the project-targeted facilities has shown significant improvement in equipment functionality and reduction of equipment downtime (see Table 4.11).

TABLE 4.11:

SELECTED EQUIPMENT FUNCTION IN THE MOH/GTZ PROJECT AREA (KENYA)

Year	1992	1993	1994
Equipment			
Microscopes	89%	100%	100%
Suction Machines	52%	74%	96%
Theatre Oper. Lamps	33%	100%	100%
Sphygmomanometers	55%	70%	86%
Autoclaves	62.5%	75%	100%
Table Boilers	68%	91%	98%

Source: MESD Report, MOH [1997].

4.7 COMMENTS AND DISCUSSION

There are a number of critical problems, inhibiting the Ministry of Health's delivery of adequate health care in Kenya [GOK/IMF/WORLD BANK 1996]. Many of these problems are linked with the rising demand for health care services due to rapid population growth, and the need for fiscal restraint. These two factors have curtailed the government's ability to expand into under-served peri-urban and rural areas and to prevent deterioration in the quality of health care service delivery. For example, there are chronic shortages throughout the country's health system in terms of health care equipment, spare parts and consumables, and supplies and drugs, especially in rural areas.

Severe inequalities in the distribution of personnel between rural and urban areas is also problematic. For example, less than 15% of doctors practice in rural areas and over 80% of trained nurses practice in large urban areas [MOH 1996]. Moreover, there are also imbalances in resource allocation by region; the number of persons per hospital bed in Kenya ranges from 220 persons in Nairobi to 1 280 in the largely rural North Eastern Province. Utilisation of resources is hampered by lack of comprehensive health data and rational planning for staff development [MOH 1994a].

Another major weakness is to be found in the co-ordination and management of the health sector. There is duplication of services provided by NGOs and concentration of NGO services around urban areas, leaving peri-urban and rural areas to be covered by the Ministry of Health.

A few problems of particular importance to this study are discussed here.

Health Care Financing and Health Care Services

The Ministry of Health is seriously under-funded. Per capita expenditures on health have declined, as mentioned in Section 4.5.1 from US $ 9.50 in 1980/91 to US $ 3.50 in 1996/97. While Kenya's health infrastructure has grown rapidly since independence - there are currently well over 3 200 health care facilities nation wide with approximately 1 100 MOH dispensaries, 400 health centres and 100 hospitals [MOH 1993b, 1996] - these gains in the infrastructure have nevertheless been outstripped by population growth. The capacity of the Ministry of Health to meet the demand for services has thus been curtailed.

A number of facilities have been constructed but never opened, and equipment that has been bought cannot be used adequately due to lack of funds for spares and consumables. This has caused the health service referral system to fail, resulting in unnecessary congestion of hospitals by patients who could have been treated further down the line, at lower cost, in health centres and dispensaries. Finally, the cost of caring for AIDS patients could be equivalent to the entire 1993/94 recurrent budget of the Ministry of Health by the year 2000 [NASCOP 1996].

Clinical Engineers and Clinical Engineering Technicians

The Ministry of Health has over 45 000 staff on the payroll. It has a surplus of administrative staff but a deficit in numbers of professional medical and engineering staff. For example, there are about 341 engineering staff (two engineers at headquarters, the rest technologists, technicians and craft persons) responsible for maintenance of facility plants and equipment country-wide.

The estimated total investment in health care equipment and devices in 1990 was over KSh12 billion. Each year an average of KSh 1 billion is invested in new equipment in the public sector [Kachieng'a 1991]. However, there is a major deficit of clinical engineers and technicians in the public sector to manage such high investments on technology. Low maintenance budgets and insufficient engineering expertise have led to unacceptably high levels of equipment downtime in the public sector [MOH 1993d].

Classification of Facilities and Standardisation of Essential Equipment

There are nine principal types of health facilities in the Kenyan public health system, ranging from rural dispensaries to Kenyatta National Hospital, which is the national referral, teaching and research hospital. There are additional specialised facilities for certain types of ailments, maternity, orthopaedic cases, etc., and private, mission and NGO facilities which, though licensed by the MOH and subject to inspection, are managed privately.

Visits to facilities revealed gross disparity. For example Kathiani sub-District Hospital in Eastern Province, with a bed capacity of 200 and 350km from Nairobi, was better equipped than Kajiado District Hospital, with 350 beds and only 80km from Nairobi. At the time of this research (November 1996), Kajiado had only two stethoscopes and all essential equipment was out of order due to lack of maintenance funds. The absence of a standard essential equipment list has led to the situation where lower level hospitals are equipped with sophisticated equipment that is under-utilised due to lack of trained operators or specialists.

There is a need to establish criteria for classification of various levels of health facilities. These could include services offered, physical structures, minimum essential equipment, staffing norms (medical and technical), catchment population and number of beds. These data are critical for deriving workload statistics as they provide the baseline against which expenses, human resources and patient loads can be measured. The planning of the distribution of facilities and services in Kenya is far from ideal.

Information Technology: Workload and Operational Data

Routine, regular workload and operational statistics - such as the number and types of patients, procedures, diagnoses, etc. - form the essential core data against which other data and information are checked and compared for planning or management purposes. Unit costs, derived by comparing clinical data against expenses, catchment population served, and staff deficits or surpluses in any type of resource, can be readily identified using a mix of operational and workload statistics.

Such data are not available in Kenya. At present these statistics are compiled at most quarterly and often only annually. Reporting rates from facilities are low and the headquarters of the Ministry of Health does not have complete data for all facilities for any one year. Furthermore, those workload data that are compiled are often derived from morbidity and mortality statistics with no valid cross-reference with medical records, residence of patient, public health survey data, etc. Due to high volume of information and inadequate computing facilities, there are considerable opportunities for data contamination through transcription and arithmetic errors in the manual collection of data [MOH 1994a].

In summary, the government has a twofold role in health information systems and operational research: firstly to generate the information necessary to guide health policies and public health spending, and secondly to provide certain types of information about the performance of health care providers that would be too costly for consumers to collect. To this end, the government can:

- Gather and synthesise epidemiological and other information necessary to monitor health status, detect disease outbreaks, guide public policy and program design.
- Support research, where needed, to generate local solutions to local problems.
- Facilitate standardisation of information about performance, as measured by health production and health outcomes, of both public and private health providers.

Where necessary, this information should be synthesised and publicised to aid both providers and patients in making informed choices about health care.

All these health and management information systems need to be available at all levels of the health system in order to provide health facility managers and planners with the information they require for decision making and funding allocations.

4.8 CONCLUSION

The country's economic performance has had both direct and indirect negative impact upon the health sector and the health status of the Kenyan population. It is hoped that the present government's macroeconomic policy, with focus on growth and sustainability, will help to reverse this unfortunate trend.

Many causes of ill health in Kenya can be effectively addressed through improved nutrition coupled with preventive actions such as the provision of better sanitation and clean water, immunisation programmes and relatively simple curative health interventions. Yet during the 1990s not only has expansion of health services into under-serviced rural areas been curtailed, but the quality of existing government health services has declined. Efforts to restrain the growth of expenditure on health care costs have fallen heavily on drugs, consumables, equipment and maintenance services, while personnel costs continue to rise. In addition, an increasingly large share of public spending on health has been devoted to urban hospitals, further limiting the expansion of rural and primary health programmes.

Furthermore, Kenya has a major problem in utilising her technological stock in the public health sector. A high proportion of health care equipment is not functioning due to insufficient maintenance. Health services have been compromised due to high equipment downtime.

As the Kenyan Government faces the problem of financing health care in a context of high technology and scarce resources, a careful comparison and analysis of competing and conflicting possibilities must be undertaken. It is hoped that this present study will contribute towards reduction of economic waste in the use of technological investments in the public health sector.

CHAPTER 5

HEALTH AID TO SUB-SAHARAN AFRICA

Chapter 5 reviews health aid to Sub-Saharan Africa. In particular, a bilateral aid project in Kenya, the MOH/GTZ project is reviewed and assessed.

Whatever happens in the recipient countries can be adduced to support the maintenance or extension of aid. Progress is evidence of its efficiency and so an argument for its expansion; lack of progress is evidence that the dosage has been insufficient and must be increased. Aid is thus like champagne: in success you deserve it, in failure you need it.

Graham Hancock

Lords of Poverty, 1989

5.1 DISTRIBUTION OF HEALTH DEVELOPMENT AID IN SUB-SAHARAN AFRICA

According to the World Bank [1990], official development aid to developing countries in 1988 was US$ 51 billion – half the net receipts of external capital by developing countries. For the low-income countries, most of which are in the Sub-Saharan Africa (SSA) region, aid represents 70% percent of the external finance. A high proportion of aid to SSA is directed to health care and economic projects. In many of the African countries, aid constitutes a large part of the health recurrent and development budgets.

Health aid is provided by three broad groups of donors: bilateral donors, multilateral agencies, and non-government organisations [World Bank 1987, 1990]. Bilateral donors, in particular, provide aid for many reasons – political, strategic, commercial and humanitarian. Improving the health status of the population in the recipient country is only one motive amongst others [World Bank 1990].

During the late 1980s, bilateral donors accounted for 62% of the total health assistance in (SSA), while multilateral agencies provided 32% and non-government agencies 6%. On average, 44% of donor funds were used for capital investment, 22% for technical assistance, 13% for operating costs and 2.4% for training [World Bank 1995b].

In the 1990s, the donors' trend has been to provide aid for health through multilateral channels. As a result the World Bank disbursements of funds to health projects in developing countries were expected to grow from US $350 million in 1992 to about US $ 1 billion in 1995 [World Bank 1993a], and to over US $ 2 billion in 1998 [World Bank 1995a], making the World Bank the single largest source of external health funding in the African region. Table 5.1: presents the distribution of health development assistance by donors to various demographic regions in 1990. It can be seen that SSA has been the main recipient of health aid.

TABLE 5.1:
OFFICIAL DEVELOPMENT AID BY DEMOGRAPHIC REGION (1990)

Region	Health Aid Received (million of US $)	Health Aid per capita (US $)	Health Aid as Percentage of Health Expenditure (%)
Sub-Saharan Africa	**1 251**	**2.45**	**10.4**
Other Asia and Islands	594	0.87	1.4
Latin America and Caribbean	591	1.33	1.3
Middle Eastern Crescent	453	1.31	1.3
India	286	0.34	1.6
China	77	0.07	0.6

Source: Investing in Health, World Development Report 1993, World Bank [1993a].

5.2 THE HEALTH AID PUZZLE IN SUB-SAHARAN AFRICA

Donors are important financiers of health care in Africa, especially where the government has been unable to meet health needs due to revenue shortfalls [World Bank 1995a, 1995b]. As an example of the role of foreign aid in the provision of health care, a study in Rwanda and Togo revealed that bilateral and multilateral aid - official and private - is an important source of health sector financing, especially for capital investments [Laurent 1982, World Bank 1995b]. The foreign aid share of the total health expenditure is as high as 64% in the two countries [Laurent 1982]. Although no specific study has been done on how foreign health aid influences the choice of health technology, these conditions of aid dependency are likely to limit the scope of choice of technology. Table 5.2 presents the per capita external assistance for the health sector for selected African countries in 1990.

Although many countries have benefited significantly from aid, some of the poorest countries have become trapped in "aid dependency." They need it just to maintain their present low quality of life, when it should be used to improve it to higher levels [World Bank 1990]. Viewed from the African perspective, another fact about technical aid is particularly worrying: in many African countries technical aid directed to the public health sector has done much less than might have been hoped to reduce the disease burden [World Bank 1993a, 1993b]. In the SSA region health expenditures and health status do not show positive associations; on the contrary they exhibit a negative correlation [World Bank 1995a, Kachieng'a *et al.* 1999). Many pieces of health care equipment procured through donor funds remain non-functional or under-utilised due to inadequate operating budgets and poor investment decisions [Kachieng'a 1992a & 1998a, Kwankam 1992, World Bank 1993a].

TABLE 5.2:

EXTERNAL ASSISTANCE FOR THE HEALTH SECTOR-SELECTED AFRICAN COUNTRIES (US DOLLARS)

Country	Per Capita Aid
Burkina Faso	4.7
Cameroon	3.3
Ghana	1.9
Kenya	**3.5**
Madagascar	1.5
Malawi	2.5
Mali	4.3
Mozambique	2.9
Nigeria	0.6
Senegal	4.9
Tanzania	2.1
South Africa*	**0.06**
Uganda	2.8
Zambia	0.7
Zimbabwe	4.2

Source: World Bank [1993a], TableA.9 and World Bank [1995a], Table 10-3.

*South Africa – Before the 1994 democratic election health aid was channelled mainly to NGOs and private organisations. Aid per Capita was estimated at 35 million population.

Note: Estimates of development assistance for health care are expressed in US Dollars at the official exchange rate. Total aid flows represent the sum of all assistance for health to each country by bilateral and multilateral agencies, international agencies, and international non-governmental organisation (NGOs).

While donor assistance has played an invaluable role in shoring up public initiatives for health care, such assistance has had negative side-effects that are at odds with the original aim of improving the health status of the population [World Bank 1995a, 1995b]. Prominent among these observations are:

- The organisation for Economic Co-operation and Development reports that "in spite of their stated commitment to primary health care, relatively large resources are devoted by donors to sophisticated urban-based facilities including hospitals and specialist clinics" [OECD 1989]. This suggests the need for closer scrutiny of the impact of health aid flows, as well as greater use of external finance to run projects in rural or under-served areas.
- Donor financing has often worked against sustainability when it has been used for vertical programmes or inappropriate capital or development expenditure [World Bank 1995a, 1995b]. Although such funding may have the goal of expanding coverage and quality of services, recurrent costs necessary to sustain the capital investments are often very high and beyond the country's ability to finance.
- While most donors have provided health assistance without conditions for explicit policy reform, the priorities implicitly embedded in donor funding have virtually driven the selection of health strategies in Africa [WHO/AFRO 1993b].
- Government information on external assistance programmes is often sketchy, leading to ineffective co-ordination and monitoring. External evaluations are often conducted without involving the recipient country [Engelkes 1993]. Moreover, government and donor frequently differ in definitions of health programmes and accounting requirements. This has led to situations where health planners and policymakers often do not know the overall purposes, locations or amounts of external resources being used.

Other studies have also pointed out the mixed results from external aid to health projects. Bilateral aid programmes are loaded with political and commercial agendas. A substantial portion of bilateral aid is "tied"; that is recipients are required to purchase health care equipment and services from the donor countries [Kachieng'a 1992, World Bank 1995a]. There are also allegations that a greater portion of health aid money is used in purchasing expertise from the donor, thus curtailing the development of local capacity building [Hancock 1989]. 'Tied aid' not only bypasses the international bidding system for equipment procurement, but also ignores the need for equipment standardisation in the recipient country. In most cases the health needs are not assessed to establish the health care equipment requirements [WHO/GTZ 1990, Kachieng'a 1992, 1998a].

The World Bank and international donor agencies invest substantial resources and effort in supporting health development in the Sub-Saharan region [World Bank 1995b]. In view of the negative aspects that have been discussed above, it is clearly a continuing challenge to health policymakers and planners to ensure that health aid be well-directed and used as effectively as possible to improve health status in the region. This becomes even more imperative with declining health aid flows from industrialised countries to SSA [World Bank 1995a, 1995b]. This requires the following health aid policy reforms:

- Health aid should be based on needs and performance, not on political or commercial considerations.
- Health aid should be directed more effectively to promote health system sustainability, rather than being project-focussed.
- Health aid should be used to 'nurture' policy reforms geared towards effective delivery of primary health care services.

- Health aid mix (projects and programmes) should be designed according to the conditions in the recipient country and its health sector. Quality is as important as quantity.
- Health aid programmes should be focussed on projects which have potential to contribute significantly towards enhancing a country's health growth and development.
- Aid projects and programmes should be tailored to focus on creating and transmitting health management knowledge and capacity building.
- Aid agencies need to change 'aid philosophy'. Success of aid projects and programmes should not be judged on how much is spent but on how much is accomplished, in terms of relative improvement in health outcomes.

In a broader perspective, African governments in the SSA region should use technical aid to do what they can do best, that is investing in infrastructure and human capital – roads, water and sanitation, education and health care.

5.3 WHY ASSESSMENT OF THE ROLE OF HEALTH AID IN KENYA?

The assessment of the role of technical aid in the development of the technological capacity of a developing country is important because, as several studies have indicated, the acquisition of major technology in such countries is normally through foreign aid [Banta 1986, World Bank 1991d, 1993a, 1995a, 1995b, MOH 1997, Kachieng'a *et al.* 1999].

Donors of health aid prefer to finance physical capital installations like the construction of a health facility, and are reluctant to support recurrent costs of aid-funded projects. However, many strategic initiatives for reduction of disease burden on the population make intensive use of recurrent resources [World Bank 1995a]. In addition, because funds for aid are drawn from public taxes; to court taxpayers' support in a donor country, bilateral aid must be seen to have some tangible returns for that donor country. Technical aid that assists in creating markets for health care equipment and other medical products is aggressively marketed, more so than aid that is only beneficial to the recipient country. Most African countries do not have the capacity to carry out health needs assessment and therefore cannot bargain adequately for beneficial bilateral health aid projects. Kenya is thus a net importer of both technology and technical expertise.

In a publication entitled *Better Health in Africa*, the World Bank [1995a] suggested that more specialised aid in the areas of technology and capacity building would reduce efficiency losses and enhance sustainability of health systems in the Sub-Saharan region. Kenya is a leading recipient of technical aid from the World Bank. For example in 1991 the World Bank provided over US$ 34.5 million for rehabilitation of Kenyatta National Hospital and health services in Nairobi in general [World Bank 1991a, 1991b, 1991c].

According to the World Bank [1995a], technical aid to health in African countries has declined in real terms due to global economic constraints. The 1997 UN *Human Development Report* [UNDP 1997] also notes that, despite rapidly growing poverty and barely functioning health services in SSA, health aid to the region is declining. The report emphasises that more health aid and poverty reduction programmes are urgently needed in the region. This calls for optimal aid utilisation through effective planning, management and co-ordination.

Given its scale and its contribution towards reduction of the disease burden in Africa, it is important to assess the effectiveness of external aid to health care and learn from successes and failures. A number of multilateral aid donors such as the World Bank, World Health Organisation (WHO) and UNICEF have recognised this and have been modifying their policies to take into account the lessons of experience [World Bank 1993a]. With this objective of assessing the effectiveness of external aid to health care in SSA, an evaluation of the bilateral MOH/GTZ Project now being implemented in Kenya (see chapter 4 section 4.6.1) is given in section 5.4.

5.4 EVALUATION OF MOH/GTZ-HEALTH FACILITY MANAGEMENT IMPROVEMENT PROJECT

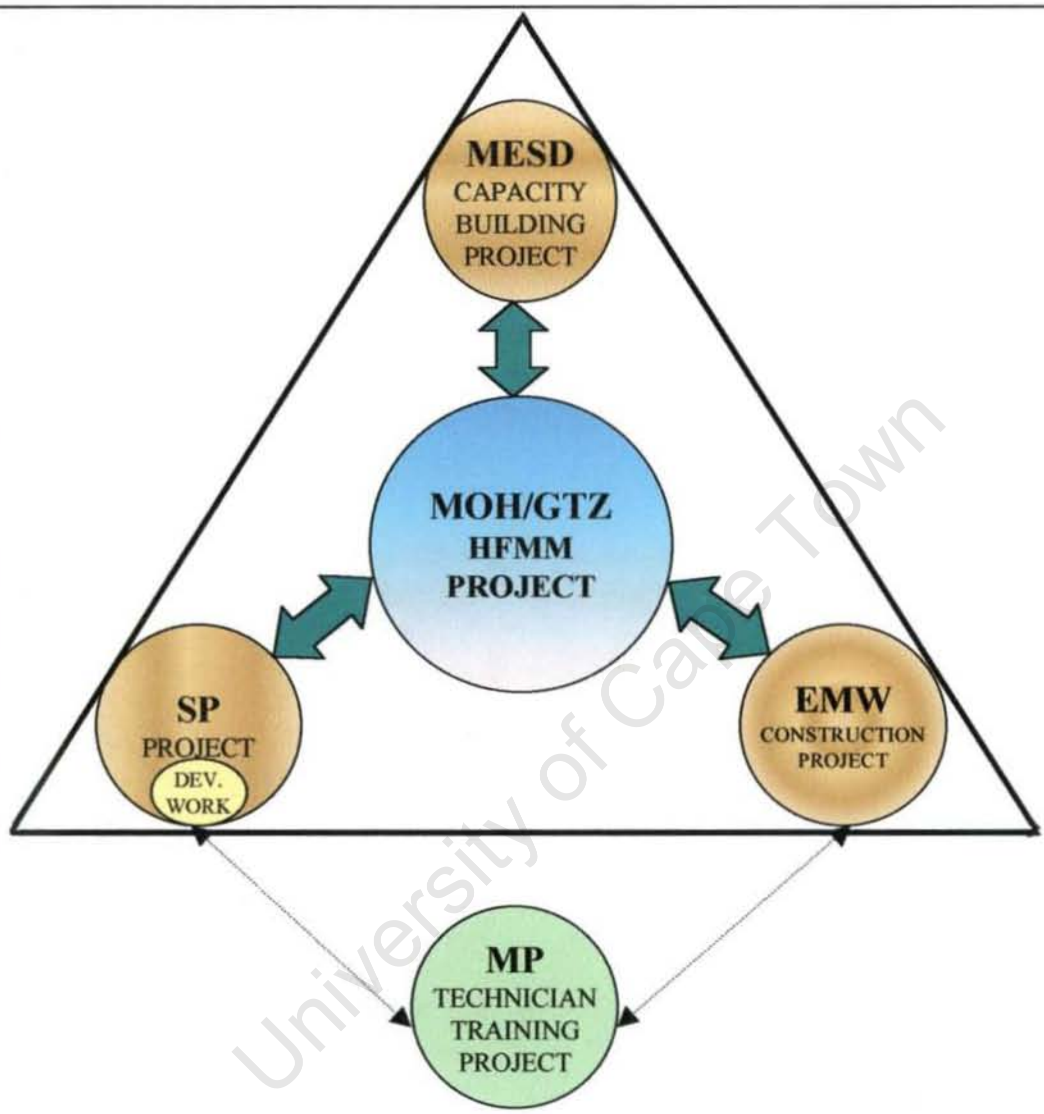
5.4.1 BACKGROUND

The original MOH/GTZ project started in the early 1980s, but up to 1988 the project was focussed on the construction, establishment and equipping of the Medical (Clinical) Engineering Department at the Mombasa Polytechnic, which offers courses in medical engineering to ordinary and higher diploma candidates [Kachieng'a *et al.* 1992]. The graduates from the institution are responsible for the maintenance of health care equipment in all public health facilities countrywide [MOH 1993a].

The health care-related component of the MOH/GTZ project started in 1989 and is scheduled for completion in the year 2000. The project is divided into four phases. The conceptual framework of the MOH/GTZ project is presented in Figure 5.1. The project phases and goals are presented in Table 5.3.

Figure 5.1:

MOH/GTZ Health facility maintenance management project



△ - Major Components of MOH/GTZ HFMM Projects

MESD - Medical (clinical) Engineering Services Directorate

SP - Spare parts Project (including equipment development workshop)

EMW - Equipment Maintenance Workshop (Development of clinical Engineering department)

MP - Mombasa Polytechnic

Source: Kachieng'a 1998a and Project documents (1989-1998).

TABLE 5.3:

MOH/GTZ PROJECT PHASES AND GOALS

Project Phase	Project Goals
I **12/1989 – 6/1992**	• Setting up spare parts depots. • Training and upgrading of clinical engineering technician skills. • Constructing and equipping of equipment maintenance workshops in the designated training hospitals (pilot). • Strengthening Medical Engineering Services Unit.
II **7/1992 – 6/1995**	• Further construction and equipping of equipment maintenance departments at hospitals in the project area. • Development of National Scheme of Service for Medical (Clinical) Engineers and Medical Engineering Technicians. • Establishment of Medical Engineering Services Directorate (MESD) in the Ministry of Health. • Strengthening equipment maintenance services in public health facilities.
III **(7/1995 – /1998)**	• Strengthening the managerial capacity of the Medical Engineering Services Directorate. • Strengthening the management of equipment maintenance services countrywide. • Establishing an inventory of health care equipment in hospitals in the project area. • Establishment of equipment and management database at MESD.
IV* **(7/1998 – 6/2000)**	• Capacity building in technology planning and management at the MESD. • Establishing Equipment Asset Management Systems in all major public hospitals. • Pre-purchase technical analysis of equipment (efficacy, efficiency & cost of ownership) for Tender Board evaluations. • Development of Equipment Procurement Policy • Developing essential equipment list for various facility levels • Establishment of Equipment Regulation and Licensing Board. • Developing policy for 'targeted' technologies transfer. • Development of National Health Care Technology Policy.

Source: From Kachieng'a [1998a] and GTZ project files from 1989 – 1998.

* Project goals for Phase IV of the MOH/GTZ project proposed by the author of this thesis (see also section 5.6).

Phase I (12/1989 – 6/1992) of the project was aimed at setting up spare parts depots and the production of essential spare parts. In addition an advisory service was to be provided to the Ministry of Health to facilitate the transformation of the Medical Engineering Services Unit into a fully-fledged directorate in the Ministry of Health.

The second phase of the project (7/1992 – 6/1995) was directed towards establishment of equipment maintenance departments, upgrading of the skills maintenance staff and the establishment of a Medical Engineering Services Directorate (MESD) in the Ministry of Health. The ambitious original plan to manufacture spare parts locally had to be abandoned, since the plan proved not to be commercially viable. In place of the spare parts manufacturing venture, an innovative idea to create a development workshop was hatched. The purpose of this workshop was to propose 'appropriate modifications and technical improvements' for health care equipment.

The third phase of the project (7/1995 – 6/1998) was aimed at strengthening the efficiency of management of maintenance services and enhancing the managerial capacity of MESD. The main goal of the MOH/GTZ project is to establish a system of functional maintenance services for health care equipment in public health facilities. According to the project documents, 48 million Deutsche Marks have been used in the MOH/GTZ project since December 1989 [EFRG 1995].

5.4.2 PURPOSE OF EVALUATION

The purpose of this evaluation of the MOH/GTZ Project is to show how foreign technical aid can be utilised for national capacity building of human resources in the planning and management of technology and the maintenance of health care equipment. The aim of the evaluation is not to support the project or condemn it, but to highlight professionally the project components and experiences that can be used for development of similar systems in other developing countries. Health care technology planning, management and assessment are specialised fields in the modern health care systems, even in industrialised countries. Development of local human resources is critical for sustainability of health services and for the effective management of health care technology transfer. These objectives cannot be achieved in African countries without international co-operation and support from specialised institutions like the World Bank, World Health Organisation and others.

5.4.3 DECLARATION OF INVOLVEMENT

The author, in a professional capacity as a consultant, made direct contributions to the project design of Phases I and II, and thereafter was seconded to the Ministry of Health to establish the Medical Engineering Services Directorate. He developed the protocol for the establishment of MESD [Kachieng'a 1992b] and also developed the National Scheme of Service for Medical (Clinical) Engineers and Medical Engineering Technicians in Kenya [Kachieng'a 1992c]. Since then, Medical (Clinical) Engineering has been recognised as a profession by the Government of Kenya, with established career paths for all the staff at various levels. The author was the head of the MESD from 1991 to 1993.

5.4.4 EVALUATION METHOD

The evaluation was achieved through site visits. The author and two research assistants visited the project area, comprising four provinces (Central, Coast, Nyanza and Nairobi). Equipment maintenance services and project goals per facility were examined and compared with the actual results on site of a sample of four hospitals in every province except in Nairobi, where the evaluation was focussed on the operations of the MESD and staff capacity building requirements. The project co-ordinators, project managers, hospital administrators, clinical engineers and clinical engineering technicians were interviewed about project targets, achievements, time scales and failures. Project records, documents and annual project evaluation reports were examined, together with the site reports and observations of the research team; the reports and documents were analysed and ranked according to a grading system. The grades were: Successful (75% of target indicators achieved); moderately successful (50% of target indicators achieved); and failure where the target indicators achievement was below 50%. The evaluation process took 21 days.

TABLE 5.4:

MOH/GTZ PROJECT EVALUATION RESULTS PER PHASE CONTINUUM

Period	12/1989 – 6/1995	7/1992 – 6/1998	7/1995 - 6/1998	7/1998 - 6/2000
Phase	Phase I	Phase II	Phase III	Phase IV
	Technicians training Spare-parts depots Equipment. W/shops			
I	First continuum			
		Scheme of service Estab. MESD Equip.maint W/shops		
II		Second continuum		
			Management capacity Equip. database Equip. inventory	
III			Third continuum	
				Phase in progress
IV				Fourth continuum

Evaluation Key:

	Successful
	Moderately successful
	Phase in progress

5.4.5 EVALUATION RESULTS

The project evaluation results, shown as a per phase continuum, are presented in Table 5.4. The evaluation results are condensed and summarised below under the headings of project achievements and project deficiencies.

Project Achievements

The achievements of the MOH/GTZ results project can be summarised as follows:

1. Training of medical (clinical) engineering technicians and their deployment to the public hospitals.
2. Constructing and equipping of equipment maintenance workshops in hospitals (project area).
3. Establishment of the Medical Engineering Services Directorate in the Ministry of Health (Kachieng'a 1992b).
4. Development of the National Scheme of Service for Medical Engineers and Medical Engineering Technicians (Kachieng'a 1992c).
5. Reduction of non-functioning equipment in the project area (see Table 4.11:).
6. Setting up the spare parts depots in Kisumu, Nyeri and Mombasa.
7. Successful establishment of Equipment Rehabilitation and Development Workshop.
8. Recognition of medical (clinical) engineering as a profession by the Ministry of Health and medical research institutions.
9. Improvement in equipment maintenance budget allocations.

Project Deficiencies

1. Low participation of engineers and technicians in equipment selection and procurement.
2. Complete inventorisation of equipment in hospitals in the project area has not been achieved.
3. Spare parts depots are poorly managed and under-utilised.
4. MESD has not convinced the Ministry of Health of the necessity to allocate realistic equipment maintenance budgets.
5. The MESD Medical Engineering Services Directorate has not strengthened its managerial capacity enough to effectively co-ordinate engineering services and provide advice to the Ministry on technology issues and policies.

5.5 COMMENTS AND DISCUSSION

The most important characteristics of the MOH/GTZ project noted during the field visits were the simply formulated project targets and indicators (per site) with definite time scales. The deliberate avoidance of statistical jargon made implementation easier for the field staff. The conceptual design is such that each project phase, although a complete unit on its own, acts as a springboard for the next phase, giving project continuity and technical synergy between phases.

Establishment of MESD

The establishment of the MESD in Ministry of Health headquarters has created awareness in the Ministry of Health of the importance of technology in a modern health care system. Thus maintenance of health care equipment has now been recognized as a critical component of a functioning health care system [MOH 1997]. However, it took over three years for the World Bank, WHO, GTZ and other donor organizations to convince the Kenyan Government of the need to establish a directorate to co-ordinate health care equipment procurement and manage the maintenance of equipment in public hospitals. There is an urgent need to disseminate information on the potential and benefits of HCT in the public health sector.

As a result of the establishment of the MESD, equipment maintenance budgets have been increased, although they are still below the international standards. Equipment maintenance has become a policy issue [MOH 1997]. With more technology coming into health care, the directorate's role will have to be broadened to include technology assessment and policy formulation.

Equipment Maintenance Workshop

The establishment of equipment maintenance workshops has progressed well from Phase I to Phase III of the project. All hospital administrators interviewed highlighted the usefulness of equipment maintenance workshops, although insufficient maintenance funds were mentioned as a major constraint.

Spare Part Depots

The spare parts programme is very strategic for sustainability of health services in Kenya. Lack of spare parts has been a contributing factor to high service efficiency losses and under-utilisation of equipment in the public health services. The spare parts program started with many administrative problems, mainly related to the setting up of a revolving fund mechanism. It has belatedly overcome its organisational constraints and has been technically integrated as a vital part in the overall maintenance service.

In addition to the initial administrative problems, the programme has suffered from inadequate business acumen. It has unlimited potential, but management needs to be streamlined. The spare parts programme could be expanded to cover essential consumables needed in hospitals; secondly, for the project to exploit the abundant market, it should operate as a business entity and market its services to both public and private hospitals, and even to neighbouring countries like Tanzania and Uganda.

Equipment Development Workshop

The equipment development workshop has become a star of the project. It has proved to be very successful in rehabilitating idle equipment in various hospitals, thus contributing to the reduction of high replacement costs. Its products, such as a 'mobile theatre lamp' and 'incubator room', are already used in public hospitals. Prototypes of two products have been made by local firms and could be commercially successful when fully developed [Paton and Nyamu 1996]. The development workshop could offer a research base for technologies targeted for transfer. It can also be used for equipment testing, calibration, pre-purchase technical evaluation, and technology assessment research.

5.6 CONCLUSION

Most projects involving health aid to health care in African countries give sterile promises which are never realised due to poor project design and inadequate integration with local site requirements. In that regard the MOH/GTZ project has been successful. Each site (hospital) had its targets and indicators, time scale and deadlines. The co-ordination of the sites was localised, unlike other technical aid projects co-ordinated from distant capital cities.

However the success of a health project does not depend only on good conceptual design, but also on effective planning and co-ordination from both the executing agencies and beneficiary Ministries. There is also a need to create positive awareness about the project, and cultivate bureaucratic and political support.

The MOH/GTZ project has been comparatively successful because of both good project design and broad support from the Ministry of Health and the Ministry of Finance. More often than not, pressure from donor agencies can accelerate the required changes in attitudes in the public sector of developing countries. In Kenya the World Bank and the GTZ played a major role in highlighting the importance of health care equipment maintenance in the public sector and the need to establish the Medical (Clinical) Engineering Directorate.

Reducing disease burden through health aid calls for more than money; building capacity is crucial. Donors have unduly neglected the institutional and managerial aspects of specialised fields such as health care technology planning, management and assessment. Donors often prefer to hire experts for the projects, outside the bureaucratic structure of the governments. The result is that aid contributes less than it should to institutional building in the recipient country. According to the World Bank [1990 and 1995b], technical aid to health projects has been least effective in SSA, where success is most needed. It stands to reason, therefore, that local capacity building which facilitates effective project management determines the success or failure of donor-sponsored projects. There is an urgent need for capacity building in technology planning, management and assessment. Technological investments in health care can only contribute to better health outcomes if properly planned and effectively managed.

In the case of Kenya, this calls for strengthening of the MESD in the Ministry of Health. The international donor community can play an important part by supporting capacity building, and by assisting the directorate in formulating national technology policy and the establishment of an Equipment Licensing Agency. Future donor-sponsored projects in Kenya should incorporate capacity building as an integral project component. Investments in health care technology assessment research, planning and management are bound to yield high returns in better health in Kenya.

5.7 RECOMMENDATIONS

MOH/GTZ Project Specific Recommendations:

The Medical Engineering Services Directorate should focus on the following activities in phase IV of the project.

1. Consolidation of the capacity building programme in technology planning and management at the MESD through recruitment of staff suitably qualified to carry out technology evaluations and assessment.
2. Establishment of Equipment Asset Management Systems in all major public hospitals.
3. Co-ordination of pre-purchase technical analysis of equipment (efficacy, efficiency and cost of ownership) for Tender Board decisions.
4. Propagation of the use of information technology for collection of operational data and in the management of health care technical support services.
5. Development of an Equipment Procurement Policy.
6. Development of an Essential Equipment List for various facilities levels.
7. Establishment of an Equipment Regulation and Licensing Board.
8. Development of policy of 'targeted' technologies transfer.
9. Development of National Health Care Technology Policy.
10. MESD should have permanent representation on the Equipment Tender Board.

General Recommendations

The conceptual design of the MOH/GTZ project is broad and result-oriented, and can be used in other African countries with minor modifications. Holistically it encompasses all project components that are critical in providing support for health care technical services:

training of engineers and technicians; equipment maintenance workshops; sourcing of spare parts; managerial capacity building; and establishment of the Medical (Clinical) Engineering Directorate to manage, supervise and co-ordinate all technical services.

One lesson stands out in all donor-supported health projects: success and failure in health projects and programmes spring from the actions of both the donors and recipients. Some health-related projects are undertaken mainly to satisfy donors; often, because the recipient government wants funds for something else. A health aid project can only be successful if it is synergistically integrated into the health care system. This requires not only a sound conceptual technical design, good performance and co-ordination of the project, but also strong political will from the recipient country. Lack of commitment from recipient governments has been one of the factors contributing to project failure [World Bank 1995a, 1995b]. WHO (1997a) recommends that local participatory of planning of health projects, full use of local capacity and resources are strategic for project sustainability and strengthening of community ownership of health services.

Finally, external aid providers need to re-examine their activities and emphasise a longer time horizon, broader programmes of support to health sector reform and of inter-sectoral assistance, and comprehensive capacity building with the aim of long-term sustainability rather than individual project-based support. The 1997 UN *Human Development Report* [UNDP 1997] recommends that health aid to SSA should shift away from external technical assistance and personnel, and towards long-term support for national capacity building. Health aid should focus on promoting health growth, and include identification of health service bottlenecks. It should also support attempts to eliminate economic wastes in resource allocation and distribution [WHO/AFRO 1993b, Kachieng'a 1998a].

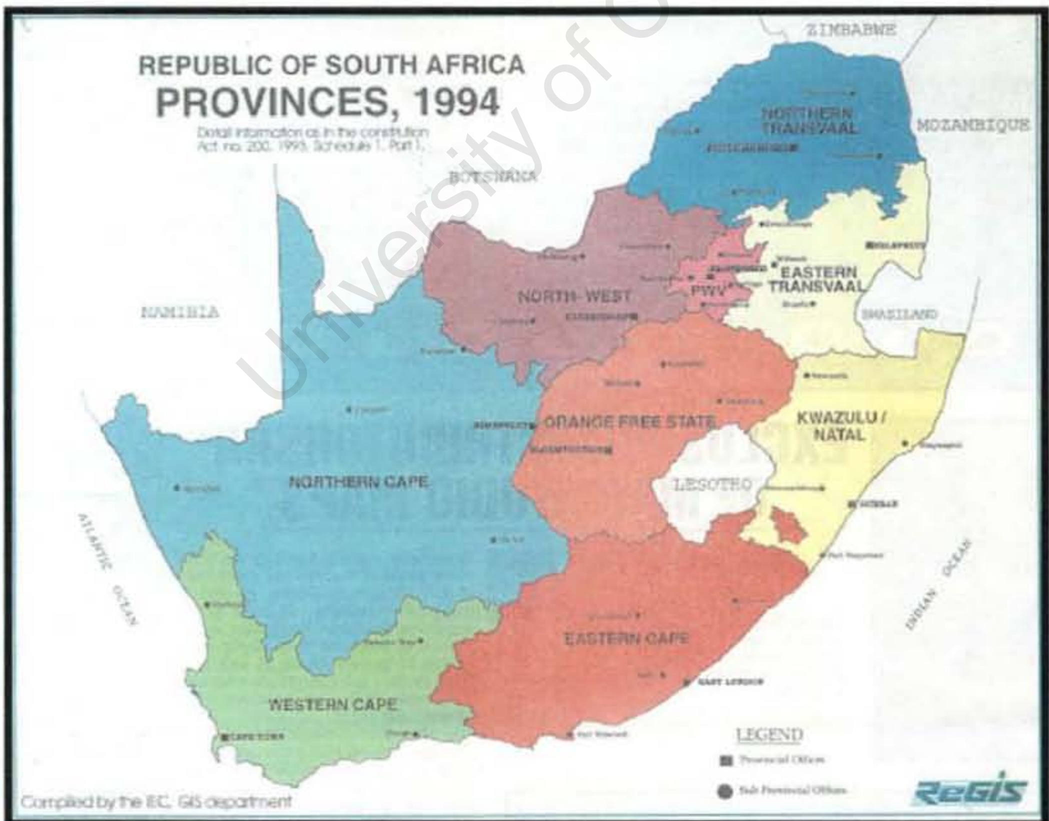
African Governments also need to play a vital role in this process by developing comprehensive health policies with increased commitment to primary care, establishing overall health sector financial plans, and emphasising cost-effective packages of basic services. These actions by recipient countries can help to persuade donors to make new financial commitments, to further the cause of better health in Africa.

CHAPTER 6

SOUTH AFRICA – A SITUATIONAL ANALYSIS

Chapter 6 provides a situational analysis of health care services in South Africa. This has been carried out similarly to that for Kenya (Chapter 4), and here again relevant aspects of the country's population dynamics and the national economy are included.

Map of South Africa



6.1 GEOGRAPHIC PROFILE

South Africa covers an area of well over one million square kilometres of the Southern African subcontinent. On its western coast is the cold Atlantic Ocean and to the south east it is washed by the warmer Indian Ocean. The waters meet at Cape Agulhas, generally known as Cape Point, the southernmost tip of the Cape Peninsula. Its north western neighbour is Namibia; on its northern border is Botswana; Zimbabwe, Mozambique and Swaziland lie to the northwest. An enclave within the borders of South Africa is the Kingdom of Lesotho.

In broad geographic terms, South Africa can be divided into just two regions. The greater is the semicircular interior plateau, varying in altitude from the central part of the Great Karoo (a flat, semi-desert area that covers around 400 000 km^2) to the towering Drakensberg in the east. The second is a narrow coastal belt fringing the plateau on three sides. The land terrain covers a vast interior plateau rimmed by rugged hills and a narrow coastal plain and coastline 2 798 km long. South Africa is located approximately between latitudes 22^0 S and 35^0 S and longitudes 17^0 E and 35^0 E.

South Africa is a country rich in diversity and contrasts, both in the character of the cities and the nature of the land. Eastwards from the modern metropolis of Johannesburg lies the rugged Escarpment which falls rapidly away to the humid, subtropical Lowveld. To the southeast lies KwaZulu-Natal, with its own complement of bushveld, wetland and marine reserves. In contrast the Eastern Cape Province has the spectacular and largely unspoilt Wild Coast. Along South Africa's southern shores lie forests and lakes, against the backdrop of the Outeniqua Mountains. Over 1500 kilometres southwest of Johannesburg lies South Africa's southernmost seaboard culminating in the Cape Peninsula and the city of Cape Town at the foot of Table Mountain.

A number of South African rivers rise in the Drakenberg mountains of KwaZulu-Natal, eight alone on the aptly named Mont-aux-Sources (mountain of springs) massif. Many of these, including the Tugela, cut their way down the eastern slopes, and over the eastern coastal plain to discharge into the Indian Ocean. South Africa's largest watercourse, the Orange River, flows west across the subcontinent, plunging through the Augrabies gorge, close to the Namibian border, before discharging into the Atlantic Ocean. Though much of its course crosses arid, treeless terrain, its waters are increasingly being used to irrigate flanking farmlands.

6.1.1 CLIMATE

Weather patterns in South Africa, dictated by ocean currents, altitude, prevailing wind and the ever-changing nature of the land, vary dramatically from place to place.
With respect to rainfall, though, there are three broad but distinct regions. The south-western tip of South Africa, centring on the city of Cape Town, has a winter rainfall from May to August. The southern and eastern coastal belts of South Africa enjoy heavy perennial showers in summer. Rains on the great central plateau and in the lowveld to the east come irregularly and without warning in heavy thunderstorms.

South Africa is one of the world's drier countries: mean annual rainfall is only 464 mm [Joyce 1996], little more than half the global average, although heavy rainfalls occur periodically in some parts. Only a third of the country gets enough rainfall for non-irrigated farming; just a quarter has perennial rivers, and even these are subject to seasonal flow. Climatic conditions of South Africa can be described as mostly semi-arid. There are subtropical conditions along the East Coast, with sunny days and cool nights, and the Cape Peninsula has a mild Mediterranean climate.

6.2 NATIONAL ECONOMIC PROFILE

South Africa is a curious mix of first world sophistication and third world under-development. On the one hand it has immense natural resources, employs the latest technologies, and supports advanced industrial and commercial structures; there is a great deal of money at the top end of the economic scale. On the other hand, the standard of education among the majority of South Africans is low; there are too few jobs and services for the rapidly expanding population and the poverty circle is very real, threatening stability and pressuring the government to enforce equity in the distribution of economic resources.

South Africa is well endowed with natural resources, the main ones being gold, gem diamonds, platinum, nickel, tin, uranium, copper, vanadium, phosphates, salt and natural gas. The main strength of the economy lies in the rich mineral resources, which provide two thirds of exports [McIntyre *et al.* 1995].

The economic core of South Africa consists of:
Pretoria - Witswatersrand - Vereeniging (Gauteng), Durban - Inanda - Pinetown (DIP), the Cape Peninsula and Port Elizabeth - Uitenhage, as well as the metropolitan areas of East London, Pietermaritzburg, Bloemfontein and the Free State Gold Fields. Thirty five percent of South Africa's population lives in this economic core; this consists mainly of the whites, Coloureds and Asians [McIntyre *et al.*1995].

South Africa is an upper-middle income country with a gross national product of US $ 2 560 per person in 1991 [World Bank 1993a]. Its economic structure reflects its level of development, with agriculture and mining accounting for only 13.8% of its gross domestic product (GDP), manufacturing and construction accounting for 32% and services accounting for 54.1% [Du Toit and Falkena 1994]. According to the 1991 census, 56% of the population live in cities or large towns, 1% live in small towns or villages and 43% live in the rural areas [CSS 1993].

In spite of having a level of output per person higher than every other country in Sub-Saharan Africa except Botswana and Gabon, South Africa faces economic problems. Since the early 1980s its GDP has increased by less than 1.5% per year while its population has grown by 2.5%. Its gross domestic income, which takes into account changes in the exchange rate, has not grown at all, and its gross domestic income per capita has fallen substantially [McIntyre *et al* 1995].

There is great income disparity between whites and blacks: 51% of annual income goes to the richest 10% of the households while under 4% goes to the poorest [World Bank 1995a]. The poorest of the poor are non-whites. The imbalance is very severe, making South Africa one of the most unequal of societies in the world [Fallon and da Silva 1994].

With regard to commerce, South Africa has the most sophisticated free-market economy on the African continent. The country represents only 3% of the continent's surface area, yet it accounts for 40% of all industrial output, 25% of gross domestic product, over half of generated electricity and 45% of mineral production. About 75% of South Africa's economic activity occurs in the four main metropolitan areas, which together represent about 3% of the total land area: the greater metropolitan area surrounding Johannesburg; the Durban/Pinetown area in KwaZulu-Natal, the Cape Peninsula, and the Port Elizabeth/Uitenhage area in the Eastern Cape. The Witwatersrand is the financial and industrial hub of the country and accounts for about 60% of all economic activity [GCIS 1998].

6.2.1 ECONOMIC DISPARITY AMONGST PROVINCES

Before 1994, South Africa was divided along racial lines into four independent states, six self-governing territories and four provinces of white South Africa (Table 6.1). It is now organised into a single, multiracial country with an elected National Parliament and nine provincial executive bodies.

TABLE 6.1:
NEW AND OLD POLITICAL AND ADMINISTRATIVE STRUCTURE

Previous division	Present provinces
'Independent' states	Eastern Cape
Transkei, Bophuthatswana, Venda,	Mpumalanga
Ciskei (TBVC states)	Gauteng
Self-governing Territories	Kwazulu-Natal
Kwa-zulu KaNgwane, QwaQwa, Lebowa,	Northern Cape
Ganzankulu, KwaNdebele	Northern Province
'White' South Africa	North-West Province
Cape, Natal, Orange Free State	Free State
Transvaal	Western Cape

Source: McIntyre *et al.* [1995].

There are considerable differences among South African's nine provinces: Northern Cape covers the largest territory and Gauteng the smallest; their populations vary from less than 1 million in Northern Cape to over 8 million in KwaZulu-Natal. There is also considerable difference among the provinces in terms of socio-economic development. Gauteng and Western Cape account for half of South Africa's GDP, in spite of containing only a quarter of its population. On the other hand, Northern Province produces only 3% of the GDP and has over 12% of the population. These differences are reflected in the average monthly personal income per capita, which ranges from 4 992 rands in Gauteng to 725 rands in Northern Province [McIntyre *et al.* 1995].

6.2.2 ECONOMIC INEQUALITY AMONG SOCIAL GROUPS IN SOUTH AFRICA

Most of the white population of South Africa (about one-seventh) enjoy incomes, material comforts, and health and educational standards equal to those of Western Europe. In contrast, most of the remaining population suffer from the poverty patterns of the developing nations, including unemployment and lack of job-related skills. One of the dominant characteristics of the South African economy is the inequality between racial groups. Fallon and da Silva [1994] estimate that in 1987 whites earned on average 9.5 times more per person than Africans. In addition, the apartheid-defined governments spent much more per person on services in white areas than in African areas. The majority of whites live in cities, which have a modern infrastructure and are served by well-funded schools and modern hospitals [McIntyre *et al.* 1995]. Most African urban localities have much poorer services, and large numbers of people live in shanty towns.

Half of South Africa's population, mostly African, is poor by any definition [Du Toit and Falkena 1994]. The highest concentration of poverty is in rural areas and peri-urban townships, where the majority of Africans live. The conditions of life in these areas are similar to those in poor areas in other parts of sub-Saharan Africa, where people find it difficult to gain access to clean and safe water and sanitation. The literacy levels are low and child mortality is high in these areas.

It is difficult to estimate the exact population of the poor in South Africa but, according to a study done in 1993/94 and analysed by Klasen and Doherty [1995], 23.7 million South Africans have an income of less than 301 South African rands per adult per month.

6.3 POPULATION DYNAMICS

The Republic of South Africa has a population of about 40 million, of whom approximately 75% are African, 15% are white and the remainder are Coloured (people of mixed race) and Asian [Welsh 1997]. The adult population comprises some 25.6-million people of whom about 14.3 million (56%) are economically active [Whitaker and Burns 1997]. The population composition of South Africa in 1995 is shown in Table 6:2.

TABLE 6.2:
THE RACIAL COMPOSITION OF THE SOUTH AFRICAN POPULATION AND GROWTH RATES 1995

Racial Group	Number (000s)	% of SA population	1991-95 rate of growth Average annual %
African	31 461	76.3	2.4
Coloured	3 508	8.5	1.4
Indian	1 051	2.5	1.4
Whites	5 224	12.7	0.7
Total	**41 244**	**100**	**2.1**

Source: RSA Statistics in Brief, CSS [1995].

Population policies during the apartheid era were reflective of the racist policies of that government. The focus was on controlling the movement of the population and reducing the fertility of the black population [Klugman 1996]. Population distribution and economic development were thus directly influenced by apartheid policies.

South Africa is organised into three distinct economic regions [McIntyre *et al.* 1995]: the economic core, the inner periphery and the outer periphery. The distribution of various population groups in the economic core is shown in Table 6.3. It is evident from the table that the white and Asian population is concentrated mainly in the richer economic core, as are, but to a lesser extent, the coloured people, whereas the Africans are located mainly on the periphery.

The inner periphery (see Table 6.3) consists of the areas previously allocated to the white, Asian and Coloured populations under the apartheid 'Group Areas' policy. It is organised into towns and commercial farms. Over 8 million people, two thirds of them Africans, live in this area. A large proportion of the population of the inner periphery work as agricultural labourers.

The outer periphery is made up of the former black homelands comprised of the so-called independent states and self-governing territories. Forty four percent (44%) of South Africa's population live in this area and are predominately black Africans. The principal economic activity in the outer periphery is subsistence agriculture.

South Africa's rapid rate of population growth will continue to put pressure on its stock of housing and its educational, health and social services. If the population continues to grow according to present trends (see Table 6.2) it will double within 55 years, although, much of that increase is expected to take place in the next few years [Bos *et al* 1994]. This factor is contributing to economic decline.

The South African government has committed itself, in its Reconstruction and Development Programme (RDP), to addressing the issues of slow economic growth and poverty alleviation. However, expert opinion states that it will take several years to overcome the structural constraints to change.

TABLE 6.3:
DISTRIBUTION OF POPULATION AMONG ECONOMIC REGIONS - 1991

	White (%)	Coloured (%)	Asian (%)	African (%)	Total (%)
Economic core (%)	9.4	5.2	2.1	18.3	35
Inner Periphery (%)	3.7	3.4	0.3	13.6	21
Outer periphery (%)	-	-	-	44.0	44
Total (%)	**13.1**	**8.6**	**2.4**	**75.9**	**100**

Sources: Urban Foundation [1991]-Population trends demographic projection model.

6.3.1 URBANISATION TRENDS

As stated above, apartheid laws had a major effect in restricting the settlement of Africans. Until 1986 the movement of Africans to the metropolitan centres was contained by influx-control legislation. In that year the controls were abolished and the movement of Africans to the cities accelerated. By 1991, approximately half of the population of the economic core was African [McIntyre *et al.* 1995].

The Urban Foundation estimates that the population of the metropolitan areas will grow by 4% a year between now and the year 2000. If the estimate holds, urban and peri-urban areas will contain half of South Africa's population by the turn of the century. This will create further shortages of housing, sanitation and clean safe water in the urban centres.

The rapid migration of previously disadvantaged groups to the metropolitan centres has led to the growing problem of urban poverty. Most of the housing in lower-income urban communities is overcrowded and squatter settlements have sprung up.

6.4 HEALTH SECTOR PROFILE

The movement towards equity in health care provision in South Africa must be underpinned by careful analysis of the existing situation. In order to put the situation of South Africa into an international context, indicators of its health status and provision of health services are compared with those for countries with similar GDPs per capita and the weighted averages for middle income countries, other countries in sub-Saharan Africa and the established market economies (Table 6.4). It is evident from this table that the health indicators in South Africa are to some extent worse than the average for middle-income countries. They compare very favourably with those for other countries in Sub-Saharan Africa (except Botswana) but are far inferior to those recorded in Hungary, Malaysia and South American countries such as Venezuela and Chile.

TABLE 6.4:

HEALTH INDICATORS IN SOUTH AFRICA AND COUNTRIES WITH SIMILAR GDPs PER CAPITA

Country	Infant mortality rate*(per 1 000)	Life expectancy at birth 1991 (years)	Annual incidence of tuberculosis 1990 (per 100 000)
Sub-Saharan Africa excluding South Africa	104	male 49 female 52	not available
Middle income countries	38	68	not available
South Africa	**49**	**63**	**250**
Botswana	36	68	not available
Hungary	16	70	38
Malaysia	15	71	67
Venezuela	34	70	44
Chile	17	72	67
Established market economies	8	77	20

Sources: World Bank [1993a] Tables A.3, 1 and 28, and World Bank [1995a].
* Data on the infant mortality rate are for 1992 in South Africa and 1991 in other countries.

6.4.1 DISEASE BURDEN

South African society - like many developing societies - is pre-eminently a society in transition, and this is reflected in its disease and death profiles. In the past few years the mortality rates have declined as a result of improved incomes, food and living conditions and access to advanced health care technology. The effects of HIV and tobacco are the only two factors which are expected to oppose the trend [Bradshaw and Buthelezi 1996].

In the words of Frenk et al [1989], "Many of the emerging illnesses are a result of a defective process of industrialisation that placed more value on economic growth than human welfare." However, the disease burden in the different sectors of the population varies significantly. Consequently a mixed profile displaying pre and post-transitional extremes and intermediate types is evident. Apartheid policies have resulted in a correlation between socio-economic status and population groups and, in certain respects, the morbidity and mortality profile of whites and Indians is that characteristic of developed countries, as lifestyle-related degenerative diseases become increasingly predominant. On the other hand, the disease and death profiles of Africans and coloureds reflect the conditions of less developed societies, with a predominance of "social diseases" (deficiency diseases, tuberculosis, gastro-intestinal disease and measles). In South Africa, therefore, there is a marked co-existence of the diseases of the rich and the poor [Frenk *et al.* 1989]. Despite paucity of data, analyses of the South African mortality data of 1990 reflected the bipolar nature of the mortality patterns [Bradshaw *et al.* 1995]. In addition, it is evident that injury (from road accidents) plays a disproportionately large role in the burden of disease in South Africa [Bradshaw and Buthelezi 1996].

Of all legally notifiable diseases, tuberculosis (TB), measles, malaria, viral hepatitis and typhoid have high crude morbidity rates in South Africa. Incidence rates of the leading groups of illness reported by the Department of Health for 1993 are presented in Table 6:5 [Fourie and Steyn (eds) 1995].

Many of the infectious diseases are preventable and access to primary health care during pregnancy and childbirth is known to reduce maternal and perinatal morbidity and mortality [Bradshaw and Buthelezi 1996]. In many respects, these conditions can be considered part of an unfinished agenda, as they could have been virtually eliminated with the appropriate provision of health services.

Even though available data indicate a decline of these diseases in all population groups, the concentration of such diseases among the African population relative to the other population groups is significant. Similarly, the data show prominence of all disease burdens in provinces that are poor and lack adequate infrastructure [McIntyre *et al.* 1995].

TABLE 6.5:

INCIDENCE OF NOTIFIABLE CONDITIONS IN SOUTH AFRICA IN 1993 PER 100 000 POPULATION

Disease/ Condition	Incidence per 100 000 population
Tuberculosis	224
Measles	32
Malaria	29
Viral Hepatitis	4.2
Typhoid Fever	4.1
Congenital syphilis	2.5
Meningococcal infection	1.2
Food poisoning	0.9
Trachoma	0.6
Pesticide poisoning	0.3
Cholera	0.2
Tetanus	0.1
Rheumatic fever	0.1
Brucellosis	0.1

Source: Health Trends in South Africa, DOH [1994].

6.4.2 DEVELOPMENT ISSUES RELATING TO HIV/AIDS

HIV/AIDS is only one of the problems amongst others faced by policy planners in African countries. In South Africa, the need to develop the economy and to provide houses, education, health and employment has been seen as more important than the HIV/AIDS epidemic [Whiteside and Barnett 1996].

It is generally accepted that socio-economic development involves more than economic growth and increases in GDP per capita; it includes factors like longevity, infant, child and maternal mortality, and distribution of income. The impact of the AIDS epidemic will affect human development. Particularly vulnerable are the indicators of life expectancy; infant mortality rates; child mortality rates and the crude death rate. Way and Staneki [1994] have noted that infant mortality rates are nearly doubling in Zambia and Zimbabwe and are increasing by 50 per cent in Uganda, due to a high incidence of the HIV virus. Child mortality rates will increase even more, as many infected infants will not survive beyond their first birthday. These authors further predict that life expectancy will fall by between 9 and 25 years in the affected countries by the year 2010.

The effect of AIDS will reverse hard-won development gains and leave people, and indeed whole nations, worse off. It is possible that these effects may last for decades. The people who fall ill and die are the parents and productive workers in society, which means that a generation of children may grow up without the care and role models they would normally have [Over 1992].

As mentioned above, the impacts of AIDS has not been given any serious consideration in South Africa. The challenge is to ensure that South Africa takes the epidemic seriously now.

The need for prevention of AIDS and planning for its impact is more urgent than ever, and this must be made a comprehensive and inclusive process.

Health care equipment will play a major role in screening and detection of the HIV virus. Planning and deployment of screening equipment at strategic facilities countrywide should be included in the AIDS programme.

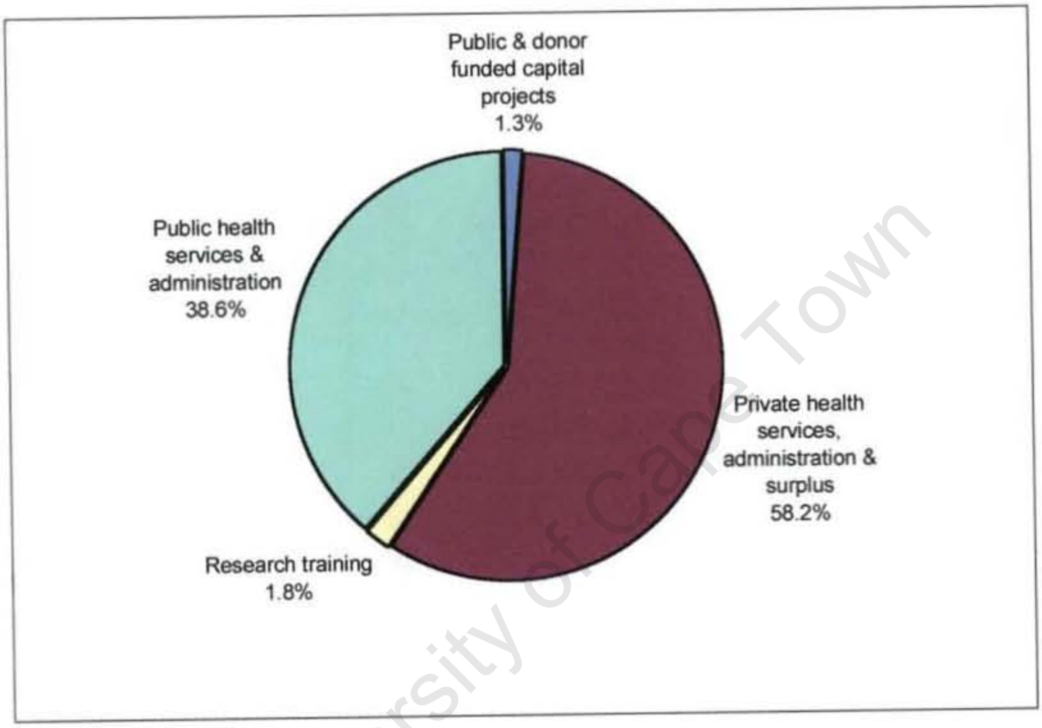
6.4.3 MAIN STAKEHOLDERS IN SOUTH AFRICA'S HEALTH SECTOR

The South African health services are provided and financed by both the public and the private sectors. The public sector caters for approximately 70%–80% of the country's population, mainly those citizens not on medical insurance, many of whom were severely disadvantaged in the apartheid era [Benatar 1986, ANC 1994b].

In funding health care services in South Africa the government and local authorities provide about 38.7% of the total, the private sector provides 60.8% and the remainder comes from donors. Figure 6.1 indicates on what activities health care funds are spent.

Figure 6.1:

Distribution of total health sector expenditure 1992/93



Sources: ReHMIS data; Blecher and McIntyre [1994]; Bunting [1994]; Deloitte and Touche [1994b]; Valentine and McIntyre [1994].

6.4.4 INEQUALITY AND DISPARITIES OF HEALTH CARE SERVICES

In the latter part of the 1980s, a number of researchers highlighted the substantial geographic disparities in the allocation of health care resources between the former 'homelands' and the provinces [Klopper and Taylor 1987, Dorrington and Zwarenstein 1988]. Even with the re-incorporation of the "homelands" in the nine provinces created under the new constitution, geographic disparities have persisted [McIntyre 1994; McIntyre *et al.* 1995]. The inequalities and disparities are substantial: for example, per capita public sector health care expenditure was nearly 360% greater in the most well-resourced province (the Western Cape) than in the least well-resourced province (Mpumalanga) in 1992/93 [McIntyre *et al.* 1995]. McIntyre *et al.* [1995] found that resources were not only maldistributed on an inter-provincial basis, but also on an intra-provincial basis (i.e. between districts within each province).

Although the democratically elected government has committed itself to reducing inequities in geographic health resource allocation, the process will require new reforms in planning and restructuring health delivery services. Immediately after the 1994 elections, the national Department of Health (Ministry of Health), in consultation with the provincial health departments and other stakeholders, initiated a geographic resource redistribution process. The stated goal was to achieve inter-provincial equity in the per capita distribution of health care budgets within a five year period [McIntyre *et al.* 1995, Doherty and Van den Heever 1996, Makan *et al.* 1996]. There have been substantial discussions and debates about the approach to be adopted for inter-provincial resource redistribution. These are extensively covered in the literature [McIntyre *et al.* 1995, Doherty and van den Heever 1996, Makan *et al.* 1996], and therefore will not be elaborated in this study. With the government's decision to implement a District Health System (DHS) in South Africa, attention is now being focused on the development of mechanisms for inter-provincial allocation of health care resources. The target aim is to achieve equitable allocation of health resources from provincial health departments to all districts.

Inequalities in access to health services are also defined mainly along socio-economic lines. Different population groups use quite different health services [McIntyre *et al.* 1995]:

- People with high incomes depend largely on the private sector, using public sector hospitals only for highly specialised services and for long-term treatment of chronic illness.
- People with low to middle incomes use both public and private primary care providers and rely heavily on the public sector for inpatient care.
- The poor depend largely on public sector health services.

6.4.5 HEALTH FACILITIES AND HUMAN RESOURCES

South Africa has a total of 162 000 hospital beds, which is the equivalent of 4.0 per 1 000 population [Chetty 1994]. The ratio of beds to population is typical for a country with South Africa's income. For example, a survey carried out by Barnum and Kutzin [1993] found a mean number of 4.1 beds per 1 000 population in middle income countries (see Table 6.6). This ratio is about 4 times better than that in most Sub-Saharan countries but still only about half that in countries with established market economies.

It is difficult to assess the availability of primary level facilities, relative to the World Health Organisation's recommendation of one for every 10 000 people [WHO 1991a]. This is because South Africa has a number of private clinics and outpatient departments [McIntyre *et al.* 1995].

TABLE 6.6:

DATA ON HEALTH SERVICE PROVISION IN SOUTH AFRICA, OTHER COUNTRIES WITH SIMILAR GDPs, ESTABLISHED MARKET ECONOMIES AND SUB-SAHARAN AFRICA

Country	Health Expenditure as percentage of GDP in 1990%	Hospital Beds 1985-1990 per 1000 population	Population per Physician in 1991
Sub-Saharan Africa excluding South Africa	4.5	1.1	9 000
Middle Income Countries	not available	4.1	2 060
South Africa (1992/93)	**8.5**	**4.0**	**1 661**
Botswana	3.3	2.4	5 150
Hungary	6.0	10.1	340
Malaysia	3.0	3.9	2 700
Venezuela	3.6	2.9	630
Chile	4.7	4.7	2 150
Established Market Economies	9.2	8.3	420

Source: For South Africa-ReHMIS survey, Chetty [1994], Development Bank of Southern Africa [1994]; for other countries –World Bank [1993a and 1995a] and Barnum and Kutzin [1993].

In 1992 South Africa had 24 500 doctors, 171 500 nurses and 9 000 pharmacists, according to the Development Bank of Southern Africa [1994]. This is the number of personnel on the register of the South African Medical and Dental Council (SAMDC), but it should be noted that these figures include those who are no longer in active practice in South Africa.

South Africa is reasonably well supplied with doctors with 1 661 people per physician (Table 6:6). The weighted averages of the number of people per doctor in 1990 were 420 in the established market economies, 2 060 in middle income countries and 9 000 in the rest of sub-Saharan Africa [McIntyre *et al.* 1995].

It is difficult to obtain data with which to compare South Africa's ratio of 237 people per nurse. The only upper-middle income countries for which the World Development Report provides data on the number of people per nurse are: Venezuela 330; Oman, 400; and Saudi Arabia, 420 [World Bank 1993a]. This suggests that South Africa has a comparatively good supply of nurses.

The geographic disparities in health care services among the provinces (see 6.4.4) are reflected in major differences in the distribution of health facilities and personnel (see Table 6:7). For example, the number of hospital beds varies from 6.0 per 1 000 in Gauteng to 2.1 in Mpumalanga. There are also substantial differences in the number of health workers relative to population. The Western Cape has 9.3 times more doctors and 2.6 times more nurses on the SAMDC register than have under-resourced provinces like Northern Province and Mpumalanga respectively. Similarly, Gauteng has 14.1 times more pharmacists than the Northern Province.

TABLE 6.7:

HEALTH FACILITIES AND PERSONNEL DISTRIBUTION BETWEEN PROVINCES IN 1992/93 FINANCIAL YEAR

Province	Hospital beds per1 000 population	Doctors per 100 000 population	Nurses per 100 000 population	Pharmacists per 100 000 population
Eastern Cape	3.5	30.7	321.3	20.1
Mpumalanga	2.1	28.3	265.8	23.1
Gauteng	6.0	127.4	618.4	109.8
KwaZulu-Natal	3.8	53.5	431.9	28.7
Northern Cape	4.0	37.6	432.3	28.5
Northern Province	2.5	15.5	293.2	7.8
North-West	3.3	22.7	273.5	22.8
Free State	4.1	46.5	382.3	38.8
Western Cape	5.4	143.8	686.3	79.8
Total	**4.0**	**60.2**	**421.5**	**42.6**

Source: Chetty [1994] and Development Bank of Southern Africa [1994].

6.4.6 THE PUBLIC HEALTH SECTOR

During the apartheid era, the public health sector was fragmented into a large number of overlapping administrative systems: each racial group had its own national department of health; every homeland and provincial administration had a department of health; and 400 or so local authorities also had health departments [McIntyre *et al.* 1995].

TABLE 6.8:

SOUTH AFRICAN PUBLIC HEALTH SECTOR STRUCTURE

Level of Government	Department(s)	Responsibilities/Activities
Central	Department of Health	• health policy formulation • determination of provincial budgets including component for local authority subsidies • co-ordination of services • line functions such as dental, forensic, national laboratory etc. • other support functions
Provincial	Provincial health departments	• determination of local authority budgets • hospital-based services and mental health • primary level curative and rehabilitation services • comprehensive primary care services in former homelands • ambulance services in conjunction with local authorities
Local (including municipalities and Regional Services Councils)	Local authority health departments	• preventive, promotive and rehabilitative primary care services with particular emphasis on communicable disease control and environmental health • ambulance services
Other (non-health) departments	Departments of Defence, Police and Correctional Services	• provision of health services for staff, their dependants and prisoners

Source: McIntyre et al. [1995]

Note: Some of the service provision responsibilities described above have been delegated to other health authorities; for example ambulance services are frequently provided by local authorities although they are the responsibility of provincial administrations.

The South African government is currently restructuring the public health service. Table 6:8 summarises the proposed restructuring format for the 1995/96 financial year. In brief, the national Department of Health budgets and co-ordinates services and provides other support functions. The Provincial Health Departments provide preventive health and hospital services, primary level care and comprehensive services in the former homelands. Local authorities are responsible for preventive and promotive primary care, with a particular emphasis on communicable disease control and environmental health.

The national and provincial Departments of Health plan to establish a new tier of district health services. The functions of these district health services have not been defined, but they will be responsible for non-specialist hospitals and comprehensive primary care services. The exact demarcation of function between provinces and districts has not been determined. This has created a vacuum in the management of health services at the district level.

6.4.7 HEALTH CARE SERVICES

The health care system in South Africa is broadly divided into two categories: hospital-based curative services, and preventive and promotive services, which are actively promoted countrywide by the government under primary health care programmes.

Curative services: Curative services in South Africa are provided by both the government and the private sector, with the latter concentrating mainly on profitable hospital-based curative services.

The government curative services are organised in a hierarchical system from the smallest to the most complicated and sophisticated academic complex (teaching). In between there are day hospitals, district hospitals, provincial hospitals, tertiary hospitals and chronic hospitals such as psychiatric hospitals. Non-hospital primary health services are largely provided through fixed and mobile clinic and community health centres.

Primary health care services: Before the 1994 democratic elections, the South African health care system was mainly curative, with functional primary health care services nearly non-existent.

There are many reasons for the high levels of sickness and premature death in South Africa, including inadequate health services, poor nutrition, bad housing, exposure to environmental risks, unavailability of clean water, low levels of education and the problem of violence. The government's strategy for addressing these problems is outlined in the Reconstruction and Development Programme (RDP) [African National Congress 1994b]. Primary health care, which is in its infancy in South Africa, is mainly driven through this government-sponsored RDP programme, which gives priority in the health sector to prevention and the provision of essential curative care to all [McIntyre *et al.* 1995].

Although, the government has not yet defined in detail the services to be covered in primary health programmes, the package is expected to include:

- Programmes to educate the populations about how to take responsibility for their health and change dangerous behaviour, such as smoking, excessive use of alcohol and unprotected sexual activity;
- Activities aimed at preventing diseases through environmental improvement or preventive programmes;
- Provision of easy access to basic medical care to prevent the development of serious and costly complications of illnesses; and

- Measures to help the disabled to be more self-sufficient and productive.

There is widespread international agreement that primary health care is the most cost-effective approach for decreasing the levels of excess sickness and premature death that are found in developing countries including South Africa [World Bank 1993a, 1995a]. In South Africa there is particular need to address issues such as staff shortages, poor service quality and lack of essential equipment, especially in rural areas. The issue of disparity in the distribution of health care services is further elaborated in section 6.6.

6.5 HEALTH CARE FINANCING

The national annual expenditure on health services is as topical an issue as it is emotional and controversial [Bourne *et al.* 1990, McIntyre 1990, McIntyre and Dorrington 1990, McIntyre *et al.* 1995]. The South African health services have been branded as fragmented, abounding in duplication and inefficiency [Price 1988, Benatar 1990, Van Rensburg and Fourie.1994], very biased in terms of service delivery across racial population groups [Benatar 1990, Van Rensburg and Fourie 1994, Anderson *et al.* 1988, Naylor 1988, Van Rensburg and Fourie 1988, Yach et al. 1991] and maldistributed with regard to their imbalance when it comes to services provided in urban and rural areas respectively [Price 1988, Van Rensburg and Fourie 1988, Benatar 1990, McIntyre 1990, Zwarenstein and Price1990, Van Rensburg and Fourie 1994].

The debate usually centres on one or both of the following issues:

In the first place, the proportion of the total health budget which is allocated to primary health care is very small compared with the much larger slice assigned to hospital-based curative services, even though the latter is inadequate. Related to this, but taking a more differentiated approach, is the issue of maldistribution according to race and region, which is of major concern in government and political circles.

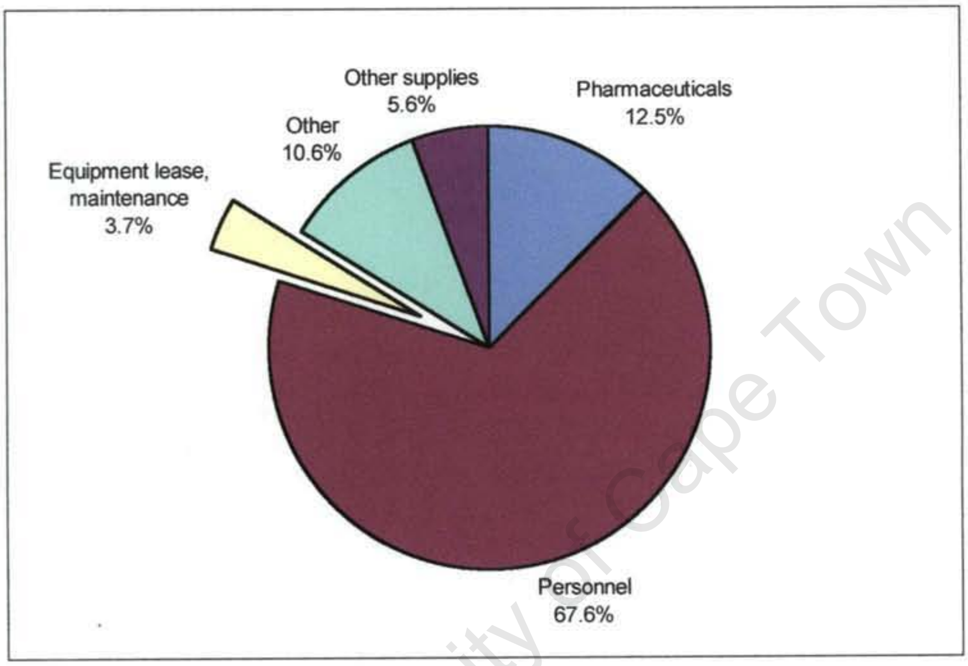
6.5.1 DEPARTMENT OF HEALTH RECURRENT EXPENDITURES

In the 1992/93 financial year, recurrent expenditure on public health was approximately 11.1 billion rands or 273 rands per capita, while capital expenditure was 386 million rands. The proportion of total government spending allocated to health (recurrent and capital health budgets) fell from 11% in 1991/92 to 10.2% in 1994/95 [McIntyre and Owen 1994]. Recurrent public health expenditure was equivalent to 3.3% of GDP in 1992/93. These percentages are reasonably high compared with other middle and upper-middle income countries [McIntyre *et al.* 1995].

The breakdown of recurrent public health care expenditure is given in Figure 6.2. South Africa's public sector health services spent 67.6% of recurrent expenditure on personnel in 1992/93. This was a comparatively high proportion to spend on salaries compared, for example, to 12 Asian countries covered in a study by Griffin [1992]. Their public health services spent 43% on salaries, 38% on non-salary expenditure and 19% on capital. The South African budget spent personnel is similar to Kenya's expenditure which about 69.5% of recurrent expenditure (see chapter 4 section 6.5). While the salaries of public health personnel are not high in comparison with other salaries in South Africa, overall salary levels in South Africa are high relative to those in developing countries. It is therefore difficult to make international comparisons when there are significant wage differentials between countries.

Figure 6.2:

Distribution of recurrent public sector health expenditure by inputs 1992/93 Financial Year



Source: McIntyre et al [1995] and ReHMIS Survey.

Note: Additional expenditure on maintenance of health facilities is reflected in the accounts of the respective Departments of Works. Unfortunately, the extent of this expenditure could not be determined.

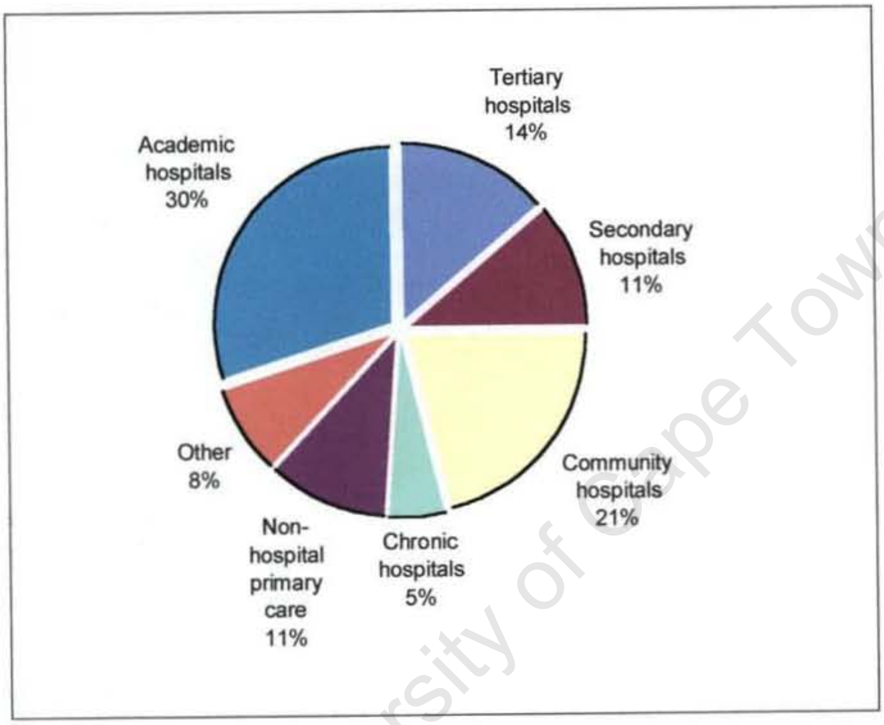
6.5.2 DEPARTMENT OF HEALTH INTERNAL ALLOCATION OF RECURRENT EXPENDITURES

Figure 6.3 shows that recurrent expenditure was concentrated on hospitals; approximately 76% of the total was spent on acute care hospitals of various standards, 5% on chronic hospitals, while only 11% was allocated to non-hospital primary health care and 8% to other services including emergency and dental services.

According to a literature review carried out by Doherty [1994], the percentage of public health expenditure allocated to hospitals varies between 35% and 70% in developed countries and between 40 and 80% in developing countries. It is difficult to compare South Africa with other countries, because of differences in definition, poor data quality and other methodological problems. Nevertheless, it is fair to state that South Africa's public health services allocate a high proportion of their resources to hospitals, compared with other African countries.

Figure 6.3:

Distribution of public sector health care expenditure by level of care (1992/93 financial year)



Source: McIntyre et al [1995].

6.5.3 DEPARTMENT OF HEALTH DEVELOPMENT EXPENDITURES

According to a Deloitte and Touche survey [1994a] carried out between the 1993/94 and 1995/96 financial years, the planned investment in development was allocated as follows: 89% on hospitals, 9% on primary care facilities and 2% on other health-related facilities. The Deloitte and Touche report [1994a] made several criticisms of health facility planning in the public sector. It was pointed out that that there is little information available on the existing capital stock or planned projects. The report concluded that the infrastructure development is not planned systematically.

There are no clear guidelines on how to critically assess the degree to which a proposal for a new facility is consistent with health sector development priorities. It is evident that the planning and management of the public sector health investment programmes are not based on assessed health needs. Provincial Health Departments should formulate investment plans based on clear definition of needs, and the recurrent cost implications of a project must be taken into account when it is evaluated.

6.6 HEALTH TECHNOLOGY PROFILE

Health technology (HT) in the South African health care system is highly sophisticated and advanced compared to other African countries. For example, the first-ever human heart transplant operation, performed at Groote Schuur Hospital, Cape Town by Prof. Christiaan Barnard in December 1967, required a team of 14 medical specialists. Thirty years later, in June 1997, an identical procedure carried out in the same hospital required a team of only eight specialists, a drastic 43% reduction of human resources (see Figures 6.3 and 6.4). This is an indication of high rate of change and utilisation of advanced capital-intensive health care technologies in the surgical procedures at Groote Schuur Hospital, one of the leading teaching hospitals in Cape Town and South Africa. Groote Schuur and the other teaching hospital, Tygerberg, as well as certain private hospitals in the Western Cape, are also internationally recognised in the fields of oncology and haematology. Professor Ben Smit at Tygerberg Hospital is internationally recognised for his leading research in radiation oncology and Professor Peter Jacobs, formerly of Groote Schuur Hospital and now in the private sector, is also known for his contributions in the fields of haematology and bone marrow transplant treatments. Other major cities like Johannesburg, Pretoria and Bloemfontein also host teaching hospitals with fairly advanced health care technologies.

The well-equipped teaching and urban hospitals give false impression of the South African health system. South African preventive health care system lack basic technologies. For example, rural hospitals lack both basic health care equipment and technical support. The challenge for health planners are facing is how to manage *cost-effectively* the big-ticket technologies and basic preventive technologies that co-exist in public health system. Health technology for preventive care and curative services should be balanced based on the national disease pattern and health needs [Kachieng'a *et al.* 1999].

Figure 6.4:
Groote Schuur Hospital Museum Photograph of the 1967 First-ever Heart Transplant Operation by Professor Christiaan Barnard

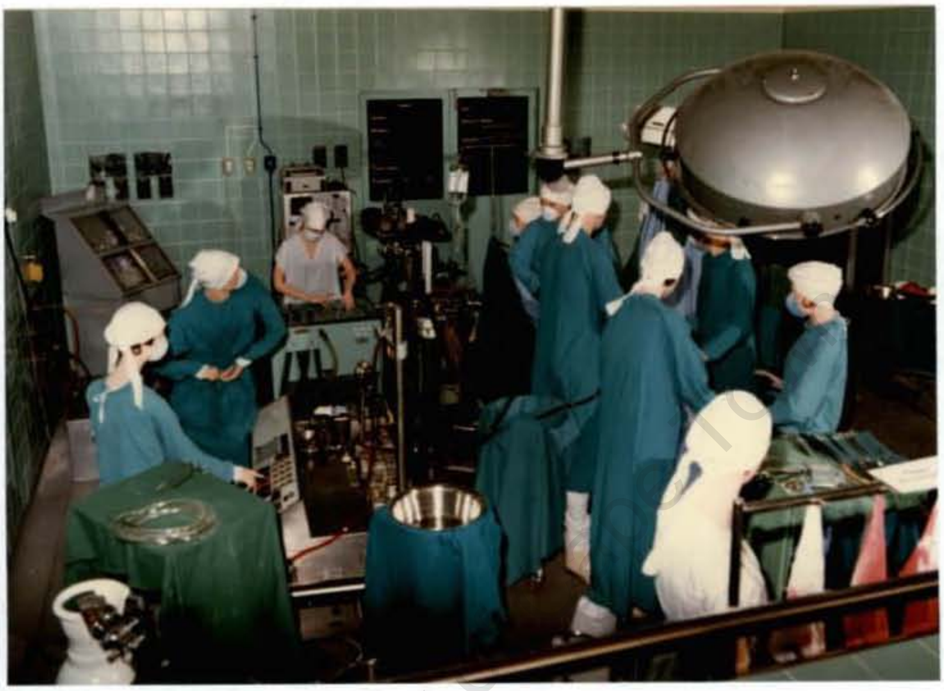


Figure 6.5:
Heart Transplant Operation at Groote Schuur in June 1997

Technologically, South Africa uses modern state-of-the-art equipment in major tertiary hospitals, but paradoxically lacks basic health care facilities and equipment in rural areas and townships. As mentioned in section 6.4.7, primary health care service is in its infancy in South Africa. In the apartheid era the rural and peri-urban areas were neglected and health care services in these areas remain under-developed. HT in South Africa is like twins adopted in different worlds, one in a developed country and the other in a developing country. Health care equipment in public urban hospitals is modern and sophisticated while the equipment in rural hospitals is old and outdated.

In the face of demands for the equitable distribution of health care services, the government has responded by attempting to shift care away from physician specialists to primary health care-givers. The process of transferring health care from hospital-based curative care to primary-based preventive care has not been very successful. Some reasons for this are:

1. There is no clear definition of what constitutes primary health care. To some health planners transferring curative care to rural areas (building hospitals in these areas) is considered to be primary health care. But even where hospitals are available, they often lack essential health care equipment and drugs, and therefore health services are compromised.

2. Primary health care programmes lack innovative technological support. Most technological innovations in health care today are for curative services, not primary health care.

In addition, despite high availability of modern health care equipment in the public sector in South Africa compared to other African countries, there is unbelievably high disparity in the distribution of high technology-based medical services amongst provinces and racial groups.

Advanced health care technologies reside in the former white areas. Although data necessary to compile an inventory of high-tech health care equipment in the public and private sectors are lacking, the preliminary evidence indicates that the distribution of health care technologies reflects the general disparities in health care in the country. Table 6.9 shows an example of this disparity in the distribution of CT scanners amongst the provinces and between the public and private sectors. Similar disparities are observed in the distribution of Magnetic Resonance Imaging (MRI) systems, cardiac catheterisation units and radiotherapy equipment [DOH 1997].

TABLE 6.9:

DISTRIBUTION OF CT SCANNERS IN SOUTH AFRICA BY PROVINCE AND BY SECTOR

Province	Population (millions)[1]	Units			Units/million population[2]		
		Public	Private	Total	Public	Private	Total
Northern	4.128	0	1	1	0	2.36	0.240
North-West	3.043	0	5	5	0	11.00	1.644
Mpumalanga	2.645	0	6	6	0	14.18	2.270
Gauteng	7.171	13	56	69	3.00	19.69	9.620
KwaZulu-Natal	7.672	5	12	17	0.76	10.76	2.210
Free State	2.470	5	5	10	2.52	10.20	4.040
Northern Cape	0.746	0	1	1	0	6.49	1.340
Eastern Cape	5.865	5	5	10	0.93	9.43	1.700
Western Cape	4.118	8	20	28	2.61	18.79	6.790
South Africa	**37.859**	**36**	**111**	**147**	**1.18**	**14.70**	**3.880**

Source: Department of Health –Health Technology Policy -Discussion Paper, DOH [1997].

[1] Census 1996, Preliminary estimates of SA population.

[2] Rates per sector are calculated on the basis of Medical Scheme membership per province.

6.6.1 HEALTH CARE EQUIPMENT PROBLEMS

In the last two decades the public sector in South Africa has acquired large quantities of sophisticated and expensive health care equipment. However, most public hospitals are finding that the sophistication of HT has outstripped the ability of hospital management to analyse, rationalise, and organise the means by which to deliver clinically appropriate state-of-the-art medical services at socially acceptable costs [Walters and Bunn 1995]. The enormous growth of technology in the health systems has not been accompanied by a concomitant growth in the wisdom to manage or control it.

The problem of equipment maintenance in South Africa is more acute now than ever before, because of an exodus of experienced clinical engineers and technicians from the public service through a state-sponsored voluntary retrenchment programme. By October 1997 as many as 4 047 health care staff had taken the voluntary severance package in the Western Cape. Of these 10.8% were highly trained and experienced engineering staff [Benatar 1997]. For example, the clinical engineering department at Groote Schuur Hospital had 47 clinical engineers and technicians in 1994, but only 18 are presently in employment. The most senior and experienced have left the public service and have joined equipment suppliers or become external providers of equipment maintenance services. Already, there is widespread obsolescence of essential equipment such as ventilators and bronchoscopes and a diminishing utility of theatres and intensive care, trauma, dialysis and radiation oncology units [Ncayiyana 1997]. The need to improve service efficiency in the use of expensive equipment demands immediate action.

6.7 COMMENTS AND DISCUSSION

Health Care Services

South Africa's health sector painfully reflects the society it serves. It provides different kinds of services to different kinds of social groups. For the most affluent segment of the population, consisting mainly of whites, there is a highly developed private sector which provides the type of medical services found in industrialised countries [McIntyre *et al* 1995]. Some of these facilities have won international recognition. Even the public sector spends a large percentage of its budget on a relatively small number of hospitals in urban centres, of which several are linked to medical schools. On the other hand, a large majority of the population does not have good access to health services. The majority of black people fall into this category. The coexistence of large numbers of people who do not have access to basic health services and others who spend a great deal of money on medical treatments explains in part why South Africa has high morbidity and premature deaths, despite the fact that it spends 8.5% of its GDP on health.

Health Care Financing

The South African government has promised to reduce the fiscal deficit in relation to GDP in the 1999 budget. The focus will be on increased and more efficient revenue collection and control of growth in major state expenditure to compensate for the constraints in the economy. Health will have to compete for budget increases with housing, education, water and other social services for which there is a great backlog of unmet need. In these circumstances, it would be unrealistic to expect much increase in the government health budget (in real terms) relative to population growth. Other sources of finance for health services are presently under discussion in policy making. Also being considered are the restructuring and re-engineering of the health system, geared towards reduction in duplication of government services, as it could be argued that there is potential for saving within the health sector which could be used to finance more services for the poor.

In summary, while there is a need to extend health services to the poor and the formerly disadvantaged groups, this will have to be undertaken in an environment of tight financial constraint. There will be a need to re-engineer the planning and management of health care technologies in the public health system, which is unlikely to see more funding for new high-cost curative technologies. Maintenance of the present equipment installations will therefore be of critical importance in the delivery of health care services.

6.8 CONCLUSION

Health Care Services

The evidence available shows that the burden of excess suffering and premature death in South Africa could be substantially diminished at a relatively low cost. Measures to improve living conditions, increase the scope and coverage by preventive programmes and provide access to basic medical services could greatly reduce the high levels of infant, child and maternal mortality and of morbidity due to preventable diseases. The most efficient and cost-effective method for decreasing the burden of excessive sickness and premature death in South Africa is to provide access to effective preventive programmes and basic curative care to everyone who needs it.

The main objectives of the public health sector over the next few years should be to improve the levels of public health by ensuring that everyone has access to at least a reasonable package of preventive programmes and essential curative services, which include both ambulatory and in-patient care. There is an urgent need to provide functional primary health care services in under-resourced areas (mainly those areas inhabited by black people).

Health Care Technology

As regards the use of health care technologies in the public sector, the objective of the government should be to achieve a greater balance between hospital-based curative care on the one hand, and community-based preventive technologies on the other. These two groups of technologies are not mutually exclusive. They both play important roles in a sustainable health care system. Hospital services will stay in high demand even after the establishment of a primary health care service which functions well and covers the entire country

[McIntyre *et al.* 1995]. Evidence available shows that wider coverage and better screening at primary level reveal more pathology requiring further investigations in a hospital setting. In absolute figures the annual numbers of hospitals admissions and consultations will for all practical purposes rise *pari passu* with the growth of the population.

Although, allocation of scarce health resources remains a fundamental problem in South Africa, it is important that investments in curative and preventive technologies be strategically balanced to enhance the free flow of patients through the primary-secondary-tertiary health care referral chain. The South African health care system needs both curative and preventive technologies. The proportionality of investments in these groups of technologies should depend on health policy goals, characteristics of national disease burden and health resources available.

Evidence collected during field visits to various hospitals in South Africa shows that the problems with investments in HCT are mainly related to technology planning, management and assessment. There are high efficiency losses in the use of expensive health care equipment in the public sector due to inadequate maintenance. Appropriate equipment procurement, together with planning and maintenance management could assist in reducing waste in technological investments in the public sector.

The challenge to the government is to develop a national policy framework for selection, procurement and management of health care technologies that meets the broad range of health care services, covering primary, secondary and tertiary heath care. Strategic integration of technology into the health system and services may be the only option for the achievement of better health and economic development in South Africa. Better health directly contributes to socio-economic development.

Health care financing

One fact that stands out in the South African society of today, is that the historical economic disparity during the apartheid era has given birth to social disparity in the present era. It is therefore inevitable that South African wealth will have to be divided more equitably so that the gap between rich and poor can be narrowed. How this will be achieved is not clear yet; whether it will require direct government intervention, result from the free play of market forces or be attained by some intermediate strategy has yet to be seen.

Among the most serious problems facing South Africa today are the deteriorating well-being of the majority of the African population, increasing dissatisfaction with health services, and the threat that these factors pose to social, political, economic and moral stability. Despite political and development problems, there are generally high hopes for the country. However, the cost of political and social transition is likely to be high, unless critical issues such as the equitable distribution of health services and related technology are addressed as a matter of urgency.

CHAPTER 7

CONCEPTUAL FRAMEWORK AND METHODOLOGY

In Chapter 7 the conceptual framework for the development of structural models and methods for studying the planning, deployment, use and management of health technology is presented. This chapter also provides insights into linkages between technology and other health care factors.

One thing I have learned in a long life: that all our science measured against reality, is primitive and childlike – and it is the most precious thing we have.

Albert Einstein

Albert Einstein by Banesh Hoffman, 1977

7.1 PERSPECTIVE

Strategic planning of utilisation of technology in health care services, institutions and facilities is one of the most difficult challenges facing health policymakers and planners in Kenya and South Africa. Other sectors of societal endeavour also raise problems, but measurement of the factors involved and the forecasting of future needs can usually be based on more precise surveys and can use mathematical analysis to a much greater extent than has been possible for health care. For example, in the field of education the requirements for classrooms and teachers can be deduced from established standards on optimum numbers of pupils per learning unit, and from demographic analyses of the population [Kohn and White 1976].

The health sector is far from being as homogeneous, predictable and amenable to measurement as other service sectors [Bridgman 1976]. However, as far as health services in developing countries are concerned, it is recognised that two large groups of technologies must be considered: technology for primary health care services and hospital-based technologies for curative services [Attinger and Panerai 1988]. In addition, the concept of integrating secondary preventive and curative medicine technologies, advocated by the World Health Organisation (WHO) for over two decades, still remains to be implemented on a wider scale in African countries.

The need for effective health technology planning and deployment for health care systems in African countries has been voiced by the World Bank and the World Health Organisation. [WHO 1987, Issakov *et al.* 1990, World Bank 1995a], but no major study has been undertaken.

7.2 CHARACTERISTICS OF HEALTH CARE SYSTEMS

Common features of the health service systems in different national settings can be identified [Bice and White 1971]. The health care systems in both Kenya and South Africa draw upon a common body of medical knowledge and skills founded upon scientific principles and conceptions of disease, sharing in a common scientific literature and developed by common scientific methods. International agencies such as the World Health Organisation (WHO) and the International Labour Office (ILO) through its Social Security Branch, have facilitated the establishment of an international medical community, with shared scientific standards and classifications as well as educational, research and service programmes [Kohn and White 1976, The President's Science Advisory Committee 1972]. The development of international congresses, international professional societies, and collaborative research programmes, as well as migration of professional staff, have furthered this trend, as have massive research and marketing activities of multinational pharmaceutical and health care equipment companies.

In addition, in each system the major responsibility for providing and supervising clinical care has been delegated to physicians who, though licensed within specific systems, have usually attained at licensure rather similar levels of knowledge and skills. There is also fairly general agreement as to the importance of an adequate supply of doctors and facilities and, at least in theory, of maintaining the population's right of access to health care in both Kenya and South Africa.

It is noteworthy that each country has set up educational and training arrangements to ensure the regular provision of doctors and ancillary support personnel, and construction programmes to maintain appropriate supplies of specialised facilities such as hospitals and health clinics. Although each country varies in the degree of control over supply and distribution of medical specialists, both spend considerable public funds on education and training activities, even if the doctors and other health care professionals may ultimately end up practising in the private sector.

Beyond these similarities, each country has a unique health system. There are differences in organisation, in deployment of personnel, in the breadth of services provided, in resource controls, in financial support, and in the use of health care technologies.

This study examines the relationships between the many variables in the two health care systems, and in the two sets of needs and uses of technology. In so doing the author hopes to clarify the effects of varying resource allocations and organisational arrangements, which have been designed to bring perceived health needs into a reasonable equilibrium with technological support.

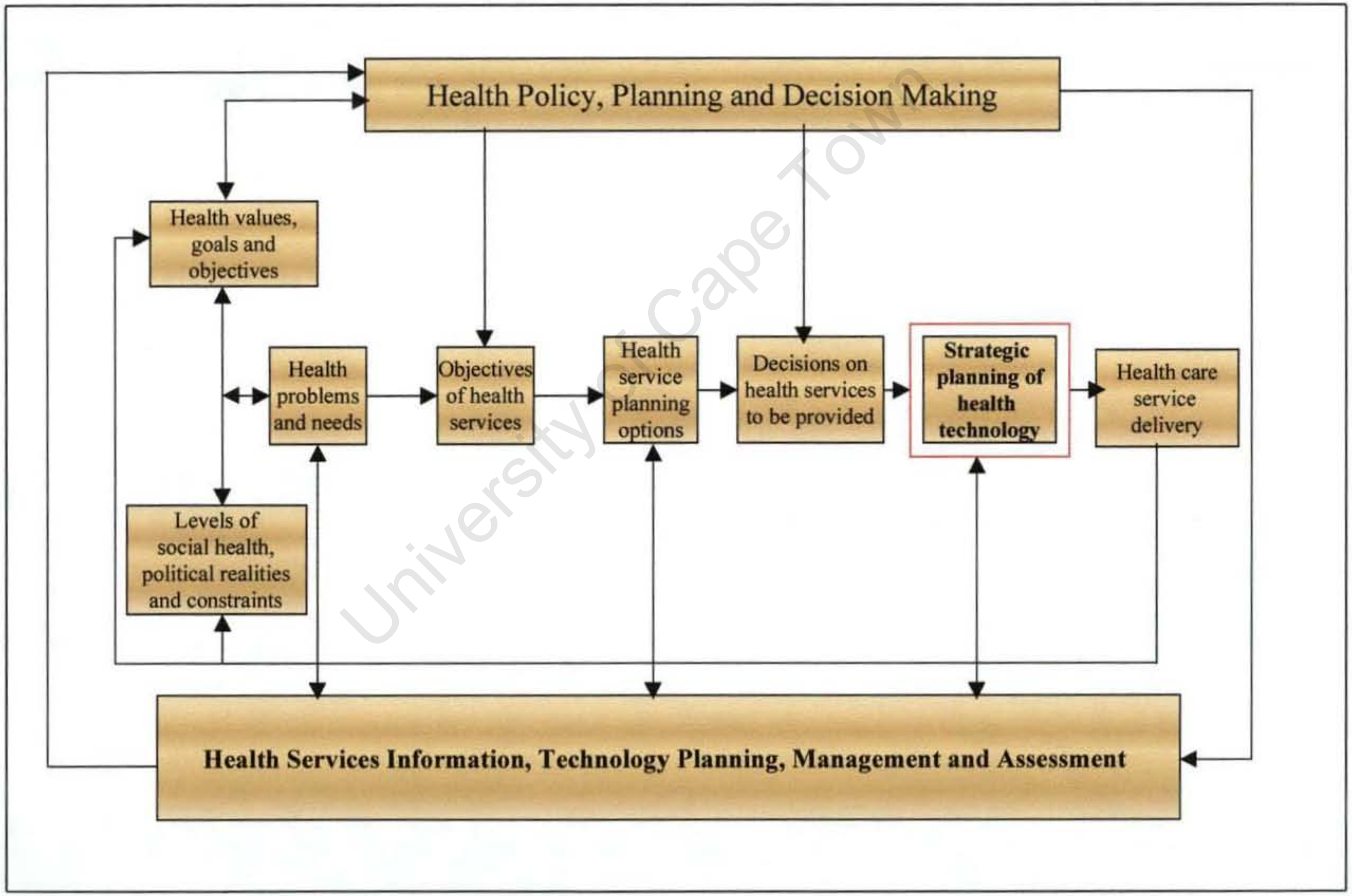
7.3 THE SYSTEM CONCEPT OF HEALTH SERVICES

In the past, resources devoted to health care have not always been viewed as constituting systems either formally or informally. However, all countries stand to gain from systematic planning of HT by clearly defining objectives, generating the necessary assessment information, and enhancing public accountability [Kohn and White 1976, Green 1992]. In recent years, 'responsible' professionals and health care service managers in many African countries have began to acknowledge the necessity for rational use and strategic planning of health care technologies in health care facilities [Kwankam 1992, Kachieng'a 1998a, Kachieng'a and Boonzaier 1999], in view of the growing complexity of technology and rising cost of services.

In their search for health care, there are complex relationships between the policy decision-makers at the political and administrative levels; the central regulatory mechanisms at the macro level; the regulators at the micro level; the providers of services; and the individual decision-maker. The health care system policy dynamics can be represented as shown in Figure 7.1. The model provides the conceptual flow chart of policy information and decisions for management of health care system and services.

Figure 7. 1:

Integrated health system policy dynamics: policy information flow and technology planning and management



In the model, the health care system is considered to be a cybernetic, homeostatic and adaptive mechanism that holds both internal and external stimuli in a state of equilibrium while remaining dynamic. To the extent that such a process involves an information system - one that requires monitoring and feedback mechanisms, and is guided by assessment data from individual decision makers and populations to guide overall decisions at the micro level of the health care system - it may be represented as a self-regulating model, designed to achieve dynamic equilibrium of health care needs, demands and technology resource use.

7.4 THE LOGISTICAL MODEL FOR STRATEGIC PLANNING, DEPLOYMENT, DEVELOPMENT AND MANAGEMENT OF HEALTH TECHNOLOGY

Health technology contributes to the prevention of diseases by protecting against or reducing the risk of occurrences as well as limiting their impact. It helps clinicians to screen abnormalities and the risks associated with these, and it contributes to the diagnosis of clinical signs for the purpose of identifying the nature, cause and extent of the pathological event [King 1987]. It contributes to treatment by restoring, improving, and replacing bodily function as well as preventing further deterioration or pain. It contributes to rehabilitation by restoring, replacing, improving, or maintaining physical or mental function impairment [David and Judd 1993, Bronzino 1995].

From a medical point of view, technology is expected to reduce the risk of disease, shorten illness duration, improve the quality of care and increase access to it, and restore or limit the decay of a person's function. Technology is also expected to contain cost and improve intervention risk management [David and Judd 1993, Goodman 1993], by improving service efficiency and productivity of health care professionals.

The reasons for acquiring technology, according to David and Judd [1993], are in order to:

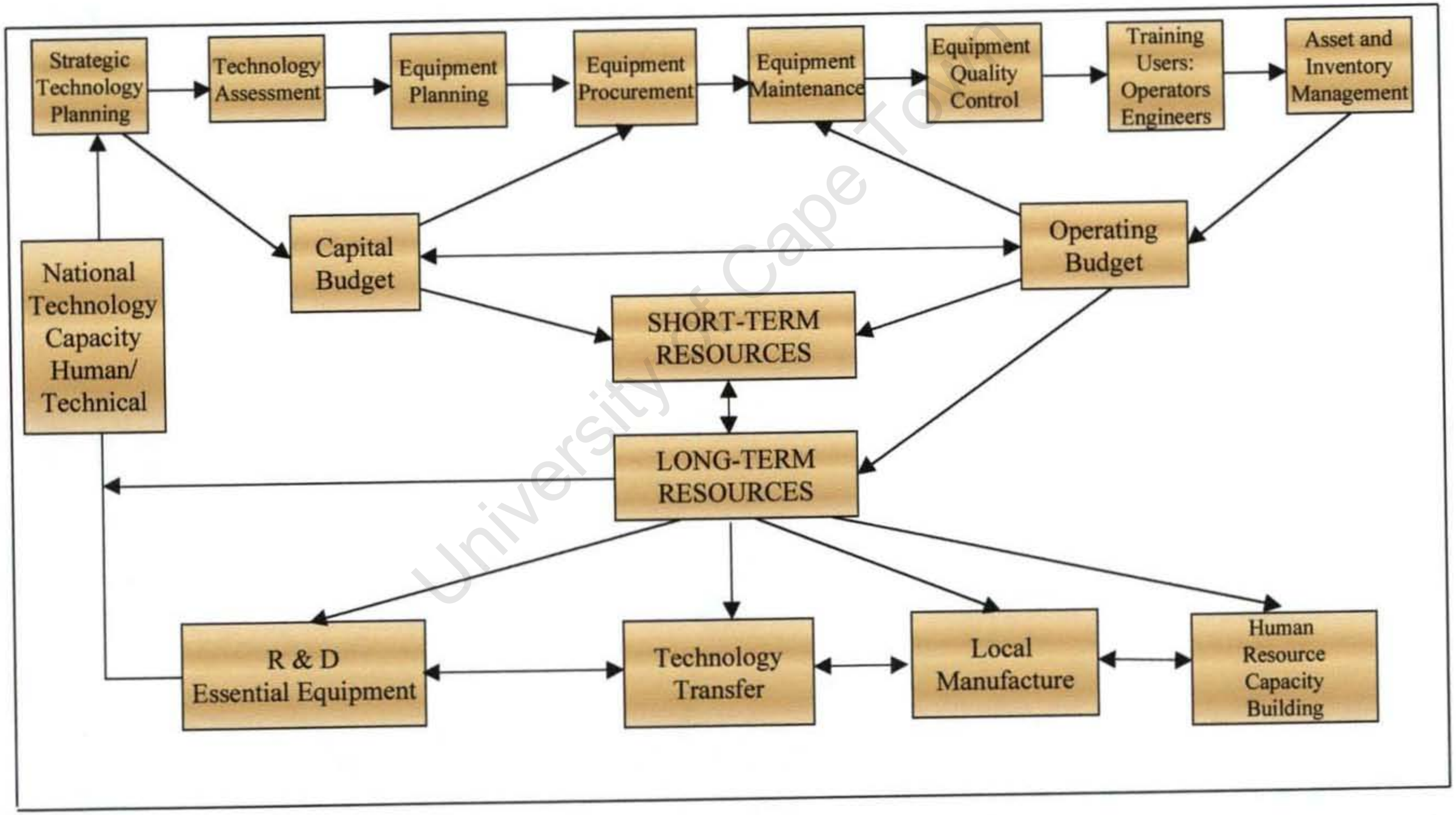
- Provide needed health services in the community;
- Improve diagnostic and therapeutic efficiency;
- Increase the hospital's cost-effectiveness;
- Reduce risk exposure; and
- Reduce patient in-days and increase throughput [Kachieng'a et al. 1999].

Technology, when appropriately selected and effectively utilised, plays a major role in supporting the hospital's strategic plan [Dyro 1993, Bronzino 1995, Kachieng'a 1998a]. Management techniques that can increase service throughput and optimise the use of existing assets are routinely sought. Strategies that increase reliability and minimise equipment downtime have been demonstrated substantially to affect any health care organisation's bottom line [Hasper 1991, Dyro 1993, Hughes 1993].

As health care technology continues to evolve, so does its impact on patient outcome, hospital operations, and financial resources. The ability to manage this evolution and its subsequent implications at macro and micro levels has become a major challenge for policy makers and health care managers in both public and private sectors.

Successful management of HT will ensure a good match between staff and technology. It is therefore essential that technology planning, assessment and management programmes become an integral part of health system planning both at macro level, and in hospitals' operations planning, at facility level. Figure 7.2 shows a simplified logistic model for strategic technology planning, deployment, use and management, and including local manufacture of health care equipment. The logistic model forms the framework for technology analysis in this study.

Figure 7.2:
A logistic model for health technology planning, deployment, development and management



7.5 FIELD WORK METHODOLOGY

7.5.1 SPECIAL FIELD WORK APPROACH

The cross-national comparative study of health care technology needs, covering 84 hospitals and representing a population of over 70 million persons in Kenya and South Africa, poses methodological problems requiring special strategies. Standardisation and uniform application of measurement and analysis techniques and procedures are required to ensure comparability of results; in addition, indicators should be at least conceptually equivalent if not semantically identical. Apart from these criteria, the methods employed are similar to those customarily used in national studies.

The methods had to yield comparable data that could be interpreted within the conceptual framework described earlier. This required extensive guidelines for specifications of population and sampling, interviewing and supervision of fieldwork, and data processing and analysis. The following section describes these methods and their rationale.

7.5.2 METHODOLOGICAL ASPECTS OF CROSS-NATIONAL SURVEY

Galtung [1967] views the variations of a dependent variable measured in comparative research as a function of several variables, one of which is research methods; i.e.

$$D = f(I, N, I^*, R)$$

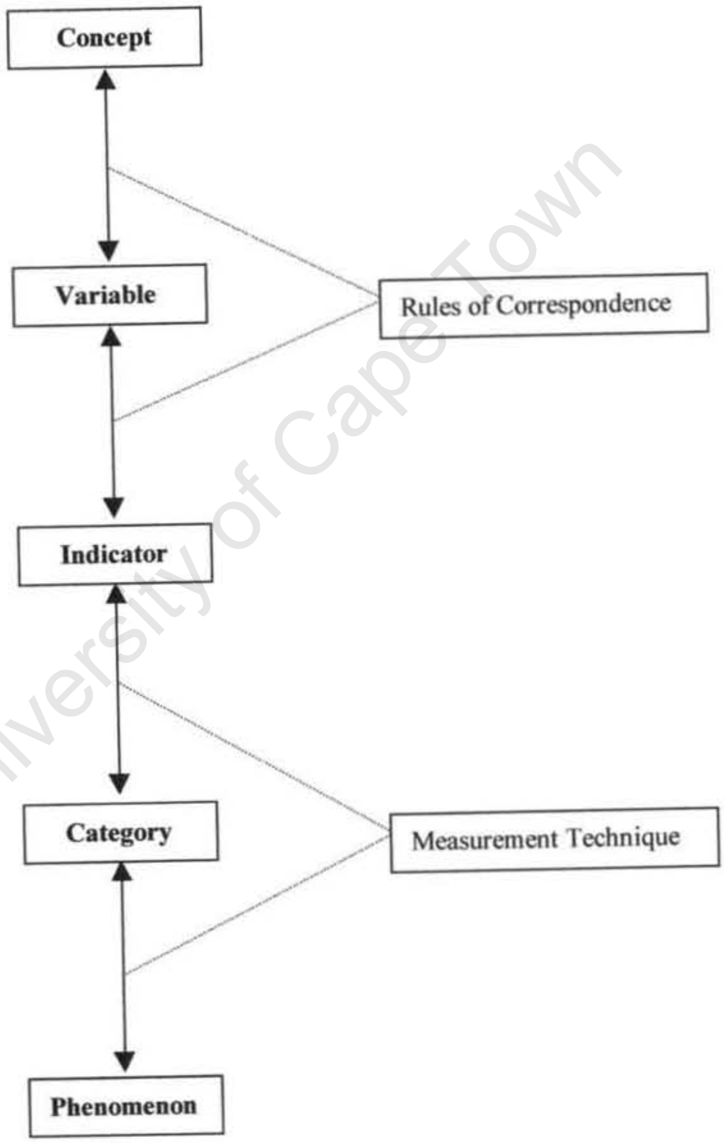
where D is the dependent variable; I a set of independent variables; N nationality; I^* a set of residual independent methods and R a set of variables introduced by research methods. Efforts were made to design and employ methods that would diminish the effects of R on D. On the premise that a difference that makes no difference is no difference at all

[Poincare 1929], variations in the technical aspects of conducting the study in each country were permitted only when the differences were considered unimportant in their effects on the results.

In the study, measurement was viewed in its broadest sense of defining the boundaries of systems to be studied, and the 'assignment of numerals to objects or events according to rules' [Stevens 1951]. The process typically involves specifying a concept, translating it into an operational definition which points to a variable that can be measured, and applying the operationally defined measurement technique to units of its indicators and related categories. Figure 7.3 presents the links in the measurement process.

Figure 7.3:

Links in the Measurement Process



Source: Adapted from Stevens [1951].

Neither the concepts of this research nor the models, which interrelate to them, pretend to a high level of abstraction. Nevertheless, all empirical research involves at least some abstraction from the diversity and fluidity of the 'real' world [Kohn and White 1976].

Identical indicators were used in both Kenya and South Africa. This was possible because the concepts and variables used in the survey were not highly abstract, and it was reasonable to assume that the manifest meanings of most variables were conceptually equivalent in the study areas. The functional roles of doctors, nurses, clinical engineers and technicians, and several other categories of health care personnel were assumed to be sufficiently similar to justify employing identical indicators of their use. Therefore, the conceptual meanings of such variables as hospital size and, equipment maintenance budgets, were assumed to be the same in all study areas. Special attention was paid, however, to the use of definitions applicable in all study areas, and to uniform survey methods.

The taxonomy of the research requires that the same variables, indicators and categorisations are used to facilitate comparative analysis. All population-based research involves comparisons, usually of sub-populations within a single population. However, in this study comparison is an explicit objective, complicated by heterogeneity among populations as well as by many other sources of diversity. To optimise results, close consultations with field assistants were maintained throughout the fieldwork, in both the countries under study, to ensure comparability, while data processing and analysis were centralised. Where data were suspect, telephonic and/ or face to interview were arranged to establish their authenticity.

The results of the survey are presented and discussed in chapters 8 – 11.

CHAPTER 8

A CROSS-NATIONAL HEALTH TECHNOLOGY (HT) NEEDS SURVEY IN KENYA AND SOUTH AFRICA

Chapter 8 deals with a cross-national survey of health care technology needs in Kenya and South Africa. The survey methodology and how it was conducted is explained before the findings of the survey on various crucial aspects of health care technology are presented.

Comparative studies release us from boundaries of our habits of thought, and show us the wide gamut of patterns possible in human interaction.

Ruth Benedict
Patterns of Culture, 1935

In the ongoing health service reforms, the use of technology occupies, and will continue to occupy, an important role in the overall strategy. The health services of both Kenya and South African health are facing challenges in providing services that meet the needs of their people. This movement towards equity in health care provision, given the current climate of limited resources in both countries, must be underpinned by careful analysis of the existing use of HT, and as such calls for strong support from a technology assessment programme which identifies HT that provides maximum effect at minimum cost.

The survey that is the subject of this chapter was undertaken with the aim of gaining insight into the utilisation of technology in African health care systems with a view to addressing the problems and the constraints.

8.1 WHY A HEALTH TECHNOLOGY NEEDS SURVEY?

The present study has recognised the enormous difficulty of any attempt to describe and measure major problems with technology in such complex entities as the health services systems. Nevertheless, it is the author's view that a health care technology needs survey in African health systems has merit and, if the urgent needs for affordable, accessible and cost-effective health care services are to be met, a start is warranted.

A cross-national HT needs survey will provide an opportunity of achieving new insights into the utilisation of technology in health care, with the general objective of improving health service delivery. The value of the HT survey will be demonstrated to the extent that generic characteristics of technological problems in health care can be identified, general principles and concepts can be formulated, and comparative methods can be developed. The aim is to apply these methods in solving technology-related problems at facility, local, national and regional levels.

Health technology problems can be viewed from the vantage point of the World Health Organization (WHO). As information on cost-effective HT planning, deployment, use and management methods are collected from a wide variety of places and countries, it should be possible for the World Health Organisation to accelerate understanding of effective delivery of medical and health services as well as technologies required to support those services. A further objective of this survey, therefore, is to contribute to such international understanding of the issues involved in health care in developing countries.

Global experience also indicates that, health research programmes, including technology assessment, which operate across large geographic regions (cross-national), tend to have great impact on health status of the population. For example, the control of onchocerciassis in West Africa opened up the vast new areas to agricultural development, leading to poverty reduction and better health. Similarly, the control of malaria in east and central Africa has contributed significantly to food production and better nutrition in the region [WHO 1997a].

8.2 THE AFRICAN PERSPECTIVE

Planning for technology in health care services and facilities is one of the most difficult challenges facing most African countries. The health sector is complex and not amenable to direct measurements as are other service sectors. To this end, two groups of activities must be considered [Kohn and White 1976, Green 1992]. On one hand, technology planning for primary health care depends on available statistics giving both the prevalence of many acute diseases and health problems, together with available resources in terms of money, personnel, transportation and facilities.

On the other hand, technology planning for secondary and tertiary health services which encompasses secondary prevention, curative medicine and rehabilitation, requires quite different and more complex assessment methods. In addition, the concept of integrating primary health care and curative medicine still remains to be implemented on any wide scale in Kenya and South Africa, although it has been advocated by the World Health Organisation (WHO) for over two decades.

The experience accumulated from technology studies in developed countries allows a critical evaluation of the progress which has been achieved, and the potential benefits and difficulties which can be expected if similar studies are performed in African countries.

Most studies of HT in industrialised countries, however, are technology-oriented, not problem-oriented [Banta 1986, Attinger and Paneria 1988, Coe and Banta 1992, Serpa-Floreze 1993]. These technology-oriented studies focus on individual technology or equipment, which is selected on the basis of cost, safety, or social impact. HT studies in developing countries, on the other hand, demand a much broader perspective, because there are far fewer appropriate and essential technologies (or equipment) among the bewildering array of alternatives, which can be afforded and used by these countries [Attinger and Paneria 1988, Kachienga and Boonzaier 1999]. These studies should focus on appropriateness and seek to enhance overall service efficiency, rather than the cost-effectiveness of any individual piece of equipment or technological procedure [Attinger and Paneria 1988, Perry and Chu 1992, Kachieng'a *et al.* 1999]. One area of HTA studies for African countries should be technologies for primary health care.

Given the impossibility of transferring results of technology assessment studies from industrialised countries to developing countries, and the small emphasis that problem-oriented studies have received in developed countries [Banta 1986, Attinger *and* Paneria 1988, Serpa-Florez 1993, Kachieng'a *et.al.* 1999], African countries are faced with the formidable task of developing the methodology for technology study that best suits their needs and capabilities. This study aims at contributing to this challenging endeavour.

are far fewer appropriate and essential technologies (or equipment) among the bewildering array of alternatives, which can be afforded and used by these countries [Attinger and Paneria 1988, Kachienga and Boonzaier 1999]. These studies should focus on appropriateness and seek to enhance overall service efficiency, rather than the cost-effectiveness of any individual piece of equipment or technological procedure [Attinger and Paneria 1988, Perry and Chu 1992, Kachieng'a *et al.* 1999]. One area of HTA studies for African countries should be technologies for primary health care.

Given the impossibility of transferring results of technology assessment studies from industrialised countries to developing countries, and the small emphasis that problem-oriented studies have received in developed countries [Banta 1986, Attinger *and* Paneria 1988, Serpa-Florez 1993, Kachieng'a *et.al.* 1999], African countries are faced with the formidable task of developing the methodology for technology study that best suits their needs and capabilities. This study aims at contributing to this challenging endeavour.

8.3 STUDY AREAS: KENYA AND SOUTH AFRICA

The constraints imposed by the overall design of the cross-national HT and concern for the feasibility of fieldwork led to a careful selection of study areas. In order to compare and contrast problems of technology utilisation in African health systems, it is desirable to maximise opportunities for observing and comparing the phenomena that characterise them. This is particularly difficult when little is known about the problems in the processes of acquisition and utilisation of technology in African health care systems.

The best opportunities for useful investigations would demand health care systems (study areas) that permit comparison within and between similar and different technology acquisition and utilisation processes. However, because of the importance of economic development and scientific progress, it would be desirable to select health care systems in which these characteristics are not grossly different.

Although Kenya and South Africa vary considerably in their stages of socio-economic development, their health sectors are both characterised by mortality rates which are consistently worse than those usually observed in other countries of similar economic development. These observations also hold true for other classical indicators (life expectancy, infant mortality), and the incidence of infectious and parasitic diseases and HIV/AIDS, which are the major causes of death in the two countries.

One major influence in selecting the study areas was the willingness of the two governments to co-operate and provide logistical support to the survey. Attempts to include the governments of Zimbabwe, Mozambique, Malawi, Uganda and Tanzania were not fruitful.

Although these governments expressed interest in the study, they could not offer logistical or financial support. In Kenya and South Africa it was possible to use state systems for the distribution of the questionnaires and for the collection of returns. This not only helped to enhance the importance of the research, but also to facilitate maximum co-operation from health facility managers. The two governments also provided free access to health facilities and made available essential and confidential health statistics, documents and reports.

Kenya has a functional primary health care service while South Africa does not, but South Africa has a stable secondary and tertiary health service. The distribution of health services in Kenya and South Africa is not uniform, being biased towards urban areas. This non-uniform development characteristic of health system is common to most Sub-Saharan countries (see the Prologue). Therefore, although South Africa and Kenya have better life expectancy averages and human development indices, the some outcome of this study may almost certainly be applied, with appropriate modifications, to other countries in the region, such as Zimbabwe, Mozambique, Malawi and Tanzania (see Table 1.1 in Chapter 1).

8.4 RATIONALE OF THE SURVEY

The aim of the survey was to investigate technology needs for the health care systems in both countries and develop recommendations for health care technology policy design. The survey considers three substantive questions:

1. How is HT introduced into health care systems in Kenya and South Africa?
2. Which methods are predominantly used in technology (equipment) selection, procurement, maintenance and management?
3. What are the main problems and constraints in utilisation of technology in public hospitals?

The survey addresses health service managers, technology assessors, planners and policy makers, and both biomedical and clinical engineers, as well as non-government organisations (NGOs) and international donor organisations promoting and supporting health projects in Africa.

8.4.1 SURVEY INSTRUMENTS

- Questionnaires
- Telephonic interviews
- Field visits and interactive interviews

8.4.2 ORGANISATIONAL SETTING

The organisational setting included a number of factors, such as hospital type (small, medium and large); whether a clinical engineering department (equipment maintenance department) existed, level of training and education of clinical engineering personnel, and their participation in equipment selection, procurement, tender adjudication and maintenance management.

8.4.3 HOSPITAL PROFILE

The administrative classification of health facilities in Kenya and South Africa ranges from a teaching hospital to a dispensary. This is supposed to facilitate health care referral systems from lower-level facilities to higher facilities depending on the gravity of the treatment required by the patient. In theory, the administrative classification should reflect the patient- and medical load of the facility, but in reality this is not so. Hospitals are generally grouped in three main categories: teaching/tertiary; provincial; and district. There are also specialised (chronic/mental etc.) and day hospitals. The present classification of hospitals is done on a historical basis and does not reflect medical loads of the facilities.

For this study, hospitals were classified by bed capacity (small, 75-300 beds; medium, 301-600 beds; large, >600 beds). An attempt to classify hospitals administratively, e.g. district, provincial hospital, was discarded because, as mentioned above, such classification failed to reflect the actual patient and work load of the facility, which influences the use of health care equipment. According to Kohn and White [1976] bed capacity is locus of hospital's budget and expenditure. The bed capacity was found to be directly proportional to the use of the hospital's technological assets and services [Frize 1990a, 1990b]. This finding was corroborated by similar studies carried out in Northern America and Europe [Bronzino 1992, Bronzino 1995].

8.4.4 SAMPLE SIZE

The cross-national health technology needs survey was conducted in Kenya and South Africa from September 1996 to September 1997. One hundred and twenty six questionnaires were mailed to hospitals; 78 replies (62 percent returns) were received as follows: Kenya (24 returns) and South Africa (54 returns). No similar cross-national technology needs assessment study has ever been done in the Sub-Saharan region to facilitate partial or full comparative analysis of returns. Literature search showed that most international surveys tend to consider 60% as a good response rate. Search tools used were Medicus Index, Medline and Citation Indices (social and science). The survey statistics are summarised in Tables 8.1 and 8.2 and 8.3, respectively. Some respondents did not answer all the questions and therefore in these cases lower totals are recorded in some of the analyses (see e.g. 8.5.2).

TABLE 8.1:
HEALTH TECHNOLOGY NEEDS SURVEY RESULTS STATISTICS

Country	Hospitals	Returns	% Returns
Kenya	30	24	69
South Africa	96	54	51
Total	**126**	**78**	**62**

TABLE 8.2:

HEALTH TECHNOLOGY NEEDS SURVEY RESULTS BY COUNTRY, PROVINCE AND HOSPITALS

Kenya		South Africa	
Province	**Hospitals**	**Province**	**Hospitals**
Central	4	Eastern Cape	2
Coast	3	Free State	11
Eastern	2	Gauteng	15
Nairobi	3	KwaZulu-Natal	3
Nyanza	4	Mpumalanga	7
Rift Valley	5	North-West	4
Western	3	Western Cape	12
Total	**24**	**Total**	**54**

TABLE 8.3:

HOSPITAL PARTICIPATION BY CATEGORY AND COUNTRY

Hospital Size (Beds)	Kenya	South Africa	Total
75–300	13	25	38
301–600	5	16	21
>600	6	13	19
Total	**24**	**54**	**78**

The results were reviewed in the following major categories:

1. Hospital budget distribution;
2. Methods of equipment selection and procurement;
3. Availability of technical capacity for equipment maintenance and management;
4. Percentage of non-functioning health care equipment;
5. Participation of clinical engineering department in equipment assessment, selection, tender adjudication, installation and commissioning;
6. Equipment documentation;
7. Major health care equipment problems in hospitals;
8. Computer distribution and utilisation;

9. Hospital utilisation indicators;
10. Hospital human resources distribution; and
11. Reasons for leaving the public sector by clinical engineering staff.

8.4.5 DATA ANALYSIS AND PRESENTATION

The questionnaire used in this survey is provided in Appendix B.

The statistical analysis of the survey data is presented in Appendix C. Frequencies of responses to questions with low scores (results) were not analysed.

Appendix C

Contains statistical measures of central tendency and distribution of variables in the following format:

- Country
- Hospital size
- Response
- Mean value
- Standard deviation
- Coefficient of variation
- Frequency of distribution

8.5 RESULTS OF THE SURVEY

8.5.1 HOSPITAL BUDGET DISTRIBUTION

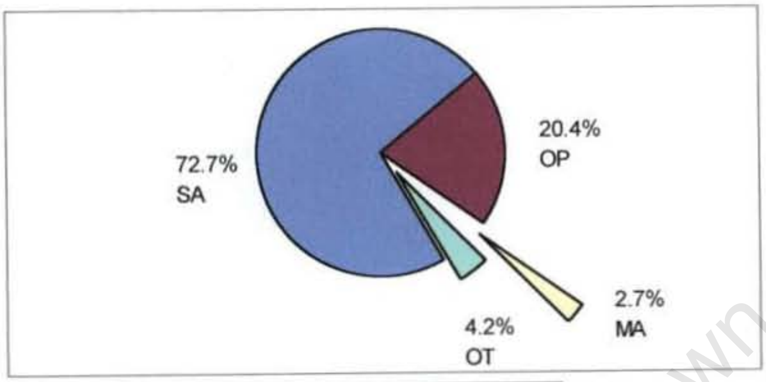
In Kenya and South Africa the hospitals' annual budgets were generally found to increase progressively with increase in the number of hospital beds. However, the budget allocations to hospitals within each hospital category were not uniform. Both the standard deviations and coefficients of variation (percentage) in every category were high, which was an indication that the allocations were not based on bed capacity or a hospital's medical workload. Field interviews revealed that the budgets were based on historical factors, rather than on assessment of expected patient medical workload.

Although the standard deviations of budgetary mean values for each hospital category in both countries were high (indicating non-uniformity of budgetary allocations), South African hospitals registered comparatively lower coefficients of variation (in percentage) in all hospital categories, respectively: small hospitals - 53%, medium hospitals - 61%, and large hospitals - 64%. Kenyan hospitals registered coefficients of variation of 203% for small, 76% for medium, and 162% for large hospitals respectively. This is an indication that at national levels, South Africa has a comparatively more uniform budgetary allocation mechanism than Kenya. This significant difference could be attributed to non-uniformity of case mix of hospitals in both countries.

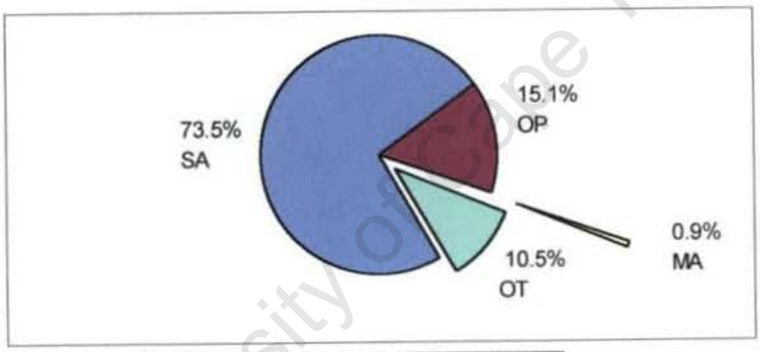
The main characteristics prevalent in all hospital budgets in the study area are that staff salary budgets are consistently high (mean average of 70 %) and equipment maintenance budgets are consistently low (mean average of 3 %). The internationally recommended ratio of health care equipment budget to hospital budget is 10 per cent [World Bank 1993a]. Figures 8.1a, 8.1b and 8.1c provide a summary of hospitals' budget distributions by country and combined.

Analysis of equipment capital budgets showed that these budgets were not the only sources for funding new equipment purchases. Physical checks of equipment purchase receipts in several hospitals showed that the sums spent on purchases were far above the equipment budget allocations. Some pieces of equipment are purchased from donated funds.

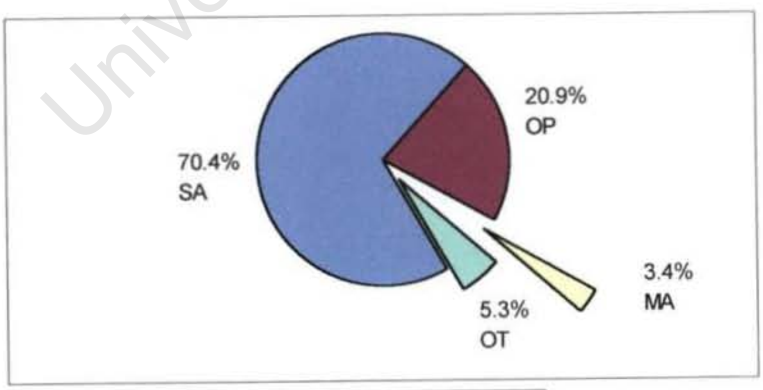
Figure 8.1a:
Facility services budget distribution by hospital size (Kenya)
KENYA



HOSPITAL SIZE (BEDS): 75-300



HOSPITAL SIZE (BEDS): 301-600

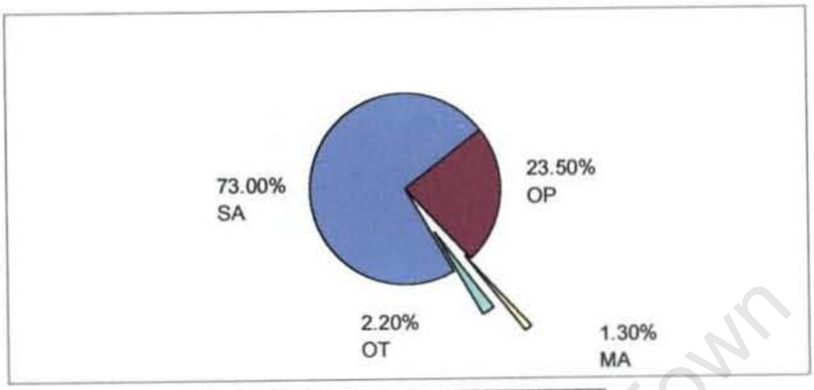


HOSPITAL SIZE (BEDS): >600

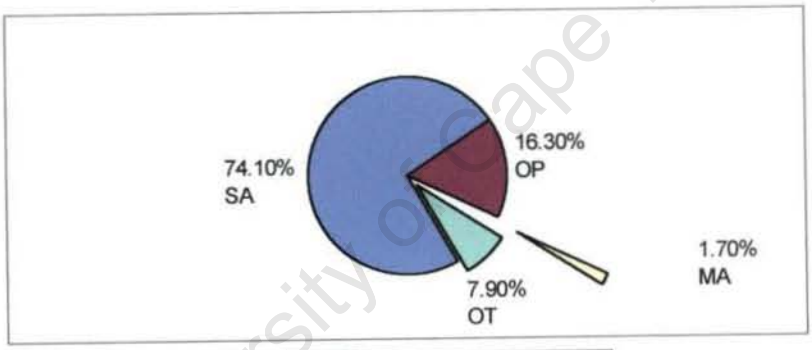
Key:
SA% = Salaries Budget/Facility Budget
OP% = Operational Budget/Facility Budget
MA% = Maintenance Budget/Facility Budget
OT% = Miscellaneous Budget/Facility Budget

Figure 8.1b:
Facility services budget distribution by hospital size (South Africa)

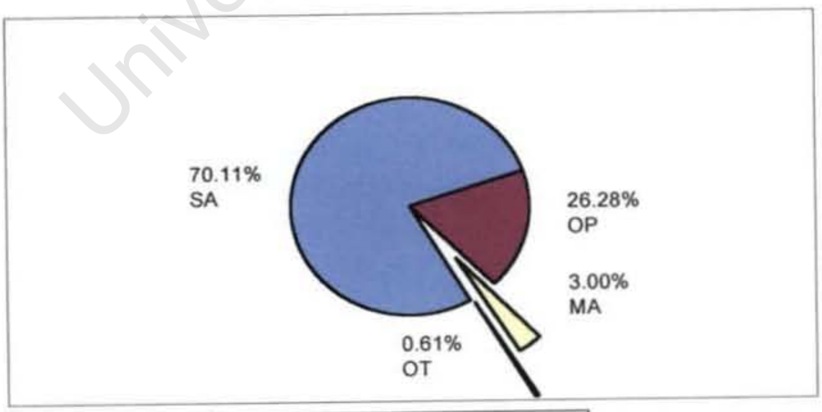
SOUTH AFRICA



HOSPITAL SIZE (BEDS): 75-300



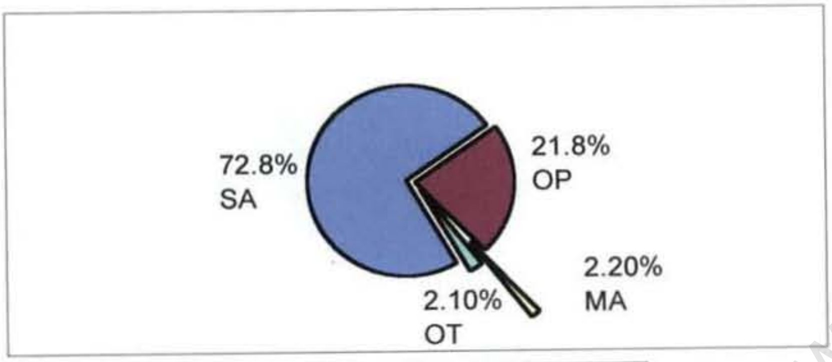
HOSPITAL SIZE (BEDS): 301-600



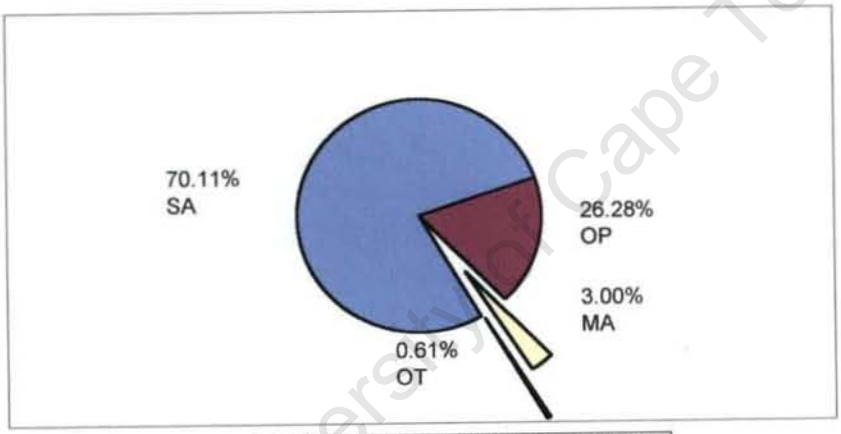
HOSPITAL SIZE (BEDS): >600

Key: SA% = Salary Budget/ Facility Budget
OP% = Operational Budget/ Facility Budget
MA% = Equipment Maintenance Budget/ Facility Budget
OT% = Other Miscellaneous Budget/ Facility

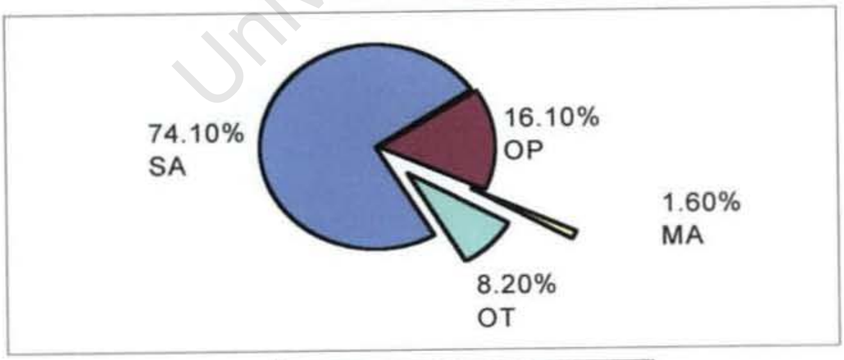
Figure 8.1c:
Facility services budget distribution by hospital size (Kenya & South Africa)
KENYA AND SOUTH AFRICA



HOSPITAL SIZE (BEDS): 75-300



HOSPITAL SIZE (BEDS): 301-600



HOSPITAL SIZE (BEDS): >600

Key: SA% = Salary Budget/ Facility Budget
OP% = Operational Budget/ Facility Budget
MA% = Equipment Maintenance Budget/ Facility Budget
OT% = Other Miscellaneous Budget/ Facility

8.5.2 METHODS OF HEALTH CARE EQUIPMENT SELECTION AND PROCUREMENT

To evaluate methods of equipment selection and procurement, respondents were asked to indicate which methods they regularly used in their hospitals, under three sub-categories:

(a) External technology consultants;

(b) User department + hospital administration + clinical engineering department; and

(c) Hospital equipment committees.

The results of the survey of equipment selection and procurement methods are summarised in Figures 8.2a, 8.2b and 8.2c, respectively. Individual responses for each of the categories and relative frequencies are in Appendix E. Only categories with enough samples are indicated.

External Technology Consultants

The use of external technology consultants is not practised in Kenya, but it is frequently used in South Africa especially in medium hospitals (301-600 beds).

User department + hospital administration + clinical engineering department

This is the most preferred method for equipment procurement in both countries according to the survey results. The equipment user department forwards their request to hospital administration, and the clinical engineering department is requested to write a technical specification for the required equipment. If enough funds are available then equipment procurement is effected. The combined results from Kenya and South Africa indicated that

84% out of 31 respondents from small hospitals, 70% out of 13 respondents from medium hospitals and 92% out of 12 respondents from large hospitals used this method.

The main disadvantage of this method is that it is narrowly focused, that is, it fails to consider "total equipment requirement" of the hospital. It can also lead to infighting between departments for the limited equipment budgets. Thirdly, it can lead to equipment "hoarding". These strong views were expressed by various heads of departments during the field interviews. Sharing is important, not only for, optimal utilisation of equipment, but also for enhancing the functioning of the hospital as a system. One functioning department does not make a hospital.

Equipment committee

Most hospital equipment committees and tender boards (in the study area) are heavily loaded with medical, not technical experts, and therefore lack technology assessment information and skills. However, the equipment committee system of procurement remains the best method amongst the worst alternatives.

Firstly, by considering equipment requirement of the "entire" hospital, the committee can eliminate duplication of purchases by different departments. Secondly, from the hospital management point of view, the equipment committee has fairly broad representation and therefore its decisions are broadly accepted.

Figure 8.2a:
Health care equipment selection and procurement by external technology consultants

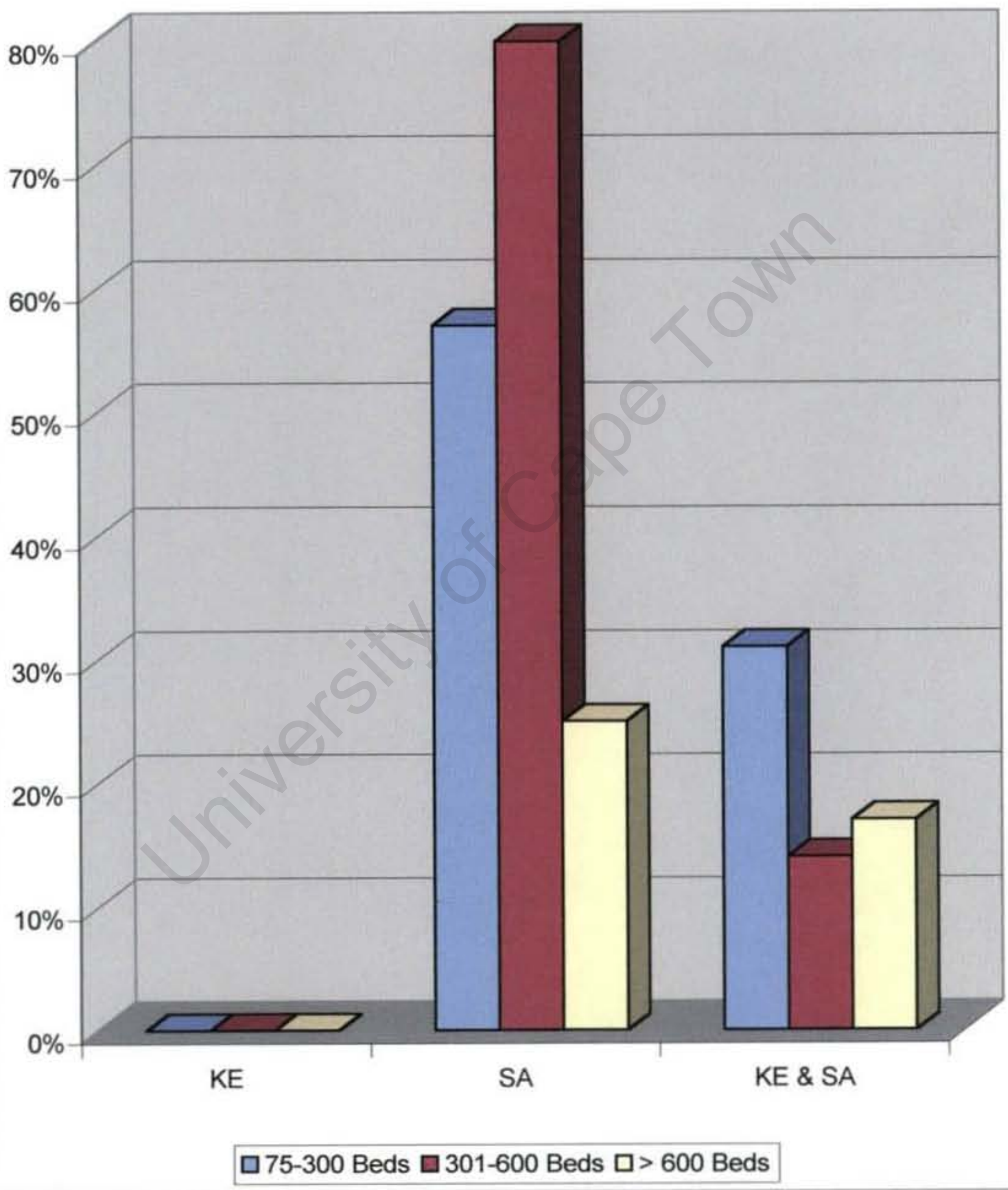
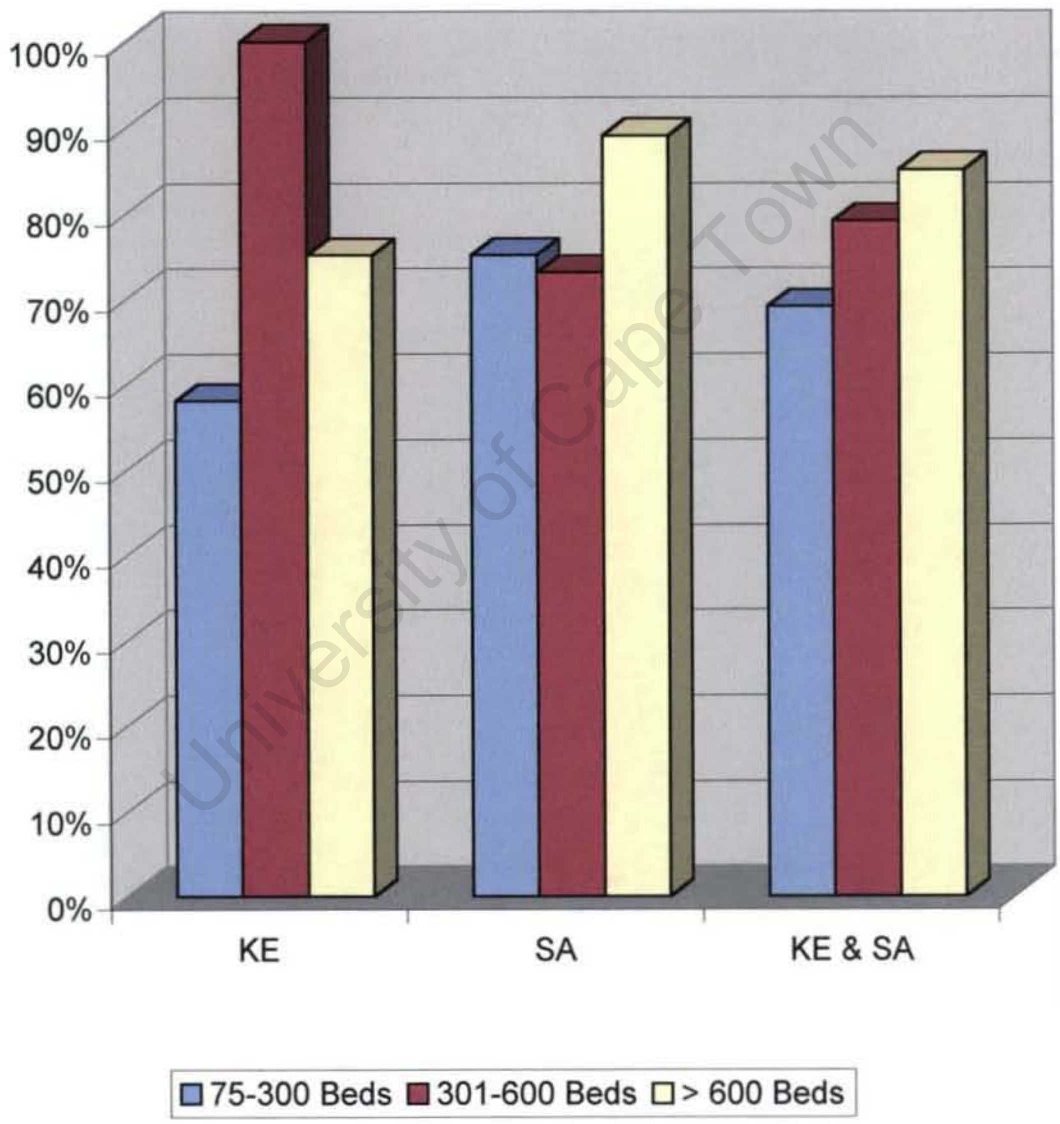


Figure 8.2b:
Health care equipment selection and procurement by equipment committee



8.5.3 AVAILABILITY OF LOCAL TECHNICAL CAPACITY AND EXPERTISE FOR EQUIPMENT MAINTENANCE AND MANAGEMENT

The availability of local technical capacity and expertise for equipment maintenance and management were analyzed under the following sub-categories:

(a) Existence of equipment procurement policy;

(b) Availability of technical expertise for equipment maintenance;

(c) Implementation of annual equipment audit;

(d) Application of quality control methods in equipment maintenance; and

(e) Equipment maintenance workshop organization.

Sub-categories (c), (d) and (e) were aimed at assessment of management capabilities of clinical engineering departments in hospital.

Summarized results are presented in Figures 8.3a, 8.3b, 8.3c, and 8.3d. The survey results on equipment maintenance workshop organisation are presented on Table 8.4. Analysis of responses to questionnaires analysed per sub-category has shown lack of technical and management capacity expertise in most clinical engineering departments surveyed. The individual frequencies of response to the questionnaires for each category are tabled by category in Appendix E

Quality control in equipment maintenance has not taken root in the hospitals studied. The overall result in the study area showed that only 13 % of small, 13 % of medium and 46 % of large hospitals apply basic quality control principles in equipment maintenance. This indicates that some 'unsafe' equipment could be returned to service after maintenance, without quality control, thus endangering the patient's life. Quality control in equipment maintenance is inadequately practised in the study area.

Figure 8.3a:
Existence of health care equipment policy

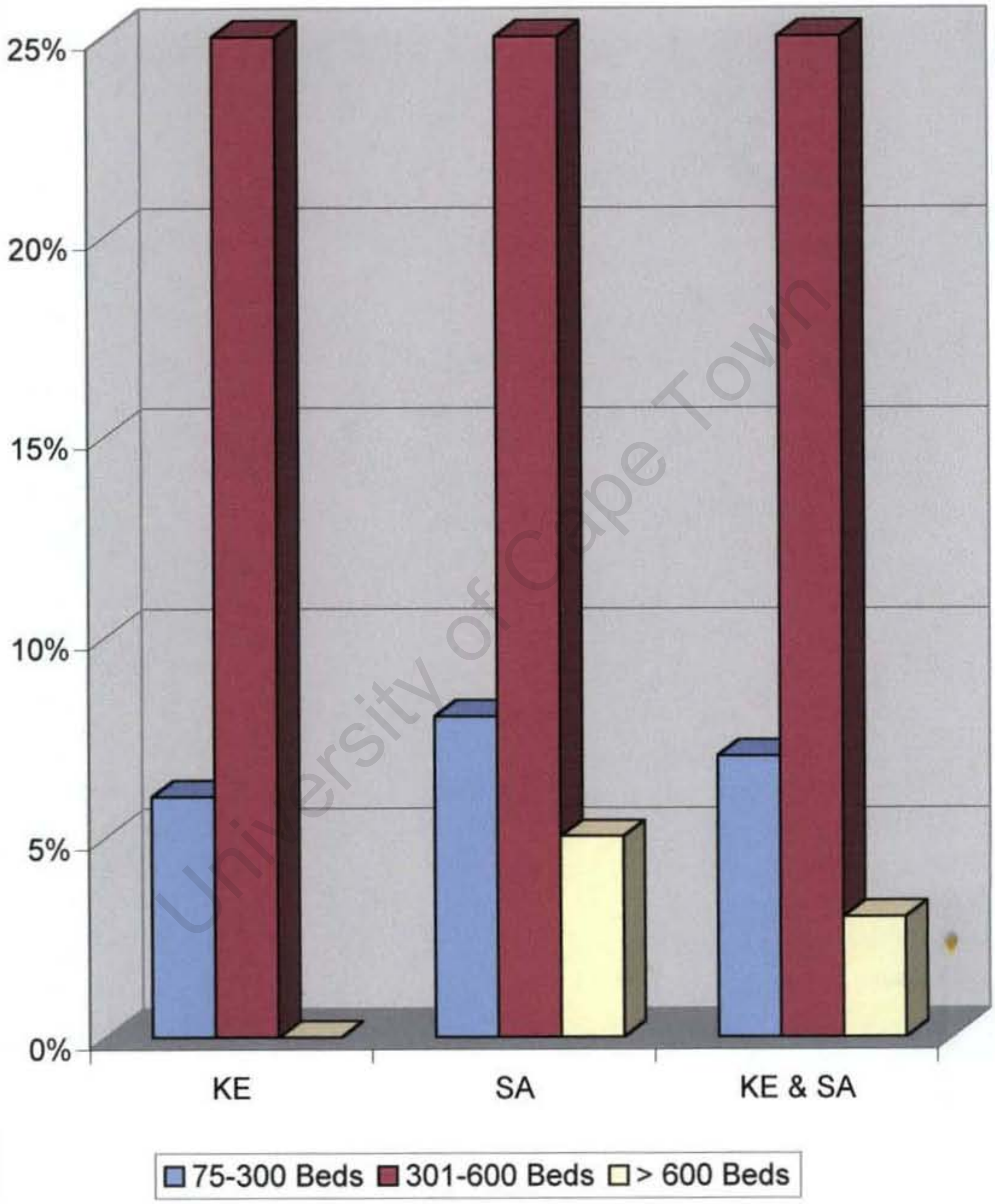


Figure 8.3b:
Availability of technical expertise for health care equipment maintenance

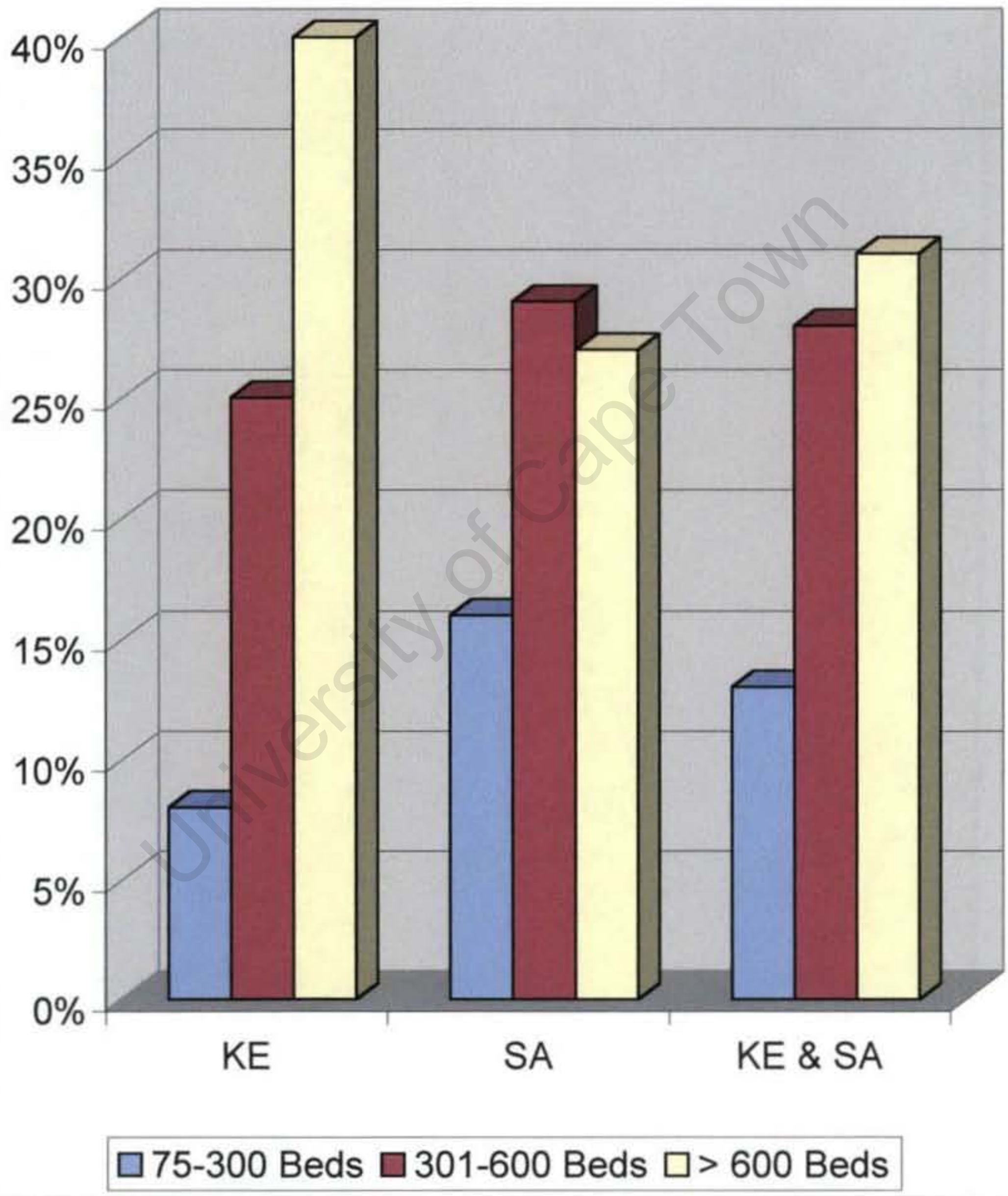


Figure 8.3c:
Equipment inventory management - annual audit

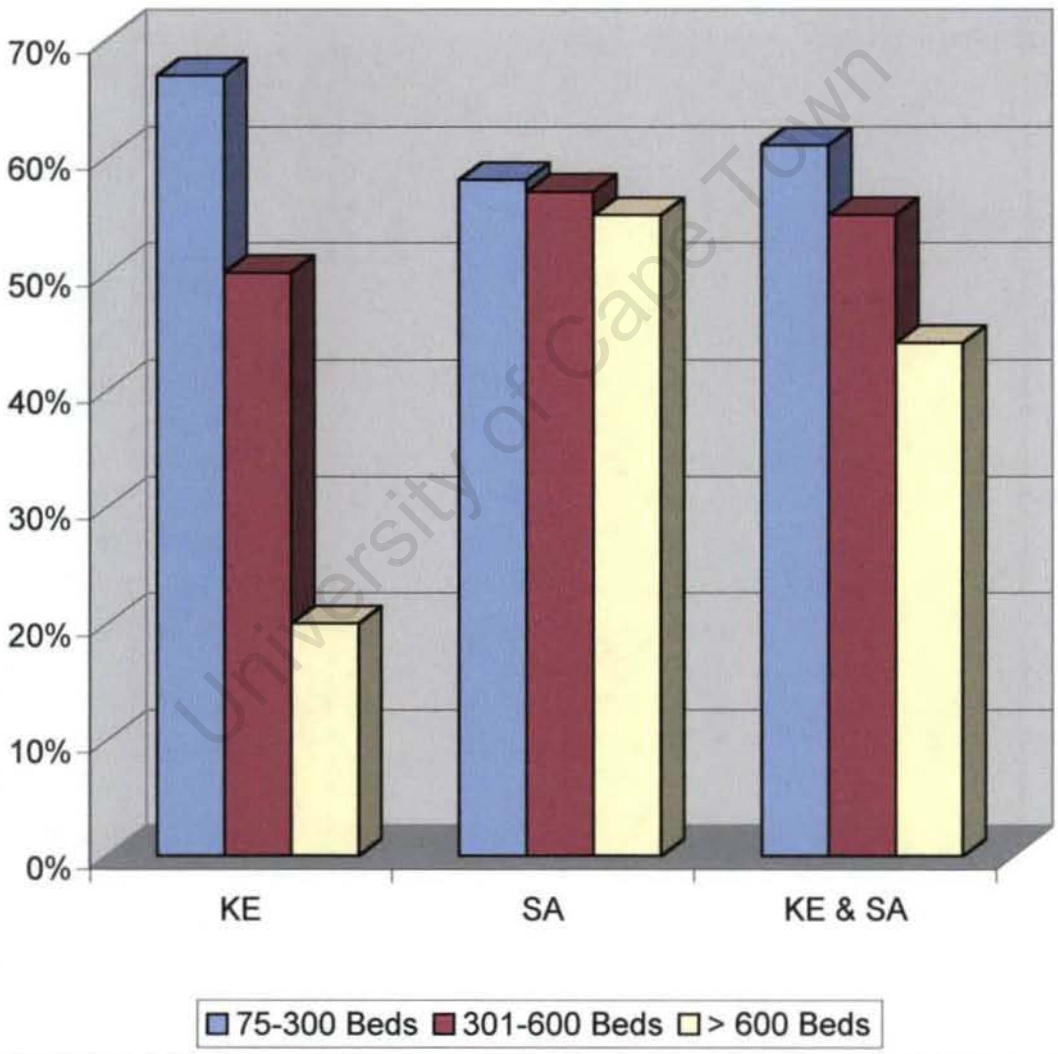


Figure 8.3d:
Application of quality control methods in equipment maintenance

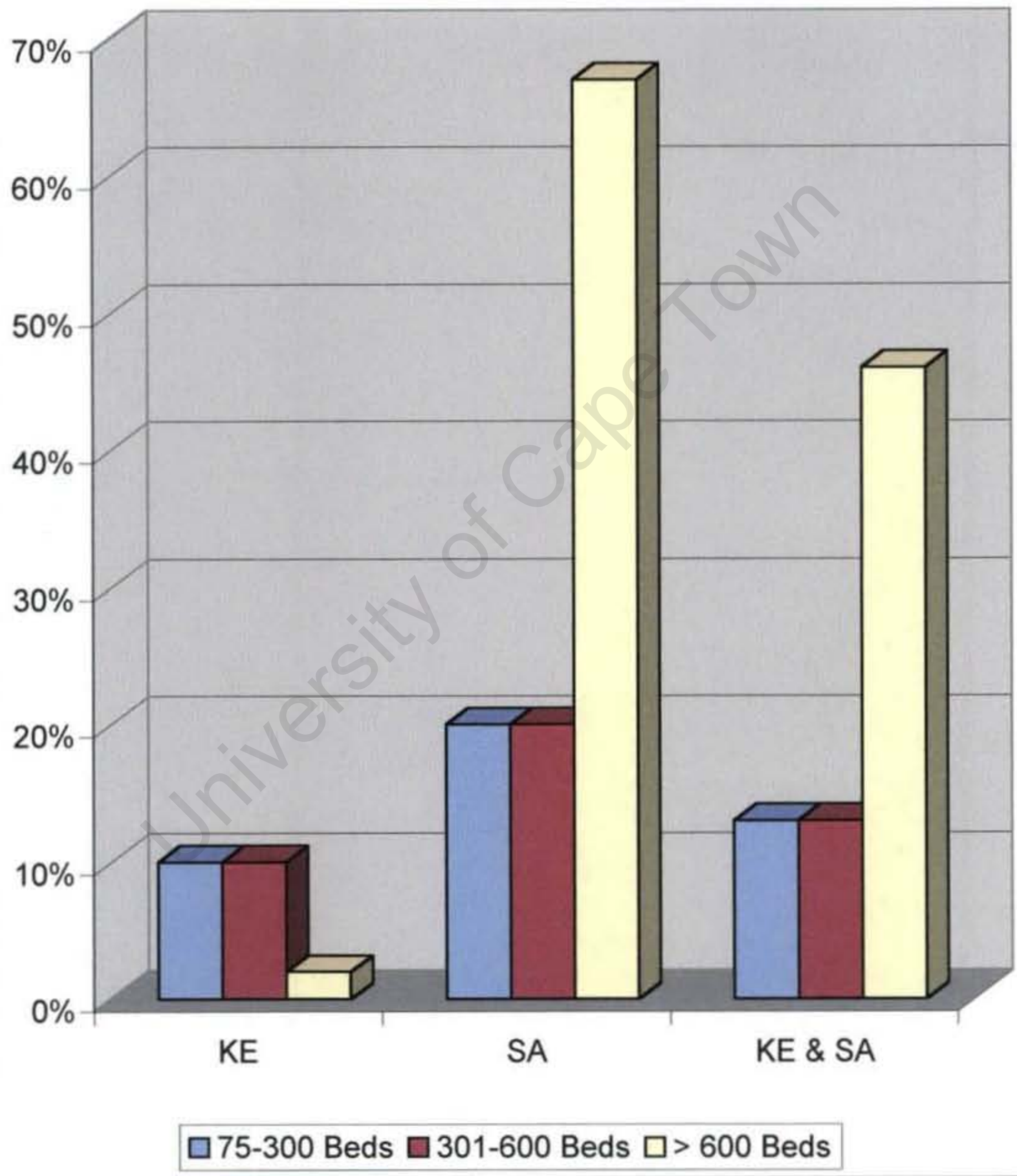


TABLE 8.4:

HEALTH CARE EQUIPMENT MAINTENANCE WORKSHOP ORGANISATION

KENYA

Hospital Size (Beds)	Response	General Workshop	Specialised W/shop	Total (%)
75-300	13	100%	0	100
301-600	3	75%	25%	100
>600	4	80%	20%	100

SOUTH AFRICA

Hospital Size (Beds)	Response	General Workshop (%)	Specialised W (%)	Total (%)
75-300	5	80	20	100
301-600	5	20	80	100
>600	7	43	67	100

KENYA AND SOUTH AFRICA

Hospital Size (Beds)	Response	General Workshop (%)	Specialised W/shop (%)	Total (%)
75-300	18	94	6	100
301-600	8	41	59	100
>600	11	57	43	100

8.5.4 PERCENTAGE OF NON-FUNCTIONING EQUIPMENT IN HOSPITAL

In the responses on percentage of non-functioning equipment in each hospital category, the majority of hospitals indicated that 25% of their equipment was non-functional due to insufficient maintenance funds or lack of technical expertise to repair the equipment. There were also a number of hospitals, especially in Kenya, where between 25–50% of the equipment was reported as non-functioning. Analysis showed that out of 72 respondents (hospitals), 73% indicated that 0-25% of their equipment inventory was non-functional, while 25% stated that 25-50% of their equipment inventory was non-functional, and 2% that over 50% of their equipment was non-functional. The results are presented in Table 8.5. In the field interviews it was discovered that more equipment is non-functioning near the end of the final year than at the beginning, as the annual maintenance budget runs dry.

TABLE 8.5:

PERCENTAGE OF NON-FUNCTIONING HEALTH CARE EQUIPMENT

KENYA

Hospital Size (Beds)	Response	0-25(%)	25-50 (%)	>50%	Total (%)
75-300	12	33	67	0	100
301-600	4	0	100	0	100
>600	5	60	40	0	100

SOUTH AFRICA

Hospital Size (Beds)	Response	0-25(%)	25-50 (%)	>50%	Total (%)
75-300	25	88	8	4	100
301-600	14	93	7	0	100
>600	12	92	8	0	100

KENYA AND SOUTH AFRICA

Hospital Size (Beds)	Response	0-25(%)	25-50(%)	>50%	Total (%)
75-300	37	70	27	3	100
301-600	18	72	28	0	100
>600	17	82	18	0	100

8.5.5 PARTICIPATION OF CLINICAL ENGINEERING DEPARTMENT IN EQUIPMENT ASSESSMENT, SELECTION AND PROCUREMENT

The questionnaires on participation of clinical engineering departments in equipment assessment, selection and procurement were analyzed in the following sub-categories:

(a) Participation in equipment technical specification writing;

(b) Participation in tender adjudication;

(c) Participation in new equipment installation;

(d) Participation in new equipment testing; and

(e) Participation in new equipment commissioning.

The relative frequency of 'YES' responses was calculated and is tabled in Appendix E. The summarized responses, analyzed by sub-category, are presented in Figures 8.4a, 8.4b, 8.4c, 8.4d, and 8.4e.

Figure 8.4a:
Participation of clinical eng. staff in equipment specification writing

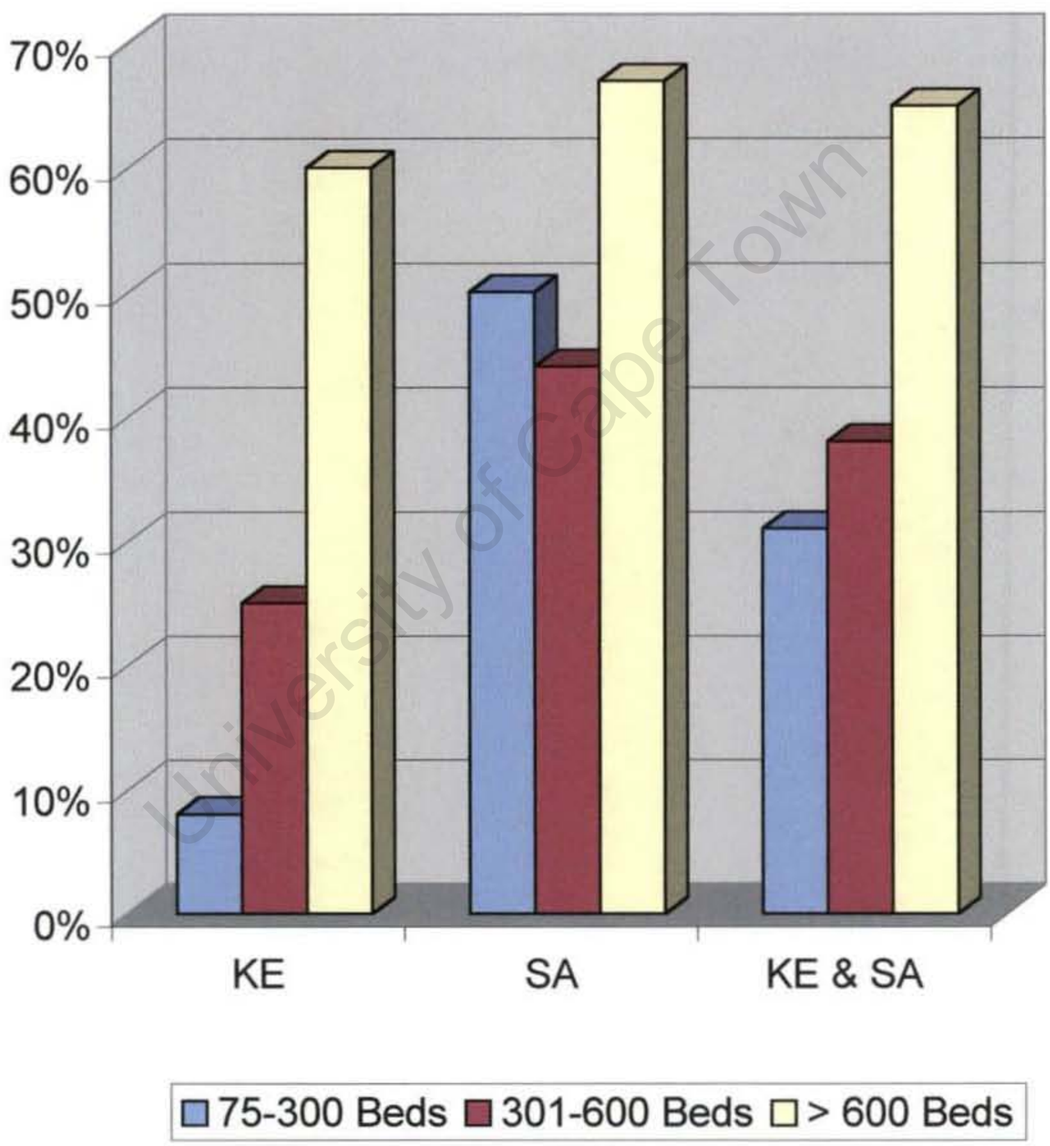


Figure 8.4b:
Participation by clinical engineering department in tender adjudication

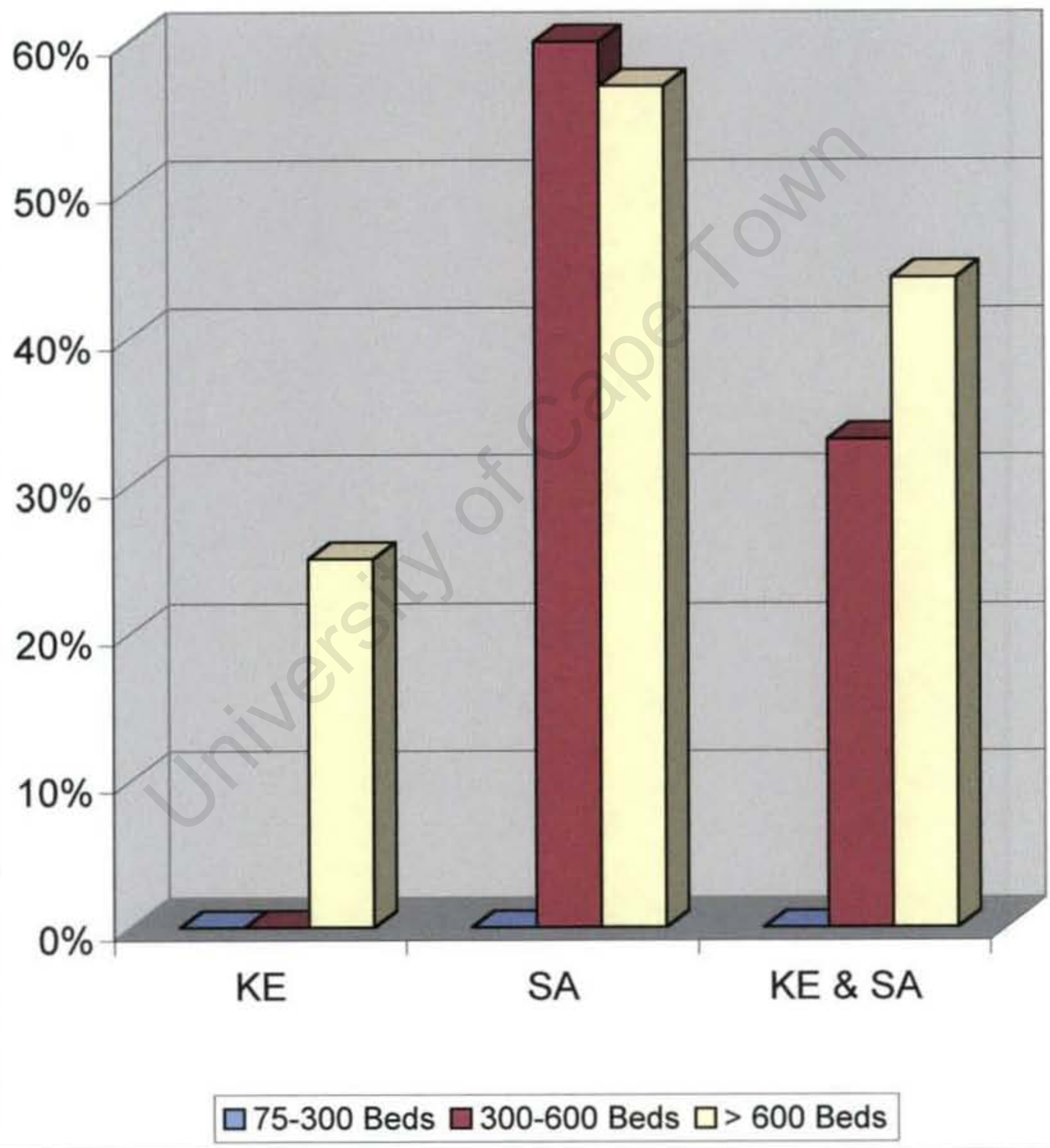


Figure 8.4c:
Participation by clinical engineering department in equipment installation

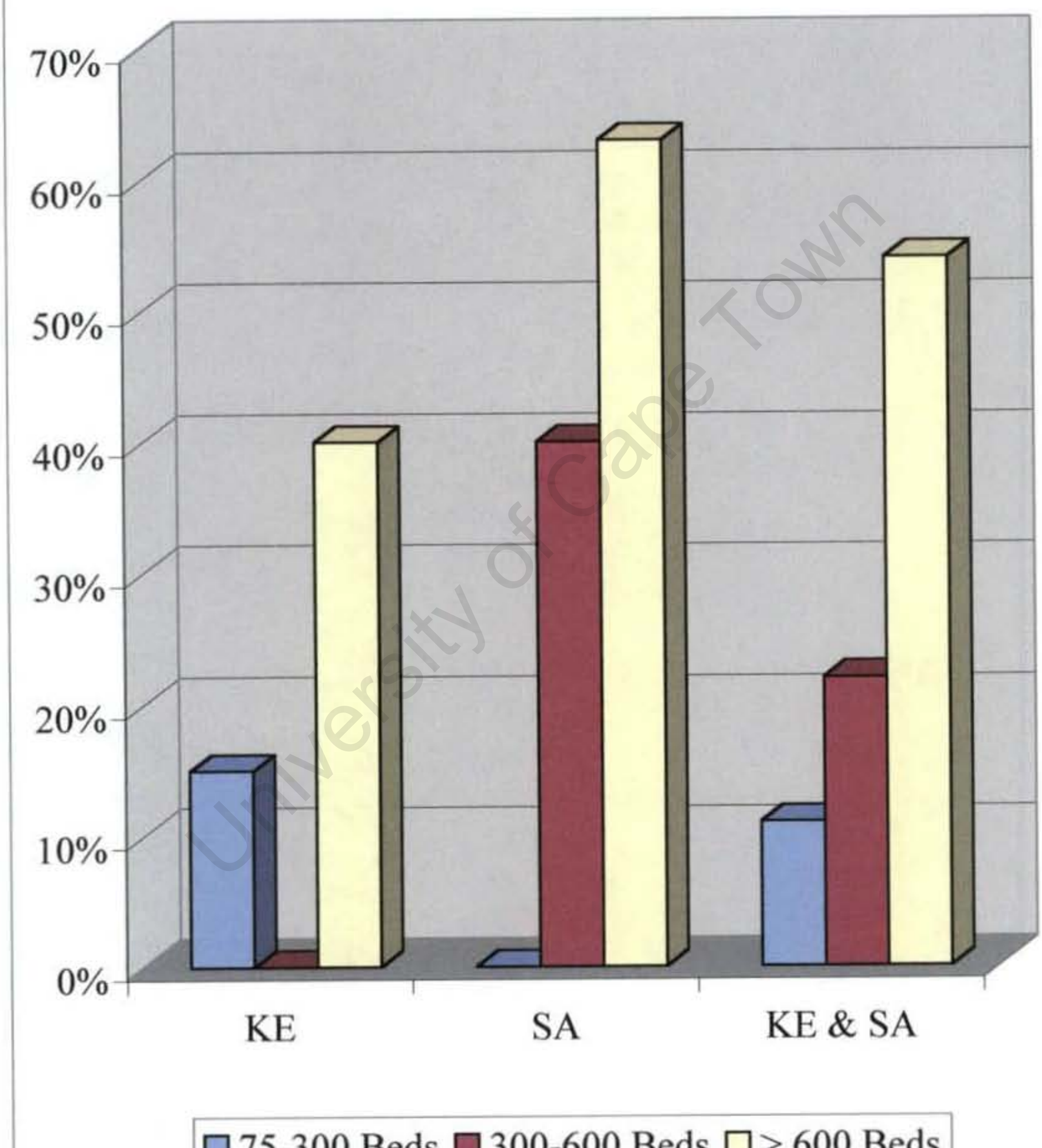


Figure 8.4d:
Participation by clinical engineering department in equipment testing

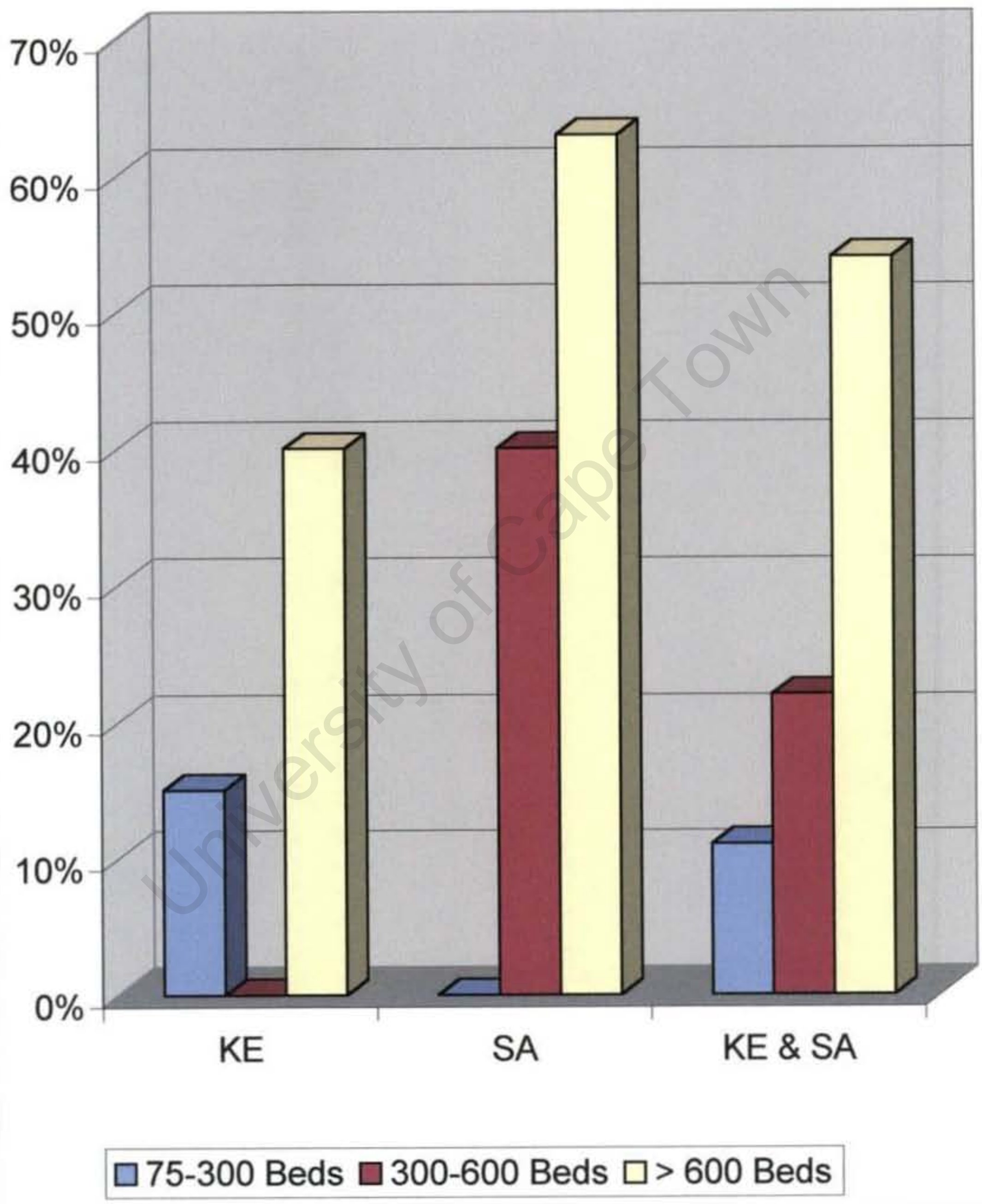
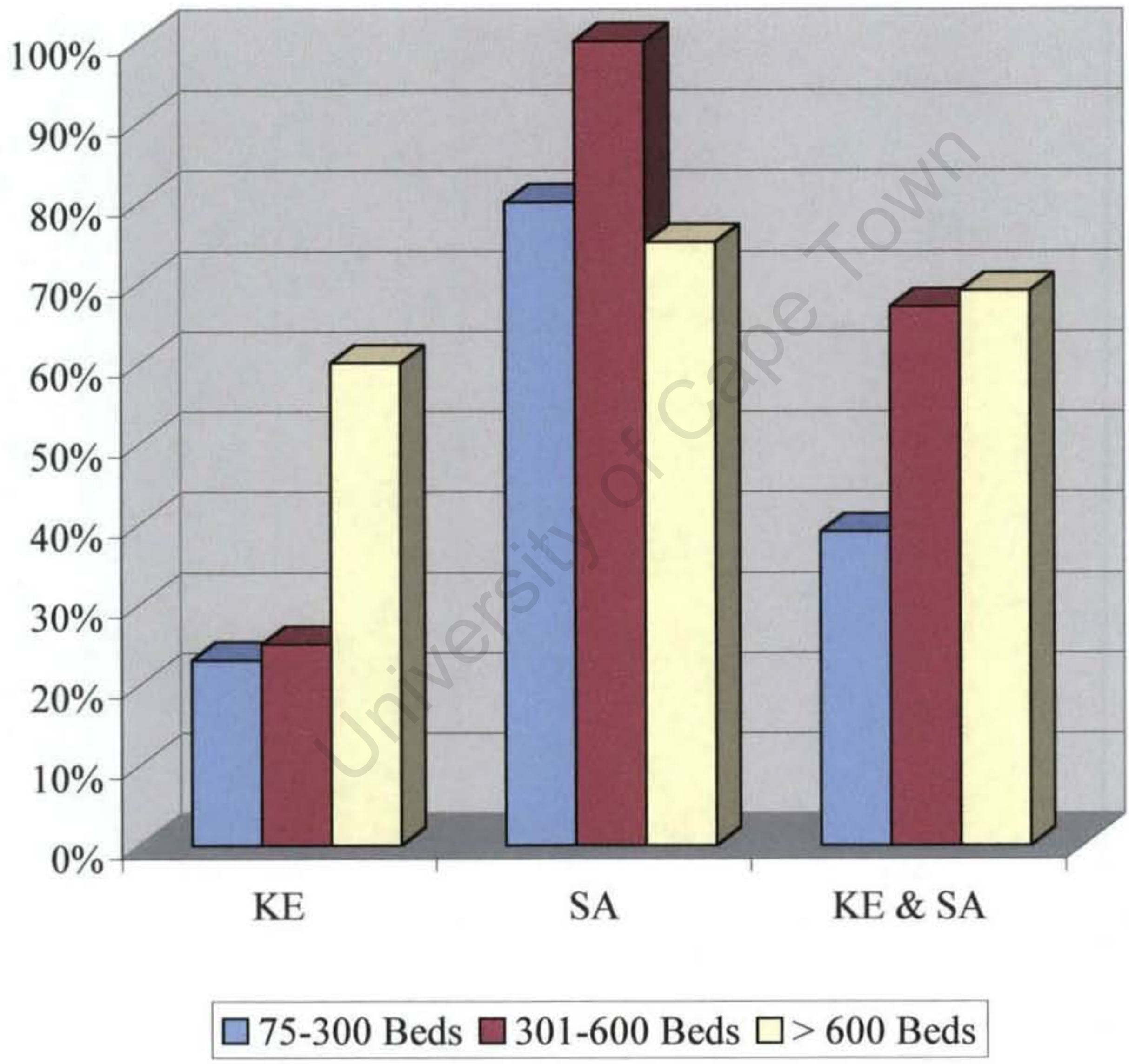


Figure 8.4e:
Participation by clinical engineering department in new equipment commissioning



Technical specification writing

The participation of clinical engineering departments in equipment technical specification writing showed progressive increases from small hospitals through to large hospitals. South African hospitals' clinical engineering departments showed higher participation, especially at large hospitals. South Africa has fairly advanced secondary and tertiary health services, which attract high technological investments. Some hospitals in South Africa even hire technology consultants to write equipment specification and manage equipment selection and procurement. The overall percentage participation in specification writing in the two countries were 31%, 38% and 65% for small, medium, and large hospitals, respectively.

Tender adjudication

The participation by clinical engineering staff in tender adjudication was particularly low, notwithstanding the fact that the department has the responsibility for all equipment maintenance. Tender adjudication is mainly done by clinicians and administrative officers from purchasing and finance departments. The combined results from Kenya and South Africa showed that there was no participation of the clinical engineering department in tender adjudication in the 38 small hospitals covered in the survey. Thirty-three percent (33%) out of the 21 respondents from medium hospitals and 44% out of the 19 respondents from large hospitals indicated that they were occasionally invited to offer 'technical advice' to the tender board, but without any voting rights.

The participation of clinical engineering staff in equipment tender adjudication is limited. It is mainly administrators and clinicians who take decisions on equipment acquisitions, but clinical engineers are expected to undertake equipment maintenance thereafter.

Equipment installation

The analysis of clinical engineering participation in equipment installation showed very limited participation in small and medium hospitals. The cross-national results showed that only 11% out of 18 respondents from small hospitals, 22% out of 9 respondents from medium hospitals and 54% out of 13 respondents from large hospitals participated in equipment installations. In small and medium hospitals equipment installation is mainly done by equipment suppliers.

Equipment testing and commissioning

Although the participation of clinical engineering departments in equipment testing was shown by the responses to be greater than in equipment installations, the results were nevertheless below expectation. For example, cross-national results on equipment commissioning showed 39%, 67% and 69% participation of clinical engineering departments from small, medium and large hospitals, respectively.

Equipment installation, testing and commissioning are normally done by equipment manufacturers or suppliers, but the participation of clinical engineering staff is nevertheless of paramount importance, because after these processes the equipment ownership is technically 'transferred' to the hospital. Furthermore, the processes of equipment installation, testing and commissioning are normally used as training grounds for equipment maintenance personnel from the hospital, and therefore the participation should be 100%.

8.5.6 EQUIPMENT DOCUMENTATION

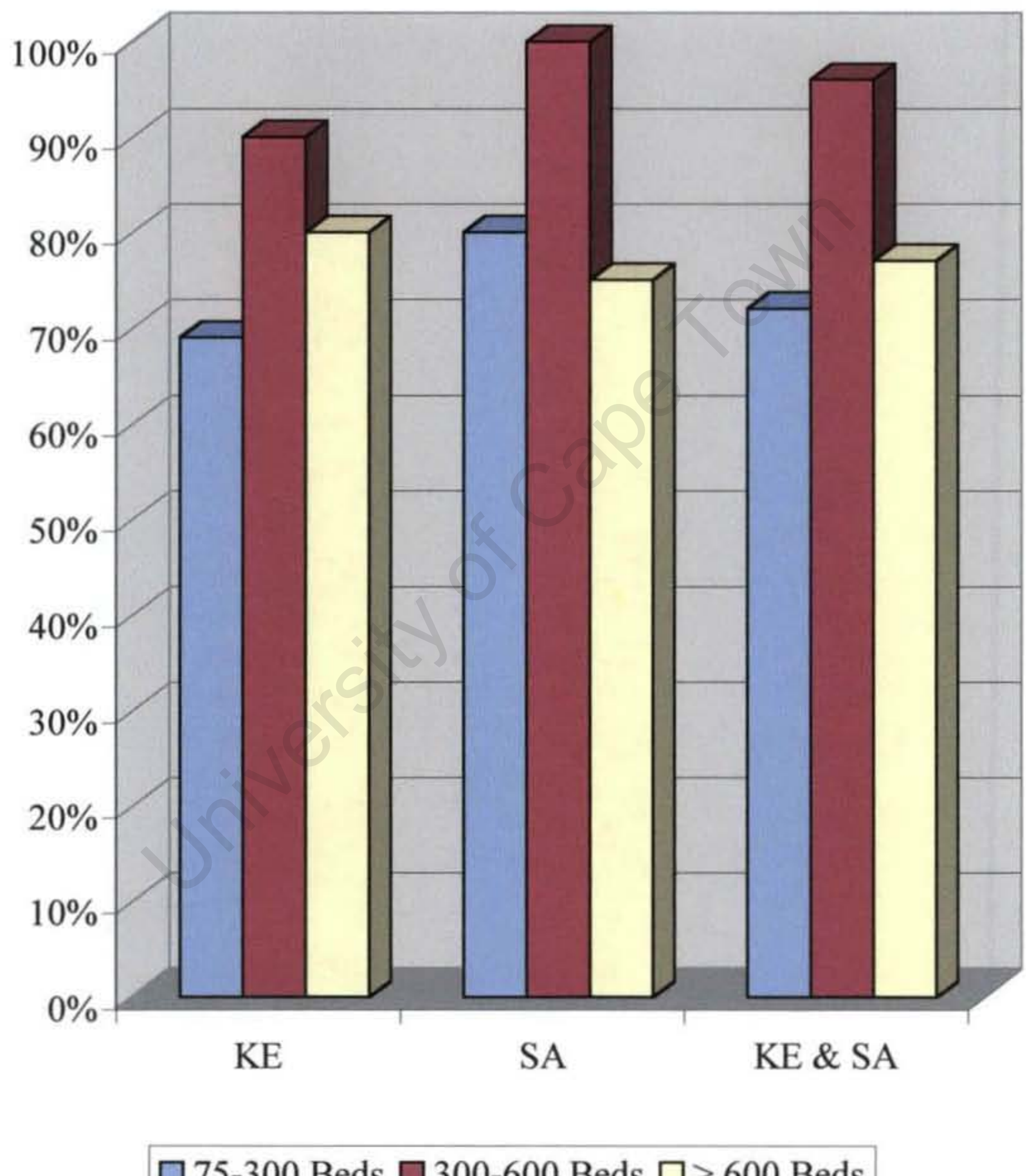
The present study showed a significant increase in availability of equipment maintenance and service manuals in both countries. Earlier studies by the World Bank and World Health Organization indicated that many hospitals in Africa lacked essential equipment documentation [World Bank 1993a, WHO 1987]. Some enterprising hospitals have even established clinical engineering libraries and subscribe to professional journals, such as *Journal of Clinical Engineering, Biochemical Instrumentation Technology, ECRI Alerts* and others. Results of the equipment documentation survey are presented in Figure 8.5.

8.5.7 MAJOR HEALTH CARE EQUIPMENT PROBLEMS

All participants from 78 hospitals were provided with a list of five frequently encountered and documented equipment problems common to most African countries. The respondents ranked the problems according to the perceived situation in their hospital. The responses were analyzed and grouped by hospital category and by relative frequency of problem. The results are summarized in Tables 8.6a, 8.6b and 8.6c. An interesting characteristic of the results is that each hospital category had a different sequence of equipment problems. This was evident in the results for both countries and cross-nationally.

The most dominant problems in small hospitals were lack of technical expertise for equipment maintenance and lack of user training. In the medium hospitals the most common problems were insufficient maintenance budgets and lack of technical expertise in equipment maintenance. Finally, in the large hospitals the dominating problems were lack of technical expertise for equipment procurement and maintenance, and under-utilisation of high-tech equipment due to insufficient maintenance.

Figure 8.5:
Availability of equipment documentation - maintenance and service manuals



The results shown in Tables 8.6a and 8.6b show similar trends in equipment problems in Kenya and South Africa. At hospitals level, identical problems were recorded. This is an indication that health care equipment problems have taken a similar pattern in the Sub-Saharan region.

TABLE 8.6a:
MAJOR HEALTH CARE EQUIPMENT PROBLEMS

KENYA

Ranking	Problems	Response (%)
	Small Hospitals (75-300 Beds)	
1.	Lack of technical expertise for equipment selection, procurement, and maintenance management	27.14
2.	Lack of ongoing technical and user training	22.86
3.	Under-utilisation of high-tech equipment	21.43
4.	Insufficient equipment maintenance budget	15.71
5.	Lack of equipment standardisation	12.86
		100.00
	Medium Hospitals (301-600 Beds)	
1.	Insufficient equipment maintenance budgets	34.37
2.	Lack of technical expertise for equipment selection, procurement, and maintenance management	21.88
3.	Lack of ongoing technical and user training	18.75
4.	Under-utilisation of high-tech equipment	18.75
5.	Lack of equipment standardisation	6.25
		100.00
	Large Hospitals (>600 Beds)	
1.	Lack of technical expertise for equipment selection, procurement, and equipment management.	32.35
2.	Under-utilisation of high tech equipment	20.59
3.	Lack of technical and user training	20.59
4.	Lack of equipment standardisation	14.70
5.	Insufficient equipment maintenance budgets	11.70
		100.00

TABLE 8.6b:
MAJOR HEALTH CARE EQUIPMENT PROBLEMS

SOUTH AFRICA

Ranking	Problems	Response (%)
	Small Hospitals (75-300)	
1.	Lack of technical expertise for equipment selection, procurement, and maintenance management	36.40
2.	Under-utilisation of high-tech equipment	23.59
3.	Lack of ongoing technical and user training	21.03
4.	Lack of equipment standardisation	12.31
5.	Insufficient equipment maintenance budget	6.67
		100.00
	Medium Hospitals (301-600 Beds)	
1.	Lack of ongoing technical and user training	29.17
2.	Lack of technical expertise for equipment selection, procurement, and maintenance management	25.00
3.	Under-utilisation of high-tech equipment	19.79
4.	Insufficient equipment maintenance budgets	15.79
5.	Lack of equipment standardisation	10.41
		100.00
	Large Hospitals (>600 Beds)	
1.	Lack of technical expertise for equipment selection, procurement, and equipment management.	34.41
2.	Under-utilisation of high tech equipment	23.66
3.	Lack of ongoing technical and user training	19.36
4.	Insufficient equipment maintenance budgets	11.82
5.	Lack of equipment standardisation	10.75
		100.00

TABLE 8.6c:

MAJOR HEALTH CARE EQUIPMENT PROBLEMS
KENYA AND SOUTH AFRICA

Ranking	Problems	Response (%)
	Small Hospitals (75-300 Beds)	
1.	Lack of technical expertise for equipment selection, procurement, and maintenance management	33.33
2.	Under-utilisation of high-tech equipment	21.25
3.	Lack of ongoing technical and user training	20.51
4.	Insufficient equipment maintenance budget	12.81
5.	Lack of equipment standardisation	12.09
		100.00
	Medium Hospitals (301-600 Beds)	
1.	Lack of technical expertise for equipment selection, procurement, and maintenance management	32.16
2.	Under-utilisation of high-tech equipment	24.48
3.	Lack of ongoing technical and user training	23.08
4.	Insufficient equipment maintenance budgets	12.59
5.	Lack of equipment standardisation	07.69
		100.00
	Large Hospitals (>600Beds)	
1.	Lack of technical expertise for equipment selection, procurement, and equipment management.	32.23
2.	Under-utilisation of high tech equipment	23.14
3.	Lack of on-going technical and user training	20.66
4.	Insufficient equipment maintenance budgets	12.40
5.	Lack of equipment standardisation	11.57
		100.00

8.5.8 COMPUTER DISTRIBUTION AND USE IN HOSPITALS

The aim of the survey of computer use was to investigate the distribution pattern of computers and their use by major hospital departments, including equipment assets management and other technical support services. Figure 8.7a shows computer distribution by country and cross-national, while Figures 8.7b, 8.7c and 8.7d show personal computer utilization by hospital departments. In general, the use of personal computers by hospital departments increased with an increase of the hospital size (beds). Significant increases were recorded in the use of computers for patients' records and research in large hospitals. Interestingly, the use of computers for equipment management did not show any significant increase with increase of hospital size, notwithstanding the fact that in many hospitals computer maintenance and repairs is the responsibility of the clinical engineering department.

Figure 8.7a:
Distribution of personal computers (PCs) by hospital size

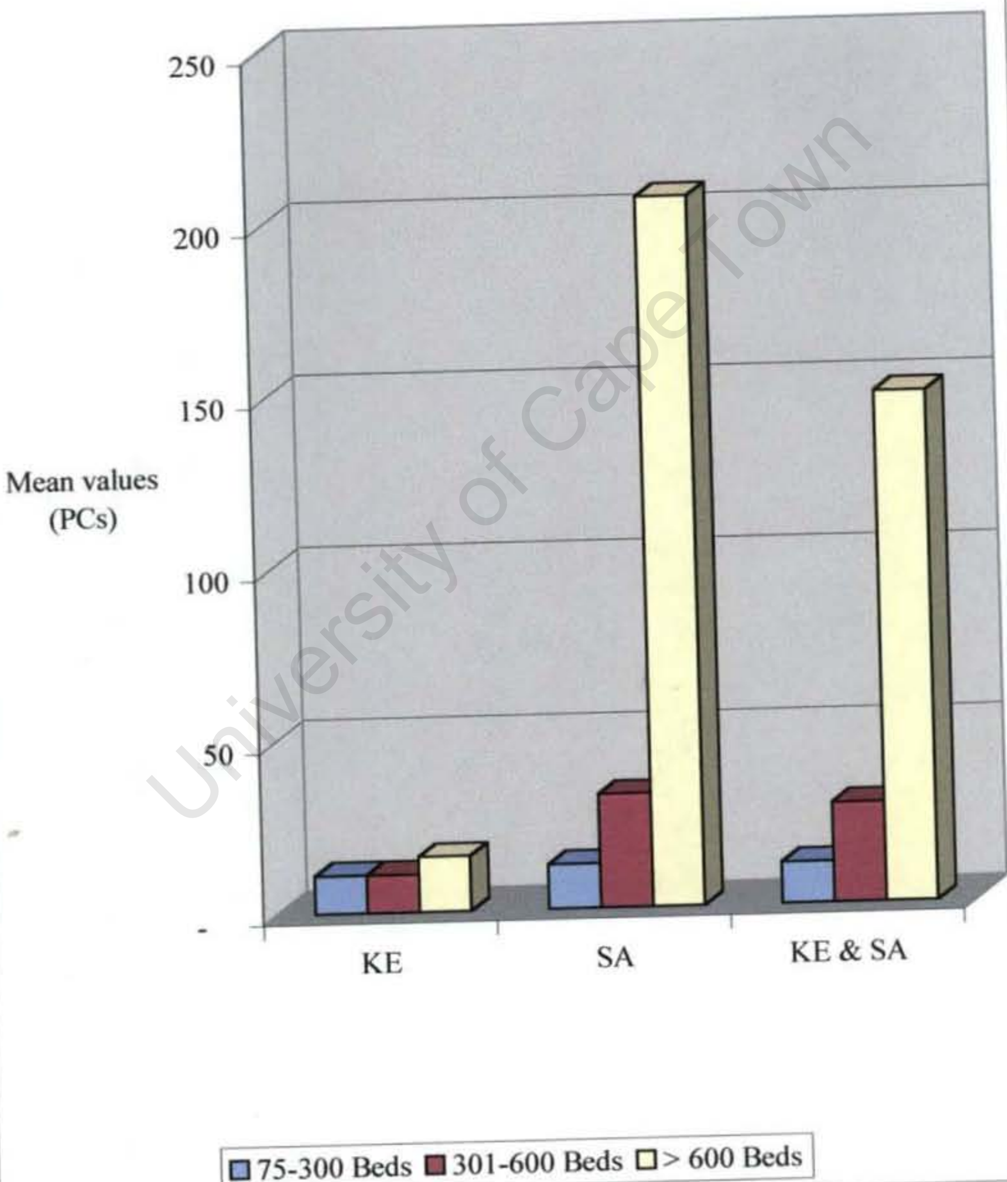
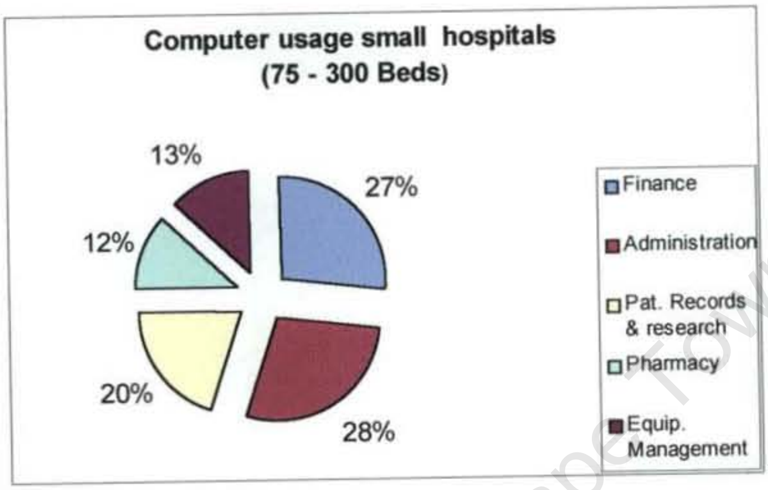
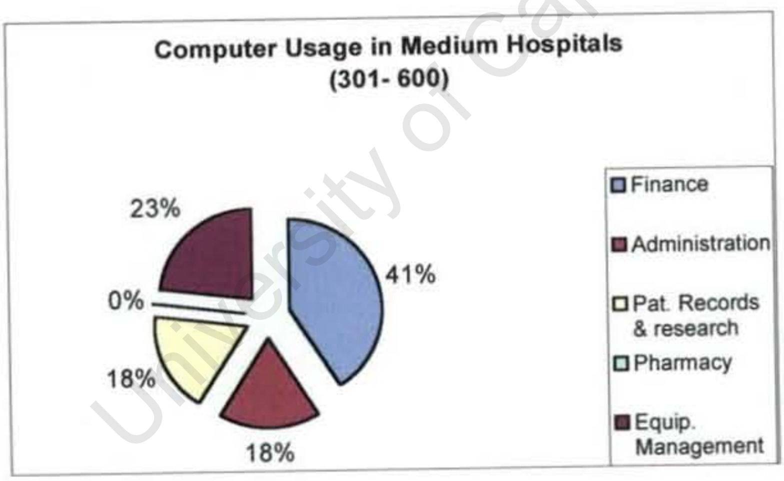


Figure 8.7b:

Trends of computer usage by hospital departments (Kenya)

KENYA





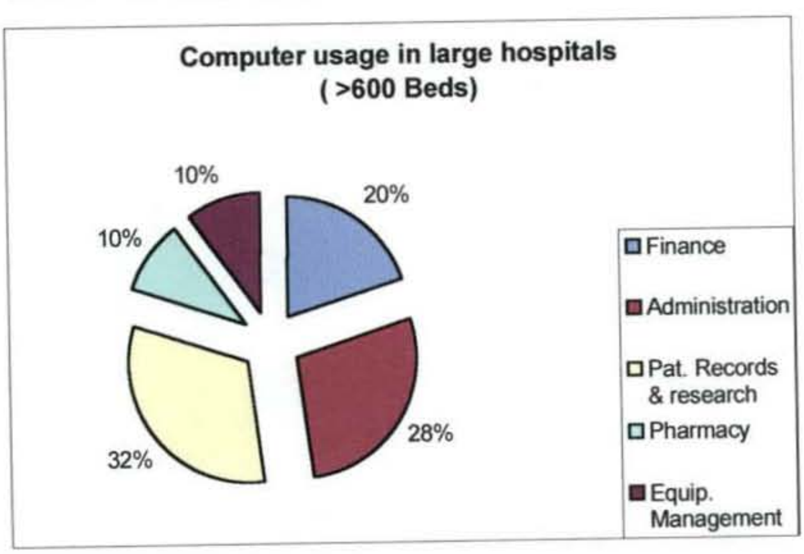
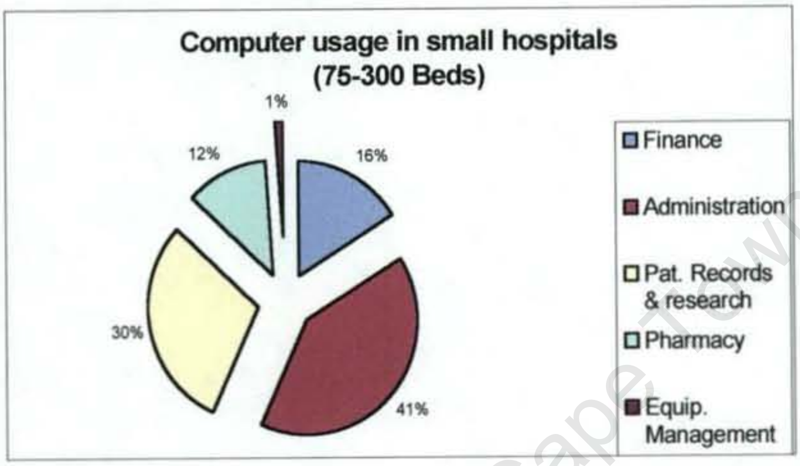
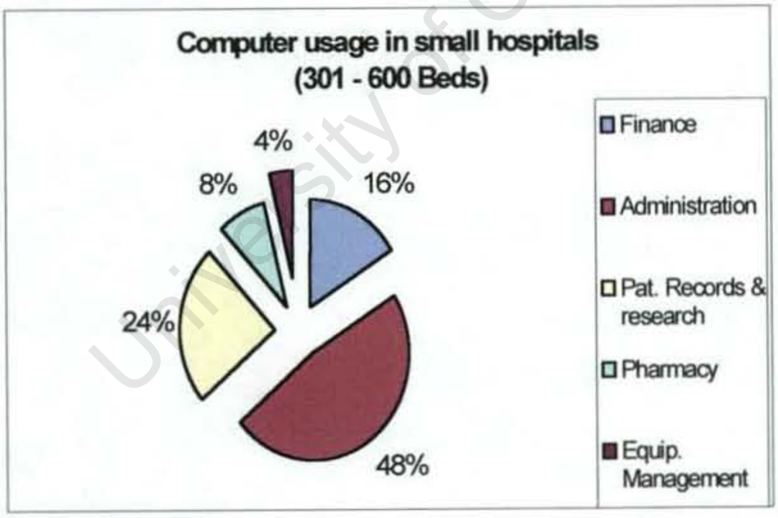


Figure 8.7c:

Trends of Computer Usage by Hospital Departments (South Africa)

SOUTH AFRICA





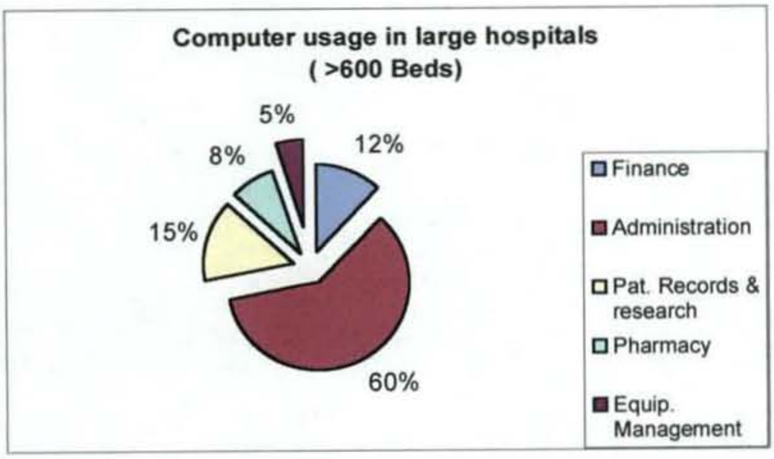
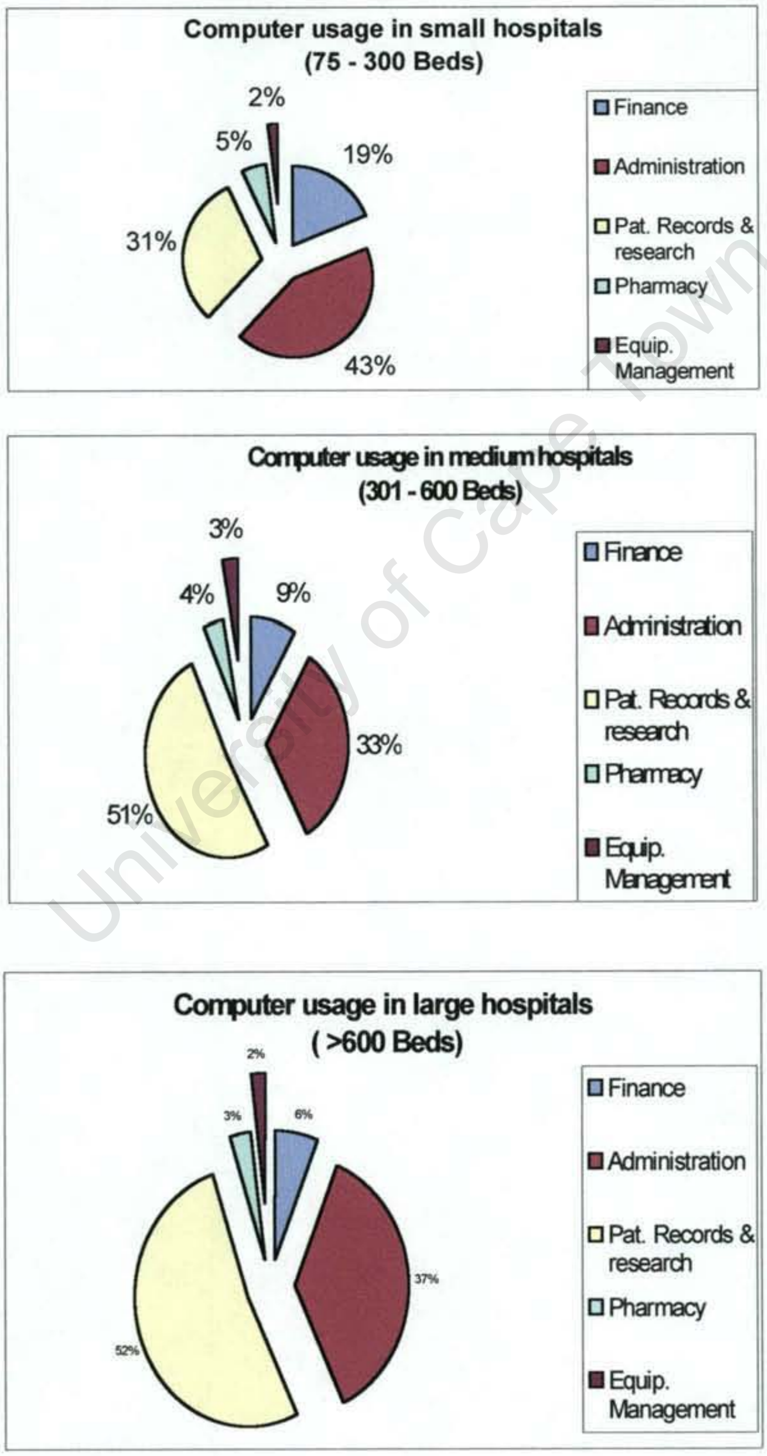


Figure 8.7d:

Trends of computer usage by hospital Departments (Kenya & South Africa)

KENYA AND SOUTH AFRICA



8.5.9 HOSPITAL UTILISATION INDICATORS

The services provided by a hospital have direct linkage to the type of technologies used. It must be emphasized at the very outset that, although hospital utilization indicators such as patient length of stay (days), deaths per thousand and bed occupancy rate were analyzed, the focus of the study was on technology, not services. Analysis of these indicators was done to highlight the fact that technology does not exist in isolation in the hospital environment.

The analyses of hospital utilization indicators are presented in Figures 8.8a, 8.8b, and 8.8c. Facility service indicators differed considerably in the study area. For example, bed occupancy rate in Kenya was over 100% in small and medium hospitals, while large hospitals only registered about 95%. In South Africa bed occupancy was under 80% in all hospitals, with medium hospitals registering lowest occupancy at 67%. Hospitals are usually designed to operate most efficiently at an occupancy rate of 85-90%; at lower levels of activity their unit costs rise and at occupancy rates above 100% the quality of their services diminishes [Barnum and Kutzin 1993].

Although hospital utilisation indicators cannot be directly linked to usage of technology in the hospital environment, nevertheless, they are dependent on hospital service efficiency, which in turn depends upon technological support.

8.5.10 HOSPITAL HUMAN RESOURCE UTILISATION

The traditional units for measuring human resources in health are crude head counts of doctors, nurses, clinical engineers and other skilled health care personnel; although recognised as insufficient for health planning, these measures still represent the necessary starting point and the most reliable index available [Kohn and White 1976]. The purpose of the human resource analysis was to facilitate completeness of discussions on technology in health care. Several studies have shown that acquisition of health technologies is heavily influenced by doctors and nurses who use the devices [Battista 1989, Goodman 1991, Gordon and Tan 1992, Kachieng'a and Boonzaier 1999]. It is therefore not practical to discuss the use of technology in health care without discussing hospital human resources.

To gain better insight into human resource distribution in the survey area, several variable ratios were used: Beds per doctor; Beds per nurse; Beds per clinical engineer and Beds per clinical engineering technician. The survey results have indicated a fair spread of doctors in the two countries at hospitals of all categories, but with heavier workload in small hospitals (75–300 beds). The distributional mean values for nurses remained reasonably constant in both countries. For example, at combined level the mean values of beds per nurse was 1.88, 1.11 and 1.38 for small, medium and large hospitals, respectively. These means seem low, but it must be emphasised that the total number of nurses included those not working in wards (e.g. those in outpatients, mobile clinics) (see Figure 8.10b). The ward nurses have higher patient loads.

In the study area clinical engineers were only recorded in large hospitals (>600 beds). Only two per country were recorded. The mean values of beds per clinical engineering technician were thus significantly high in both countries, an indication of understaffing of clinical engineering departments. The results of the human resource analysis are presented in Figures 8.9a, 8.9b and 8.9c.

Figure 8.9a :
Beds per doctor by hospital size

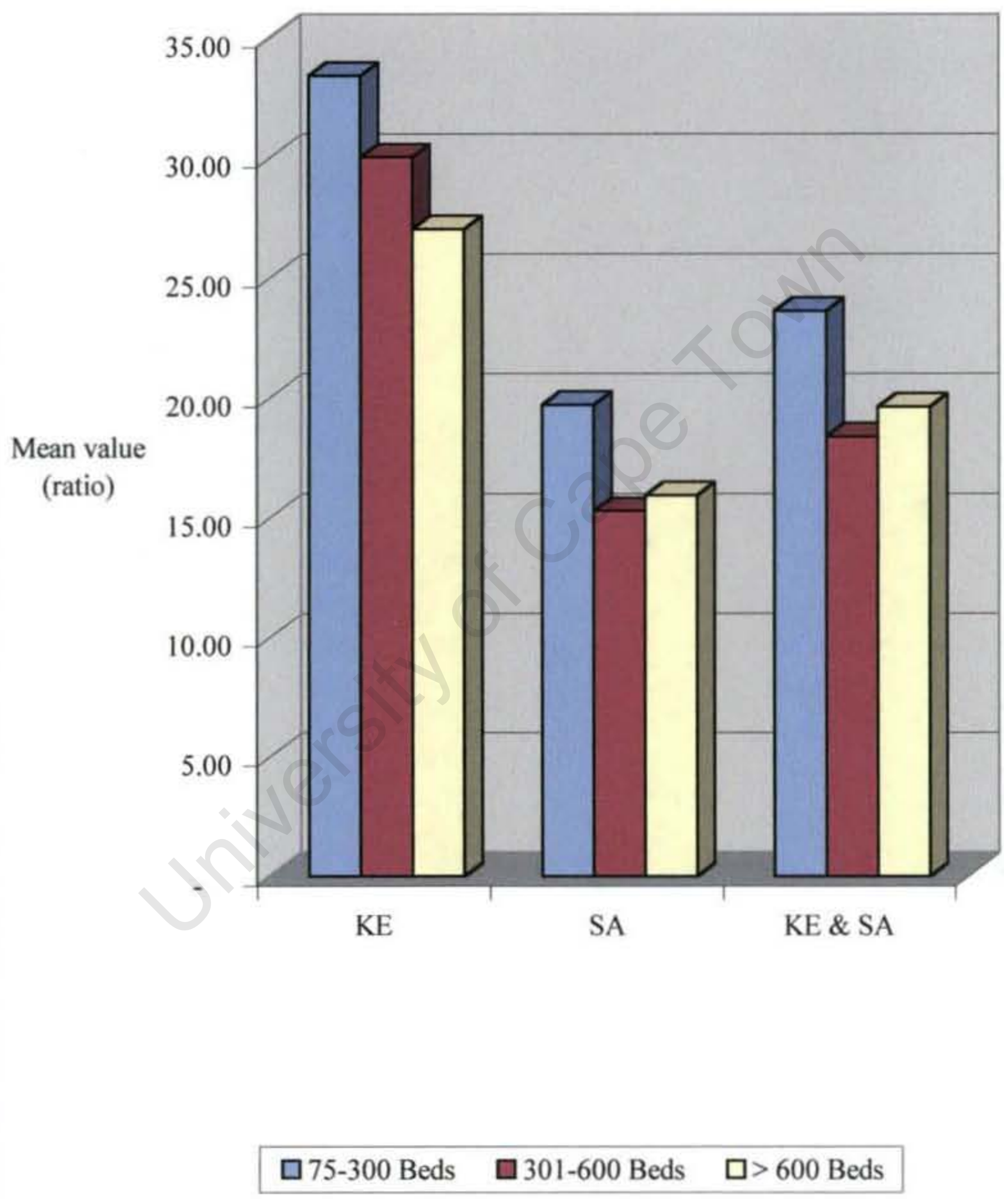


Figure 8.9b:
Beds per nurse by hospital size

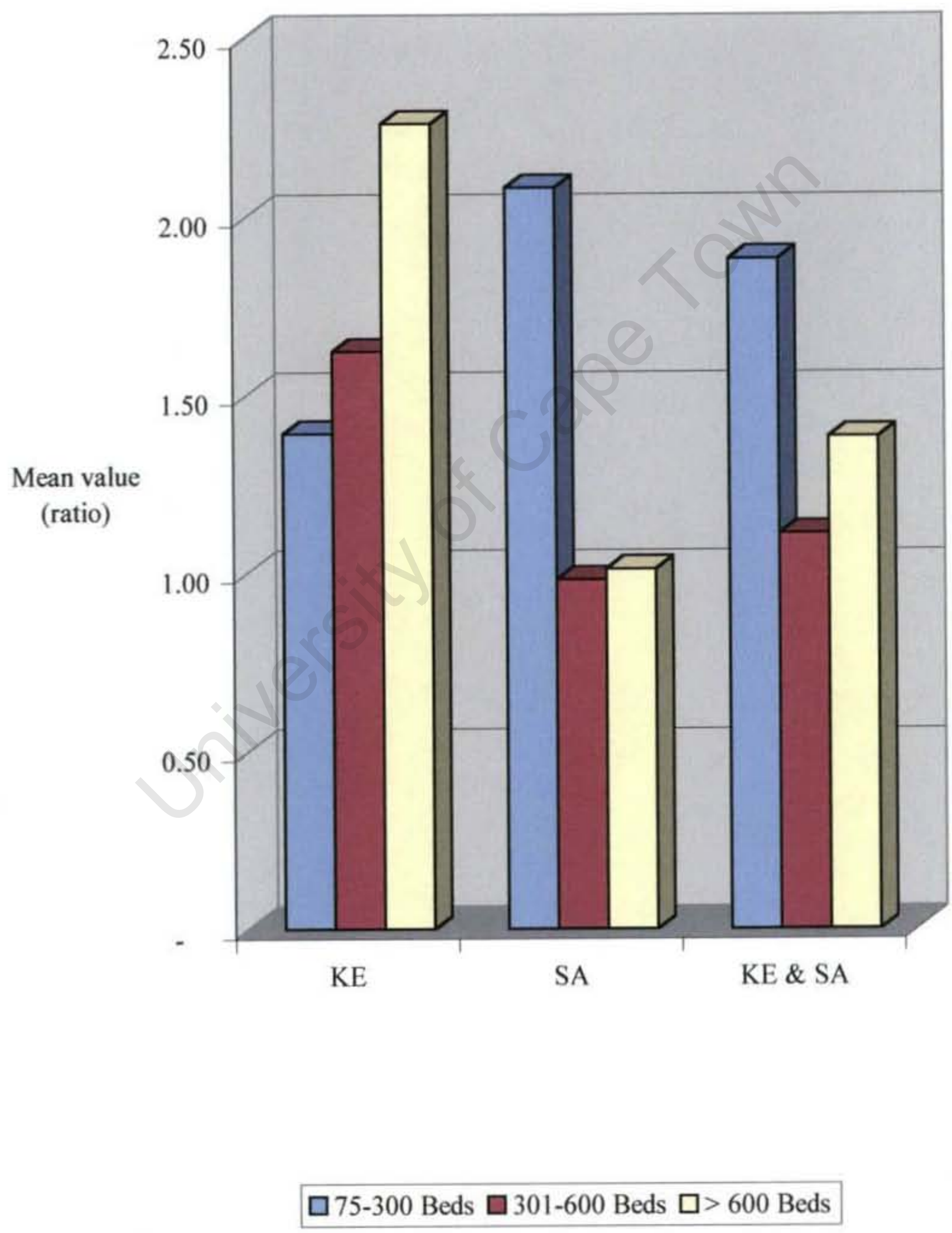
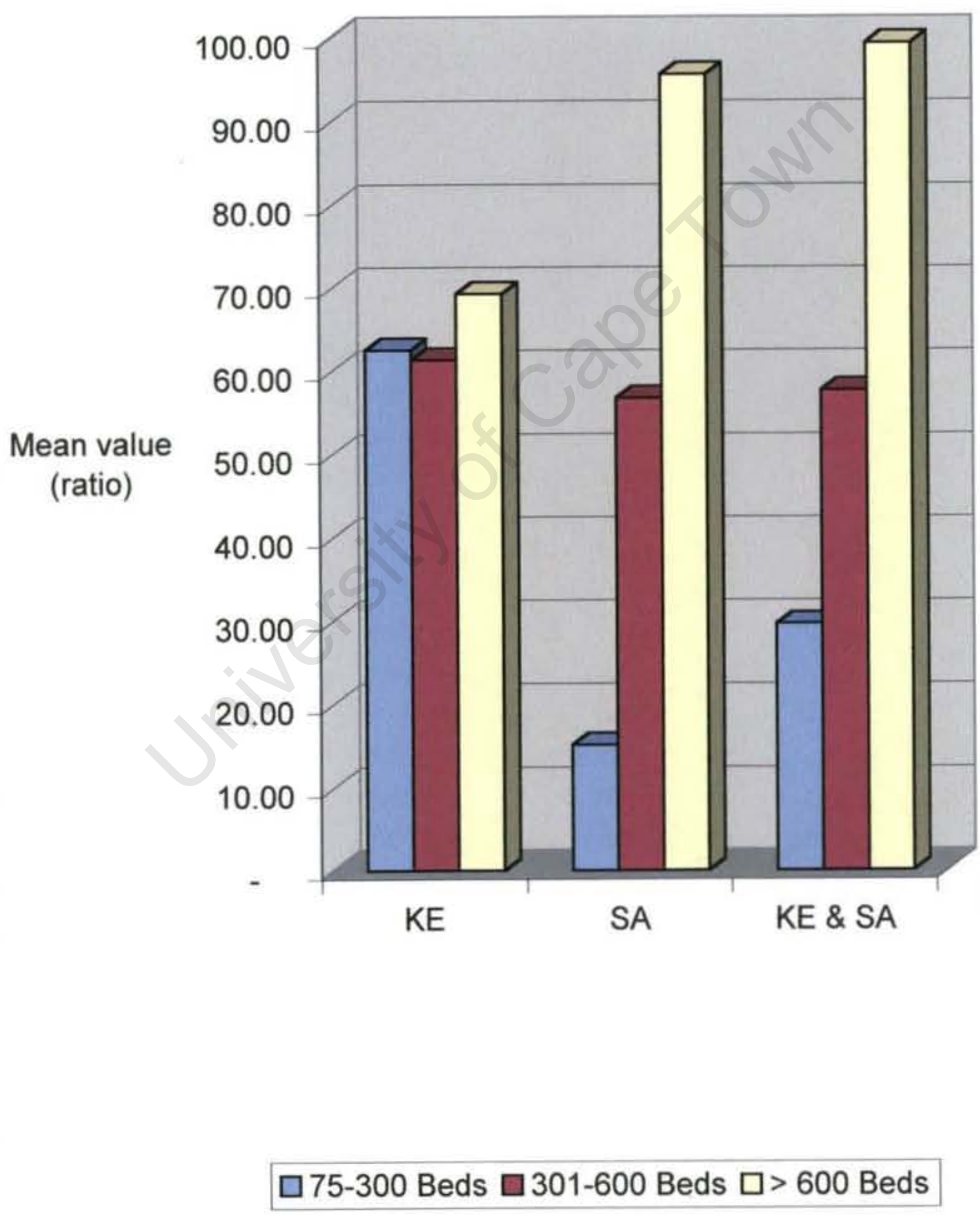


Figure 8.9c:
Beds per clinical engineering technician



8.5.11 REASONS FOR LEAVING THE PUBLIC SECTOR GIVEN BY CLINICAL ENGINEERS AND TECHNICIANS

In response to the question as to why clinical engineers and technicians leave the public sector, the predominant answer was financial reasons, followed by career development opportunities. The analysis of the responses is provided in Table 8.7.

Most clinical engineers interviewed during field visits stated that, due to a lack of a scheme of service and career path in the public sector, they only remain in this sector to gain experience before joining the private sector or becoming external maintenance contractors to public hospitals. Some clinical engineers return to mainstream engineering, such as electrical or electronics engineering. In fact, all clinical engineers interviewed during the study were 'converts' from electrical or electronic engineering. The training of clinical engineers is covered in more detail in section 8.6.9.

TABLE 8.7:

REASONS FOR LEAVING PUBLIC SECTOR BY CLINICAL ENGINEERS AND TECHNICIANS

KENYA

Hospital Size (Beds)	Response	Career development (%)	Financial reasons (%)	Total (%)
75-300	10	10	90	100
301-600	4	25	75	100
>600	4	25	75	100

SOUTH AFRICA

Hospital Size (Beds)	Response	Career development (%)	Financial reasons (%)	Total (%)
75-300	5	20	80	100
301-600	6	50	50	100
>600	8	38	62	100

KENYA AND SOUTH AFRICA

Hospital Size (Beds)	Response	Career development (%)	Financial reasons (%)	Total (%)
75-300	15	13	87	100
301-600	10	40	60	100
>600	12	34	66	100

8.6 COMMENTS AND DISCUSSION

8.6.1 HOSPITAL BUDGET DISTRIBUTION

There is a direct link between hospital budgets on the one hand, and equipment acquisition and maintenance on the other. Hospitals with high budgets also tend to employ more clinical engineers and technicians or contract more services from external maintenance service providers. Although special budgets are provided for high-tech equipment acquisitions, medium and low technologies are procured through hospital equipment capital budgets. Equipment donations are not reflected in the annual hospital budgets.

The main shortcoming of the allocation of hospitals' budgets in both countries is that they rely heavily on 'historical indicators' rather than on workload assessment methods. In the study area, allocations of hospitals' budgets were found to be generally based on 'last years figures;' there is no linkage between the hospital budget and hospital workload or the expected medical throughput. For example, from the survey data, an attempt to link hospital budget with hospital service indicators, such as deaths per thousand and patient length of stay, showed an extremely low correlation per value, an indication that the variables were statistically independent from each other.

Equipment maintenance budgets in all the 78 hospitals covered in the survey were found to be too small to provide effective maintenance of all equipment in the hospital.

One alarming feature of the hospital financial accounting systems in both Kenya and South Africa is that there is no depreciation policy for health care equipment in the public sector. Once it is paid for, the equipment is not regarded as a cost factor in future years. Only the supplies and spare parts costs are considered as running costs. Such inept accounting systems distort the budgetary allocation for equipment maintenance and the planning of replacement of obsolescent equipment. Equipment maintenance budgets, like overall hospital budgets, are generally based on 'last year's figures' or worse still, on 'gut feelings;' there is no linkage between maintenance budgets and capital value of equipment. The main purpose of the equipment maintenance budget is to support the capital investment.

In all the hospitals visited during this study (20 hospitals), little attention is paid to the implications of new capital expenditure for expensive equipment, and the continuing operational costs that flow from the use of the new equipment. In other words, when new equipment is bought, no matching budgetary provision is made to cover its maintenance. Cost or profit centres of the types used in industry and commerce are rarely established and it is seldom possible under most hospital accounting systems now in use to relate revenues and expenses to specific services. It is impossible to calculate cost of ownership (see section 8.6.5) without an equipment assets management system.

8.6.2 METHODS OF EQUIPMENT SELECTION AND PROCUREMENT

Many studies have indicated that equipment maintenance problems are linked to poor procurement methods [Bronzino 1992, Durand-Zaleski and Jolly 1990, Kachieng'a, 1992, David 1993, Kachieng'a 1998a]. Hospital equipment committees focus more on equipment purchase price than on cost of ownership. In public hospitals, the maintenance costs of expensive equipment generally outstrip the maintenance budget allocations. The usual attitude is: "We have spent so much to buy it that now we have to use it" [Durand-Zaleski and Jolloy 1990]. Therefore to keep maintaining high-tech equipment within provided equipment budgets, other equipment has to be under-utilised. Correct selection and procurement procedures could lead to reduction of equipment capital investments as well as eliminate some equipment maintenance problems [Fodor 1988, Kachieng'a *et al.* 1999].

In most developed countries, equipment acquisition is only done after meeting requirements of Certificate of Need and assessment of efficacy and safety, cost-benefit and cost of ownership analysis.

Equipment procurement policy

There is no policy for procurement of health care equipment in Kenya and South Africa. The main document for equipment procurement is the guidelines provided in the tender document. The tender documents perused turned out to be administrative tools rather than 'technical evaluation tools'. Tender boards are constituted of highly placed medical and administrative officers who may have good intentions but lack technical expertise.

8.6.3 AVAILABILITY OF LOCAL TECHNICAL CAPACITY AND EXPERTISE FOR EQUIPMENT MAINTENANCE AND MANAGEMENT

Equipment assets management

The main problem with equipment procurement is that most hospitals surveyed had no equipment inventory. This has led to a situation where hospitals know the equipment they 'want', but do not know the equipment they 'have.' Without an equipment assets management system (equipment inventory management system), equipment replacement can be driven by artificial or over-ambitious demands, leading to oversupply and unequal distribution of equipment. Motivations for new equipment are always positive, but do not always represent the real need.

High-tech equipment utilisation

The need to improve service efficiency in the use of expensive health care equipment is critical, especially in the teaching hospitals. Even where equipment is functional it is rarely optimally used. For example, in the nuclear medicine department of a leading teaching hospital in South Africa, a gamma camera unit with utilisation capacity of about 20 hours per day is only used for 6-8 hours per day. It is in the economic interest of the hospitals to use expensive equipment more efficiently and cost-effectively within its economic life span.

A few enterprising public hospitals, which tried to generate funds by offering specialised services, like radiotherapy or renal haemodialysis, to private patients to optimise the utilisation of expensive equipment, stopped because all funds generated had to be handed over to the government. The incentive for hospitals to use expensive equipment efficiently is to let such funds generated remain in the hospitals with the proviso that they be used for equipment maintenance and replacement (see also section 8.7.1 in the recommendations).

Staffing Norm

Although there is no staffing norm for clinical engineers and technicians, field inspection by the author revealed understaffing in all hospital categories. For example the clinical engineering department of a leading teaching hospital in Cape Town was operating at 38% staffing capacity. Vacant positions cannot be filled because of lack of qualified persons. The other problem with recruitment of qualified clinical engineers and technicians, particularly in South Africa, is that clinical engineering has not been recognised as a profession within the Department of Health (DOH), therefore there is no career path or scheme of service. Most technicians interviewed saw no professional future within the Department of Health. Staffing norm guidelines for clinical engineering departments for different hospital categories is presented in Appendix E.

8.6.4 NON-FUNCTIONING OF HEALTH CARE EQUIPMENT

Non functioning of health care equipment not only affects patients directly by delaying examination and treatment, but also creates an economic burden at facility and national levels. At macro level, non-functioning of equipment is an economically wasteful investment. At facility level, the rate of patient flow directly depends on equipment functionality.

It is not practicable to calculate comprehensively the money saved for the national economy if health care equipment is well maintained; neither is it possible to give a clear estimate of the lives that could have been saved. The overall cost benefit is enormous, but difficult to express in monetary terms. However, there is no doubt that non-functioning equipment offers poor return on investment and delays health service delivery.

8.6.5 PARTICIPATION OF CLINICAL ENGINEERING DEPARTMENTS IN EQUIPMENT PLANNING, SELECTION, TENDER ADJUDICATION, INSTALLATION AND COMMISSIONING

The role of the clinical engineering department in a modern hospital is very critical and strategic because the care of patients requires a partnership between medical staff and modern technology [Bronzino 1992, Dyro 1992, Menon 1993, Kachieng'a et al. 1999]. A close working relationship between clinical engineering and medical staff is the key to a well functioning hospital, but this is not achieved because of limited participation of clinical engineering staff in equipment acquisition. Adjudication of equipment tenders is an important function of clinical engineering staff because once equipment is purchased, the hospital becomes responsible for all costs incurred as a result of equipment utilization.

Local availability of technical capacity and expertise for equipment maintenance and management is arguably the backbone of functioning health systems and services. The development and implementation of comprehensive equipment assessments and management programs require a systematic approach. Such programs embrace not only the technical aspects of maintaining health care equipment, but also the development of institutional infrastructure and policy regarding equipment acquisition, use, replacement, and disposal [Bronzino 1995]. In essence, the primary goal of such programs is to ensure that the most cost-effective methods for the safe and effective operation of health care equipment are utilised. The stimulus for the development of capacity and expertise for effective health care equipment assessment and management comes from several studies [Dickey 1990, Selsky 1991, Bronzino 1992].

Tender Board

Purchase price is an unreliable guide as to what may be the actual total cost of equipment to the hospital, yet most of the Tender Board's decisions in Kenya and South Africa are, more often than not, based on the purchase price alone [Kachieng'a 1998a, Kachieng'a and Boonzaier 1999].

The more realistic guide, when considering what factors to include in cost comparisons of competing equipment, is the cost of ownership (CO). This encompasses all direct and indirect expenses associated with health care equipment over its economic lifetime, including its initial price, installation and initial training of clinical and technical staff [David 1993, Hughes 1993]. It is estimated that the purchase price represents only 20% of the life-cycle cost of ownership [David and Judd 1993]. Several developed countries also assess efficacy and safety on essential and strategic technologies before their acquisition.

In the case of major equipment acquisition, many tender boards and hospital equipment committees in America and Europe routinely carry out financial analysis on new capital investments. The most common analysis done on new equipment investment is 'Return on Investment' (ROI) [Hawkins 1992]. Harrington (1987) comments that at some for-profit hospitals in North America and Canada, new equipment will be acquired only if the projected time period for the return on investment is less than three years. ROI is one of financial ratios used to measure the yield of an investment capital.

Before acquisition of any technology, it must be borne in mind that all technologies cost money and consume resources. Many technologies such as a CT scanner or MRI will require comprehensive and high-tech modifications to an existing area, or the construction, usually high-cost, of an addition to the facility [Hawkins 1992].

The traditional practice in Kenya and South Africa to award a tender to the lowest bidder is short-sighted [Kachieng'a 1998a, Kachieng'a and Boonzaier 1999]. Practical experiences show that the cheapest equipment generally turns out to have the highest running costs [Hawkins 1992, Kachieng'a 1998a]. Equipment acquisition should be based on CO and ROI [Hawkins 1992, David and Judd 1993]. Tender boards need technology assessment information and the capacity to use it. Tender boards need to be empowered with technical information to be able procure appropriate equipment the meets clinical needs.

8.6.6 MANAGEMENT OF HEALTH CARE EQUIPMENT LIFE–CYCLE IN THE HOSPITAL ENVIRONMENT

According to the survey results and field interviews, equipment planning is not practised in Kenya and South Africa. Historically, selection of health care equipment has always been influenced mainly by doctors, who focus on medical considerations rather than technical and financial requirements [Kachieng'a 1998a, Kachieng'a and Boonzaier 1999]. Strategic matching of new equipment and old is also not practised. It is always assumed that new equipment will enhance the delivery of health services. The tendency has been towards acquisition of equipment which is medically acceptable, but technically too sophisticated, requiring not only high maintenance budgets but also highly skilled engineers to maintain it.

The life cycle of equipment consists of several phases - planning, selection, procurement, installation, commissioning, maintenance and disposal [Bronzino 1992,1995, David and Judd 1993]. Effective management of all phases of the equipment life cycle directly affects equipment functionality and downtime.

Selection requires a multidisciplinary function, with contributions from medical, technical and financial departments. Medical specification defines the medical and health care objectives, based on the health needs of the country or community. The technical specification is based on technological requirements, including utility systems, computer hardware and software interface specifications, telecommunication requirements, after-sales technical support, and training of both users and in-house maintenance staff. The financial specification focuses on investment considerations – capital financing, returns on investment and cost of ownership. The overall equipment specification should thus ensure three things: 1) that the equipment is medically effective and acceptable to users; 2) the equipment is technically sound and conforms to established requirements and specifications; and 3) the equipment will remain optimally operational with adequate maintenance budget support throughout its economic life span.

Installation of equipment is largely determined by its expected use in relation to work patterns within the department or hospital. The availability of space, electrical power supplies, and environmental factors such as temperature, humidity and air pollution should all be taken into consideration.

Equipment acceptance testing and commissioning following its installation is a critical step towards the achievement of high-quality performance. Acceptance testing is undertaken to ensure that the performance of equipment meets the technical and performance specifications quoted by the manufacturer.

Equipment maintenance is normally divided into two categories: scheduled and preventive maintenance. All major maintenance procedures carried out on equipment by maintenance staff or the manufacturer's agent, or simple maintenance by users or operators, should be complementary. Maintenance procedures are intended to put equipment into the best possible working condition, but they cannot guarantee that it is used correctly in a given procedure. Quality control gives the users confidence in the latter respect. It is now widely recognised that the attainment of high standards of efficiency and reliability in the practice of modern medicine and health care delivery system requires appropriate quality assurance [IAEA 1991, Bronzino 1995].

Interviews with heads of clinical engineering departments in 43 hospitals in Kenya and South Africa showed that equipment on comprehensive maintenance contracts had higher reliability and less downtime. On the other hand equipment under labour and material contracts tends to have on average low reliability. A major reason for high equipment downtime in time and material contracts is bureaucratic administrative processes, which require that equipment be checked first and a quotation be provided before authorisation to proceed with repairs is granted. In both Kenya and South Africa the authorisation can take from one to three weeks to be provided. Sometimes the authorisation to repair equipment is deliberately delayed because of lack of maintenance funds. This is a common phenomenon contracts tends to have on average low reliability. A major reason for high equipment downtime in time and material contracts is bureaucratic administrative processes, which require that equipment be checked first and a quotation be provided before authorisation to proceed with repairs is granted. In both Kenya and South Africa the authorisation can take from one to three weeks to be provided. Sometimes the authorisation to repair equipment is deliberately delayed because of lack of maintenance funds. This is a common phenomenon at public hospitals towards the end of the financial year.

With advancement of health care technology over the last decade, even the best in-house maintenance programme cannot always maintain every piece of equipment in today's hospitals [MSC 1992, David 1993, Bronzino 1995, Kachieng'a' 1998a]. Equipment systems such as CT scanners and other high-technology systems are often difficult to maintain with in-house resources. Lengthy training courses, testing equipment, and high cost of stocking spare parts make it difficult to maintain these systems in effective manner. Only if there is a sufficiently large amount of equipment on-site is an in-house specialist justified [David 1993, Bronzino 1995].

Equipment planning and effective management of equipment life cycles are important functions of a clinical engineering department. Proper management of the equipment life cycle reduces maintenance problems and cost of ownership, and increases service efficiency. Figure 8.10 shows the linkage between equipment failure rate over time (the so-called "bathtub curve") [Johnson 1989] and equipment management processes. The relationships between equipment failure at different sections of the bathtub curve and the equipment management characteristics are presented in Table 8.8.

Failures in section A-B of the bathtub curve can be avoided through proper management of equipment acquisition, installation and commissioning. Failures in the C-D part of the curve

Figure 8.10:

Linkage between equipment failure rate (Bathtub Curve) and equipment management processes

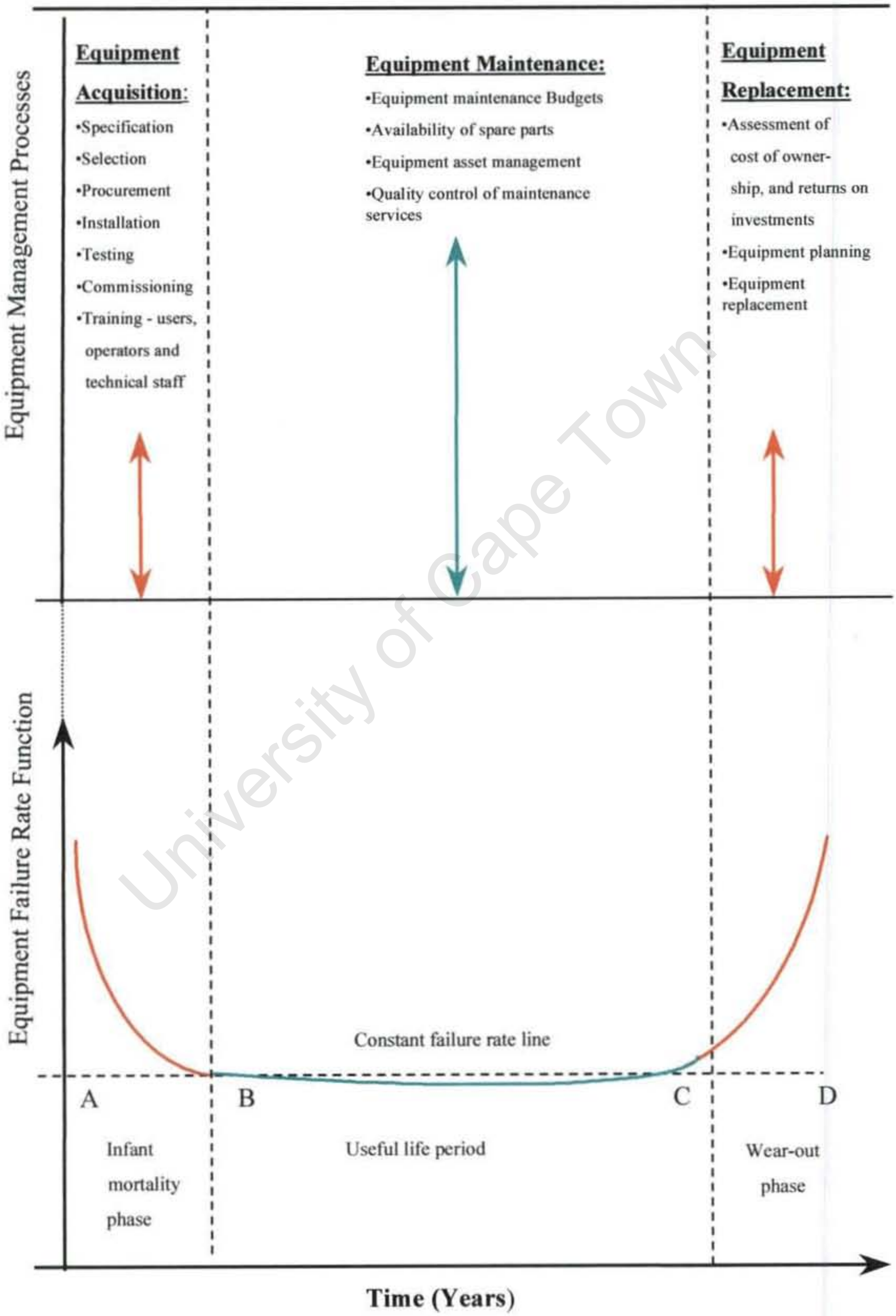


TABLE 8.8:

PHASES OF HEALTH CARE EQUIPMENT FAILURE RATES FUNCTIONS AND THEIR MANAGEMENT CONTRIBUTING FACTORS

Section (Bathtub)	Equipment Functional Phase	Management Characteristics
A-B	**Infant mortality phase** (High failure rate - due to management and operational problems)	High investment capital outlay Training of users, operators and maintenance staff (training curve effect) Management problems Operational and technical problems Low equipment utilization Low medical output (throughput)
B-C	**Useful life phase** (Low failure rate)	Appropriate maintenance budgets Expertise of clinical engineers and technicians Quality control of equipment Equipment assets management
C-D	**Wear - out phase** (High failure rate - due to aging)	High maintenance costs Low equipment utilization Low medical throughput Reduced service efficiency

can be significantly reduced through correct timing of equipment replacement. The use of equipment in section B-C can be enhanced through appropriate management of spare logistics, maintenance contracts, preventive maintenance and quality control. Well trained and skilled maintenance staff is essential at each stage for a successful equipment management programme.

Although, the management of each phase of the equipment life cycle is important, the main challenge to clinical engineers is to manage individual phases such that each phase of the life cycle enhances the operations of the next. It is important to achieve both technical and service synergy in equipment life cycle management for a hospital to provide high-quality, cost-effective health care.

8.6.7 COMPUTER USE IN HOSPITALS

During this decade the use of computer mainframes and personal computers (PCs) in hospitals has grown enormously world wide [Bronzino 1992, Subramanian and Villez 1991]. The use of PCs in African hospitals has also shown significant increase. PCs and networks are now commonplace in every facet of hospital operations, including data analysis for research, collection of new data from hospital records, and their use as teaching tools. PCs are also increasingly used as integral parts of local area networks and hospital information systems. It is evident that PCs are bound to play a greater role in health services management and data collection, therefore there is need for their structured integration into African health care systems. Computers provide hospitals with opportunities to improve operational efficiencies, to aid in managerial decision making, and more recently, to gain competitive advantage through innovative and creative applications in health care delivery systems (see survey data in Appendix C].

8.6.8 CLINICAL ENGINEERING STAFF CAREER DEVELOPMENT

As mentioned earlier, there are insufficient clinical engineers and clinical engineering technicians in public hospitals in Kenya and South Africa. As a result some health care technical services, such as the management of equipment maintenance contracts, are handled mainly by hospital administrative officers with no clinical engineering expertise. Even when maintenance services are contracted from external contractors, adequate supervision cannot be provided due to lack of qualified in-house staff. Equipment budgets in public hospitals are too limited to support 'total' outsourcing of maintenance services, and therefore, there will always be a need for resident clinical engineering staff.

Equipment maintenance problems originate from poor equipment procurement. There is an urgent need to create senior posts for clinical engineers to be appointed to the equipment tender boards, to manage technical evaluation of equipment before procurement. Assessment of health care equipment by clinical engineers before procurement would reduce both capital and recurrent costs without sacrificing the quality of care in public hospitals.

Because the appointment of clinical engineers and technicians is of strategic importance to ensure efficient functioning of the health system, it is essential to retain the services of suitably qualified personnel in the public sector. There is thus a need for a scheme of service for clinical engineers and technicians that will give such personnel a definite career path in the sector.

8.6.9 TRAINING OF CLINICAL/ MEDICAL ENGINEERS AND TECHNICIANS

It is comparatively easy to transfer the hardware and software associated with a particular health care technology from an industrialised to a developing country, but the ability to use the technology cost-effectively can only be acquired through training of local clinical engineers [Kachieng'a and Boonzaier 1999]. Technical skills have to be learnt, and infrastructural and financial arrangements have to be made in order to produce the intended medical benefits. In addition, sustainability of a technology in the health care system requires continuous technical and managerial capacity building.

Training of clinical/medical engineers and technicians is still in its infancy. With a population of about 70 million people in the study area (Kenya and South Africa), there are only three institutions offering courses in clinical and biomedical engineering. Mombasa Polytechnic (Kenya) and Pretoria Technikon offer both ordinary and higher diploma courses in clinical engineering, while the University of Cape Town offers postgraduate diplomas and degrees in biomedical engineering. Staffing norm for clinical engineering department for various hospital categories is provided in Appendix F [Kachieng'a and Stahl 1992].

Although clinical engineering courses at the above-mentioned institutions provide the necessary fundamentals in specific aspects of clinical engineering, there is need for students to go through a structured, hands-on internship experience in the hospital environment. The role of clinical engineers in management of equipment and other health care support services within the hospital is further discussed in Chapter 11.

8.7 CONCLUSION AND RECOMMENDATIONS

The problems with health care technology investments in both Kenya and South Africa arise more from inadequate technology planning (management and assessment), rather than from clinical applications of the technologies. The common problems are:

- Poor technology selection and procurement;
- Mismatch of technology and the available human resources and expertise;
- Incompatibility of new technology with existing technologies and services;
- Lack of planned budgetary support for maintenance services and spare parts, training of users and clinical engineering staff, and other operational costs;
- Lack of equipment policy and standardisation;
- Lack of a national technology policy; and
- Lack of career path for clinical engineers (South Africa).

Most of the problems are related to organisational and policy issues; and have nothing to do with clinical applications and the clinical benefits derived from individual technologies.

Some recommendation on how these problems may be addressed follow below.

1. There is need to strengthen and streamline management of the technical infrastructure for health care equipment selection, procurement and maintenance management.

2. Hospitals need equipment assets management systems for monitoring equipment life-cycle costs, maintenance costs and management of equipment replacement.

3. The operations of the tender board need to be redefined. Under the present tender conditions, there are no incentives or provisions for public hospitals to seek discounts

3. The operations of the tender board need to be redefined. Under the present tender conditions, there are no incentives or provisions for public hospitals to seek discounts and warranty credits for major equipment purchases. Secondly, although the tender board is the budget holder, it is the hospitals that carry the burden of equipment ownership and pay the economic penalties for inappropriate acquisitions, not the tender boards; therefore they should have more say in equipment acquisitions through the tender boards.

4. Equipment maintenance budgets should be linked to actual equipment capital investment and rate of utilisation. Hospitals should not purchase equipment which their maintenance budgets cannot support.

5. To achieve optimum utilisation of expensive equipment, specialised departments in public hospitals, such as radiation therapy, radiology, nuclear medicine and renal units, should be permitted to provide specialised technological services to private patients 'after hours' to generate funds for equipment maintenance and replacement and for staff training. A fund distribution formula of 50-30-10-10 can be used, where 50% of the funds generated remains in the mother department, 30% goes to the feeder departments, 10% to hospital administration and the final 10% to the government. The essence of this recommendation is to assist public hospitals to generate their own funds for equipment maintenance rather than depending on inadequate equipment maintenance budgets provided by the government.

6. There is a need for staffing norm for clinical engineering department depending on the health facility capacity in Kenya and South Africa. The proposed staffing norm for technical cadre is provided in Appendix F.

Among the most important issues that have emerged from this cross-national survey are the lack of participation of trained technical specialists in the planning and procurement of health care equipment, the absence of an essential equipment list for hospitals at various levels, and the inadequacy of training of clinical engineers to meet their changing roles in the hospital environment. These questions have been further researched and are discussed in depth in the following three chapters.

CHAPTER 9

PROFESSIONAL OPINION SURVEY

Chapter 9 is concerned specifically with a survey of the professional views of practising clinical engineers and technicians on the use of health care equipment in the public sector in Kenya and South Africa.

The ability to face unprecedented situations by using the accumulated intellectual power of the race is mankind's most precious possession.
Arthur E Bestor

HD Banta,CJ Behney and JS Willems
Toward Rational Technology in Medicine, 1981

The growing demand throughout the world for more and better health care greatly expands the role of health care equipment in the delivery of health services. The seriousness of the consequences that may arise from the use of defective equipment, including injury or death and subsequent malpractice litigation, makes it incumbent upon both manufacturers and users of health care equipment to ensure that high quality equipment is properly manufactured and maintained for safe, effective and reliable operation in a clinical environment. In addition, selection of the best available equipment often saves time and money as a result of a lower frequency of breakdowns and smaller expenditures for spare parts, service and maintenance. Selecting and procuring health care equipment which is appropriate, efficient and safe, remains a major challenge to African governments. Most African countries do not have technical capacity and the expertise to carry out health care equipment assessment.

9.1 MARKETS FOR HEALTH CARE EQUIPMENT

The market for health care equipment and devices is very large. It includes government and private hospitals, clinics, laboratories, nursing homes, medical research institutions, industrial medical facilities, pharmaceutical firms, and individual physicians and surgeons. Health care equipment is becoming increasingly important as more African countries raise their health care standards and improve accessibility to health care facilities. Most countries in Africa, including South Africa, are net importers of health care equipment. For example, a pilot field survey during this research indicated that the most frequently imported items of equipment included blood chemistry analysers, patient monitoring systems, portable infant incubators, renal dialysis machines, X-ray equipment, nebulizers, resuscitation equipment, operating tables and theatre lamps [Walters and Bunn 1995, Kachieng'a and Boonzaier 1999].

More and more health care equipment is becoming micro-processor-based. Maintenance personnel will have to be re-trained to meet the new trends in health care equipment manufacture.

9.2 LITERATURE REVIEW

Health care technology management has been defined as *an accountable, systematic approach to ensuring that cost-effective, efficacious, safe, and appropriate equipment is available to meet the demands of quality care* [ECRI 1989]. In most hospitals in industrialised countries, the importance of technology management, especially equipment maintenance, is well recognised as an integral part of hospital management.

Equipment asset management encompasses the traditional duties of a clinical engineering department. This includes involvement in equipment acquisition and other life-cycle issues, supplying equipment information and training, monitoring and evaluating equipment, and documenting equipment [David and Judd 1993, Menon 1993, Bronzino 1995, Kachieng'a 1998a].

It also includes using equipment management information to provide a more complete analysis of specific financial and clinical indicators, as well as for compliance with the regulatory and accreditation requirements [David 1993, Bronzino 1995]. Viewed from this perspective, technology management is actually the practice of integrating technology strategy with the health service strategy of the hospital, in the most efficient and cost-effective way [Kachieng'a 1992, World Bank 1993a].

It is an accepted norm in developed countries that technology forms an integral part of health policy and planning. In many hospitals in these countries, health care equipment maintenance and management have become the responsibility of the clinical/medical engineering department [Pacela 1992, Dyro 1993, Bronzino 1995].

In contrast, in many developing countries health care equipment still remains a major problem in the delivery of health services [Banta 1986, Perry and Chu 1992, Free 1992, Kachienga and Boonzaier 1999]. Equipment maintenance problems have become critical due to the short supply of trained clinical engineers and technicians. For example, in Zimbabwe the highest vacancy rate among personnel in the Ministry of Health in 1990 was in posts for medical equipment maintenance technicians [World Bank 1995a].

Poor equipment selection and procurement also contribute to maintenance problems in the health sector in most African countries [Free 1992, World Bank 1993a, Halbwachs and Issakov 1994]. Equipment tender boards lack technical expertise to select equipment that meets health needs and technology requirements. A study on equipment procurement in Kenya found that neither the Ministry of Health nor the National Tender Board had clinical engineers or technology experts as members [Kachieng'a 1992]. Lacking information about efficacy, safety, cost-effectiveness and cost of ownership, both boards used equipment purchase price as a major guide, rather than returns on investment (ROI) as should be the case. In Kenya and South Africa, lack of essential information on technology assessment is a major handicap in equipment management in the public sector.

A review of the literature on equipment maintenance problems in Sub-Saharan Africa shows that earlier studies [Bloom and Temple-Bird 1988, Mills 1991, Issakov 1994, World Bank 1993a, 1995a] were project-oriented and focused on individual, donor-supported programmes. This is the first study exclusively focused on equipment maintenance personnel. It seeks to investigate equipment maintenance problems from the point of view of clinical engineers and technicians in public hospitals.

9.3 SURVEY OF HEALTH CARE EQUIPMENT MAINTENANCE SPECIALISTS

Between September 1996 and September 1997, a number of health care equipment maintenance specialists were interviewed to determine current maintenance practices in Kenya and South Africa. The equipment maintenance experts were drawn from small (75-300 beds), medium (301-600 beds) and large (>600 beds) hospitals, as well as regional equipment maintenance workshops. The categorisation of hospitals by bed size provided a more realistic and universal measure than administrative classification, such as district or provincial hospitals.

9.3.1 SURVEY RATIONALE

The purpose of this survey of equipment maintenance experts was to investigate the factors contributing to health care equipment maintenance problems in public health institutions. Firsthand professional views and information from practising clinical engineers and technicians in small, medium and large public hospitals, as well as regional equipment maintenance workshops were used.

9.3.2 ORGANISATIONS IN SURVEY

Fifty-six questionnaires (see Appendix D) were mailed to clinical/medical engineers and technicians (equipment maintenance specialists) in public hospitals in Kenya and South Africa; 38 replies were received (68 per cent response). The respondents included 4 equipment specialists from small hospitals, 10 from medium hospitals, 16 from large hospitals, and 8 from regional equipment maintenance workshops. The responses from 3 other facilities were incomplete and therefore not included in the survey.

Of the equipment specialists who responded, 16 were based in Kenya and 22 in South Africa. The majority of respondents were drawn from urban teaching hospitals, because it has been reported that teaching hospitals invest roughly six times as much in technology annually as non-teaching hospitals, and urban hospitals invest about four times as much as their rural counterparts [Cromwell *et al.*1987]. The number of participants (experts) are summarised according to job title in Table 9.1. The average working experience of participants was 5.53 years.

TABLE 9.1:

NUMBER OF PARTICIPANTS BY JOB TITLE

Job title	Number of participants(experts)
Equipment Maintenance Managers	4
Clinical Engineers*	4
Clinical Engineering Technicians (Med./Biomed. Eng. Technicians)	30
Total	**38**

**Highly trained and experienced clinical engineering technicians with equivalent practical experience of a clinical engineer. (No graduate clinical engineers were employed in the state hospitals covered).*

9.4 SURVEY RESULTS

Table 9.2 presents a summarised survey of the statistics by institution status, capacity and number of participants.

TABLE 9.2:

HEALTH CARE EQUIPMENT MAINTENANCE SPECIALIST SURVEY DATA –INSTITUTIONS AND PARTICIPANTS

Institution status	Beds	Number of Institutions	Participants
Small Hospitals	75–300	2	4
Medium Hospitals	301–600	2	10
Large Hospitals	> 600	4	16
Regional Maintenance Workshops	-	2	8
Total	–	**10**	**38**

Results of this study were reviewed in the following categories: hospital size (number of beds); health care equipment maintenance; frequently used equipment with high maintenance demand; equipment in-house maintenance versus external maintenance service; equipment donations; spare parts inventory; equipment warranty; and recognition of clinical engineering department. The discussion of the results is comprehensively covered by category in section 9.6 of this chapter.

9.4.1 HEALTH CARE EQUIPMENT MAINTENANCE

The views of equipment maintenance specialists on equipment maintenance can be summarised as follows:

1. Health care equipment maintenance represented a problem to 34 (about 90%) of the 38 respondents.
    a) 20 indicated equipment maintenance was a *major* problem;
    b) 10 indicated that it was a *significant* problem;
    c) 4 indicated that it was an *insignificant* problem.
    d) Health care equipment represented *no problem* to 4 of the respondents.
2. The significance of the maintenance problem increased with hospital size.
    a) Based on 4 hospitals of over 600 beds (large hospital):
    3 of the participants claimed maintenance was a *major* problem and 1 a *significant* problem.
    b) Based on 2 hospitals of 301-600 bed (medium hospitals):
    1 participant claimed maintenance was a *major* problem and the other participant claimed it was a *significant* problem.
    c) Based on 2 hospitals of between 75 and 300 beds (small hospitals):
    1 participant claimed it was a *significant* problem while the other claimed maintenance was not a problem.
    d) Based on 2 Regional Maintenance Workshops, all 8 participants claimed equipment maintenance was becoming a *significant* problem because of vast changes in equipment design and inadequate training for maintenance staff on new equipment.

Field visits and also face to face interviews with equipment maintenance experts confirmed that equipment maintenance problems were severe in larger hospitals

9.4.2 FREQUENTLY USED EQUIPMENT WITH HIGH MAINTENANCE DEMAND

Equipment maintenance experts were asked to rank different equipment groups according to frequency of use and maintenance demands. All of the 38 respondents stated that diagnostic equipment is the most frequently used; monitoring equipment ranks second, followed by therapeutic equipment (third) and laboratory equipment (fourth). The frequency of use and hence maintenance demand of various types of equipment is presented in Table 9.3.

TABLE 9.3:

HEALTH CARE EQUIPMENT RANKED BY FREQUENCY OF USE AND MAINTENANCE DEMAND

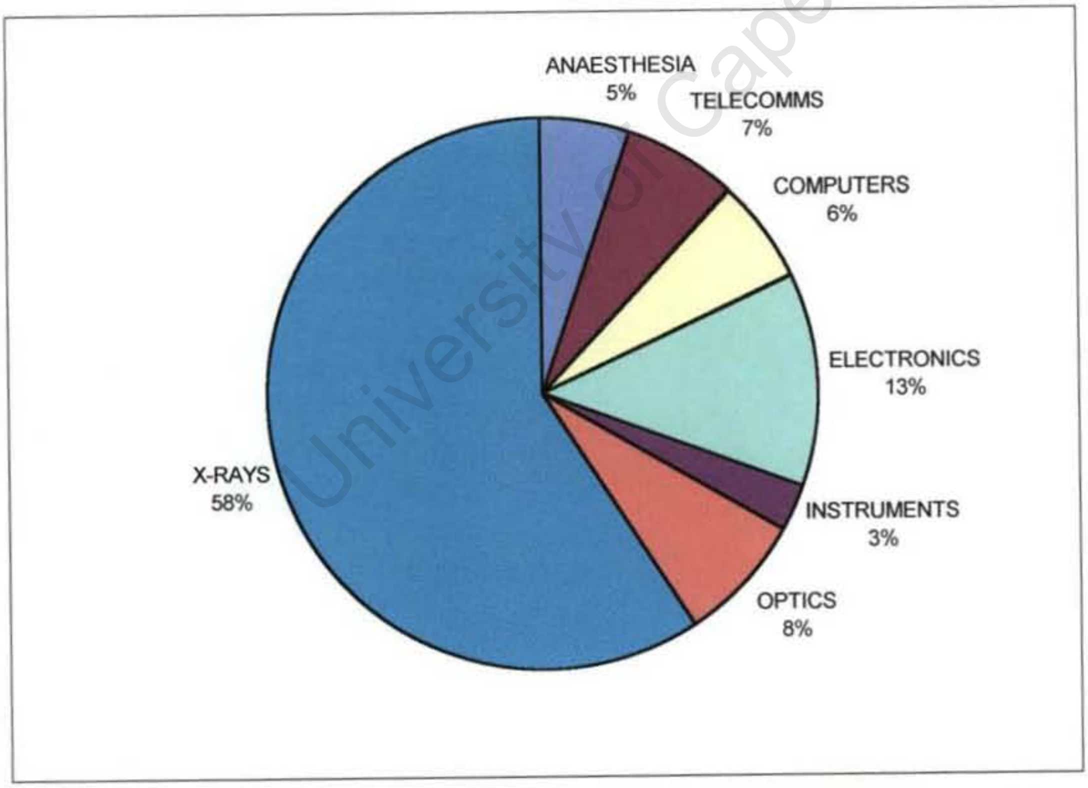
Equipment category	No. of times mentioned	% of Total
Diagnostic equipment	**42**	**40.38**
Electrocardiograph (ECG)	20	19.23
X-ray units	16	15.38
Others	6	5.77
Monitoring equipment	**32**	**30.76**
Patient monitors	18	17.30
Cardiac monitors	14	13.46
Therapeutic equipment	**16**	**15.39**
Haemodialysis machines	8	7.69
Defibrillators	4	3.85
Others	4	3.85
Laboratory & other equipment	**8**	**7.69**
Sterilizers	6	5.77
Others	2	1.92
Information & data systems	**4**	**3.85**
Computer printers/paging units	3	2.89
Other	1	0.96
TOTAL	**104**	**100.00**

The finding of diagnostic, monitoring and therapeutic equipment as groups of equipment with high maintenance demand was consisted with actual maintenance expenditures by two leading hospitals in the Western Cape (South Africa), which differ considerably from each other in maintenance structures. They both showed high maintenance expenditures on diagnostic, therapeutic and laboratory equipment, respectively.

Figures 9.1 and Figure 9.2 show the trend of maintenance expenditures in both hospitals.

Figure 9.1:

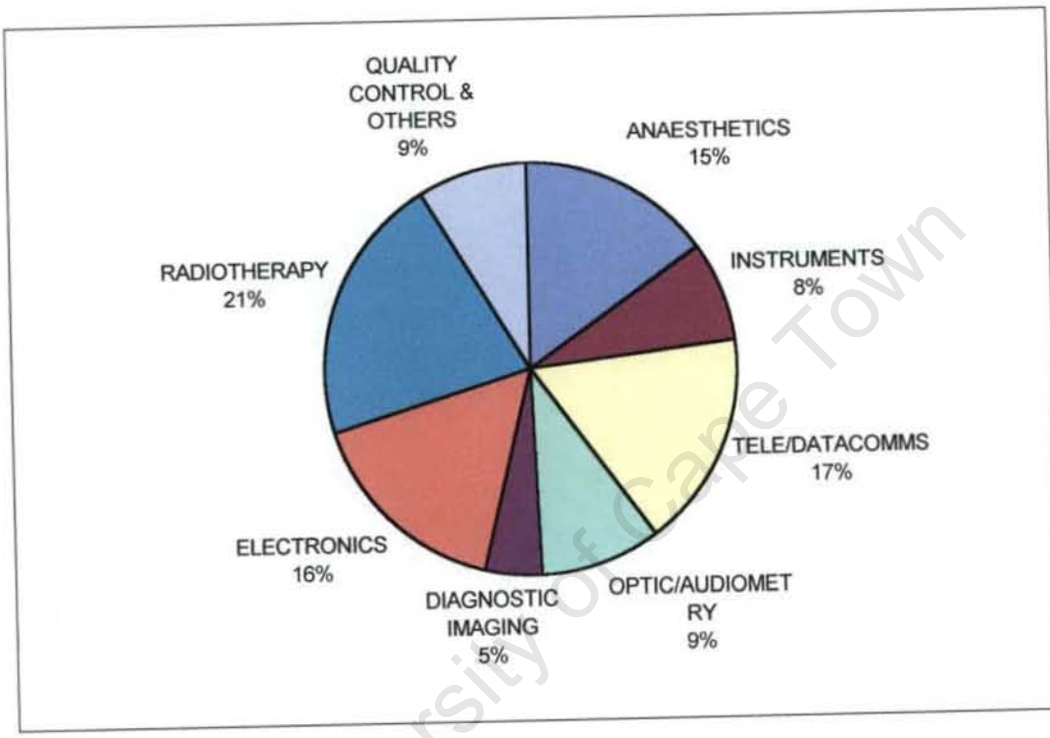
Health care equipment maintenance expenditure -1997/98 financial year.



Courtesy: Clinical Engineering Department, Tygerberg Hospital (TBH), Cape Town, (June 1998).

Figure 9.2:

Health care equipment maintenance expenditure -1997/98 financial year (GSH)



Courtesy: Clinical Engineering Department, Groote Schuur Hospital (GSH), Cape Town, (June 1998).

9.4.3 EQUIPMENT DONATIONS

Out of 27 responses from hospital-based specialists (30 in total) on the question of whether equipment donations were beneficial to the hospitals, 25 respondents claimed that most high-tech equipment donated to hospitals did not work beyond providing positive media publicity to the "donor", and much of donated high-tech equipment often ends up in equipment store rooms ('equipment funeral homes'). There are always some technical or budgetary problems associated with donated equipment. However, there were concurring views from 23 respondents that donation of simple devices like stethoscopes, scales, drip stands and basic surgical instruments were beneficial to all hospitals. Four respondents had no experience with donated equipment. Other studies have also provided negative appraisal to equipment donations [Kachieng'a 1992, World Bank 1995a].

9.4.4 IN-HOUSE VERSUS EXTERNAL MAINTENANCE SERVICE PROVIDERS

Data supplied by the participants indicated that the hospitals (eight) were predominantly using a combination of internal and external maintenance services. The larger hospitals with well-trained and experienced maintenance personnel showed a tendency to rely more heavily on in-house maintenance service. The survey data showed that smaller hospitals depend heavily on external maintenance contractors, and the maintenance departments are poorly staffed. Maintenance problems and payments for contracts are mostly co-ordinated by hospitals' administration, and not maintenance departments.

9.4.5 SPARE PARTS INVENTORY

1. Seventy percent of participants (experts) stated that they had an inventory of spare parts for some pieces of equipment. The importance of the inventory increased with hospital size as depicted in Table 9.4.

TABLE 9.4:

SPARE PARTS DEMAND BY HOSPITAL SIZE

Hospital Size (Beds)	Participants (experts) with Spare Parts Inventory	% of Total
75 up to 300	2 out of 4	50
301 up to 600	6 out of 10	60
600 and over	16 out of 16	100
TOTAL	**24 out of 30**	**70**

2. Out of 23 responses from hospital-based specialists on the question of whether spare parts inventory in the hospital was deemed critical, 18 respondents stated that it was critical and 5 said it was not. The specialists from hospitals located far from major urban centres felt insecure without essential spare parts for critical diagnostic, therapeutic and laboratory equipment. The spare parts insecurity issue also surfaced in discussions during field visits to rural hospitals. The breakdown according to hospital size is presented in Table 9.5.

TABLE 9.5:

RESPONSE ON STOCKING OF SPARE PARTS

Hospital size (Beds)	Number of Responses	"Yes" Responses	"No" Responses
75 - 300	2	1	1
301 - 600	7	5	2
> 600	14	12	2
TOTAL	**23**	**18**	**5**

9.4.6 EQUIPMENT WARRANTY

1. Thirty-three respondents out of the 38 participants in the survey answered the question on whether the present warranties offered by suppliers were satisfactory. Eighteen of the respondents stated that they were; 11 said they were not, and 4 stated that it depended on the type of equipment. The reasons most commonly given for dissatisfaction with warranty policies are presented in Table 9.6.
2. There were 35 responses to the question of whether warranties should continue to be offered. Twenty-nine respondents stated that they should, while 6 said it would depend on the type of equipment.

The specialists stated that better warranty conditions could enhance the ability of the hospitals to operate and maintain sophisticated equipment and devices more cost-effectively. They also noted that hospital administration, which normally negotiates warranty contracts, lacks technical expertise to negotiate broad-based warranty.

TABLE 9.6:

REASONS FOR WARRANTY DISSATISFACTION

Reasons	No. of times mentioned	% of Total
Limited spare parts coverage	6	55
Poor workmanship and service	3	27
Lengthy repair time	2	18
Total	11	100

9.4.7 RECOGNITION OF CLINICAL ENGINEERING DEPARTMENT

The responses on degree of recognition of clinical engineering departments by hospital administration fell into three categories: *Full recognition*, *partial recognition* and *no recognition*. Out of the total of 30 hospital-based respondents, 13% indicated that their departments were sufficiently recognised, 17% achieved no recognition and 70% achieved partial recognition. Recognition was defined as attending departmental meetings, equipment pre-purchase consultations and consultation on other health technical support issues. The factors indicating non-recognition and partial recognition were the department being bypassed during the equipment acquisition process, while still being expected to maintain and repair equipment and devices. In such cases the departments are treated as "repair depots" and as such are not recognised or supported by hospital administration. A study of the correlation between the variable of 'level of pre-purchase consultation' and recognition of the department yielded highly significant results. No recognition and partial recognition were concentrated in small and medium hospitals, while sufficient recognition of clinical engineering departments was most pronounced at large hospitals with sophisticated equipment.

9.5 DISCUSSION OF PROFESSIONAL VIEWS FROM HEALTH CARE EQUIPMENT SPECIALISTS

In this section the trends emerging from the questionnaires are elaborated with further details gathered from the subsequent field interviews with equipment maintenance specialists.

9.5.1 IN-HOUSE VERSUS EXTERNAL MAINTENANCE SERVICE

The equipment specialists were in common agreement that there is a general need for an internal maintenance staff in all categories of hospitals, either to co-ordinate and supervise maintenance services provided by external maintenance providers or to carry out actual equipment maintenance work. The findings indicated that small hospitals (75–300 beds) rely more heavily on external maintenance contractors and warranties. Medium and larger hospitals depended less on warranties and used in-house service for general maintenance, only using external contractors for specialised repairs and services such as calibration and quality control protocols.

9.5.2 EQUIPMENT WARRANTY

Warranties and services offered by manufacturers, suppliers and independent maintenance providers were viewed as inadequate by more than half of the participants. The inadequacies cited included limited time and parts coverage of warranties, poor workmanship by inadequately trained servicing personnel, and lengthy repair times, leading to high equipment downtime. It was evident during hospital visits and face to face interviews with experts that most hospitals do not have the technical expertise to negotiate appropriate warranty appropriate for their situations. More often than not, they take warranty package offered by equipment suppliers without any appropriate amendment; later on the institutions blame the suppliers for unfair warranty agreement.

9.5.3 BUDGETARY AND INFRASTRUCTURAL SUPPORT

The specialists were of the opinion that support (infrastructure and budgetary) to health care equipment maintenance remains inadequate and many small and medium hospitals have not fully recognised equipment maintenance as a major contributing factor to efficient and cost-effective health care service delivery. Some large hospitals (meaning large urban and teaching hospitals) have recognised the importance of equipment maintenance and have accordingly employed trained clinical/medical engineers and technicians and established maintenance workshops and spare parts inventory management systems. However, most hospitals still lack adequate technical infrastructure and fiscal budgetary support to maintenance services. A frequent comment from the specialists was that maintenance contracts were generally negotiated by personnel of hospitals' administration or financial departments, who do not have the technical capacity to assess consequences and technical implications of the contracts.

9.5.4 EQUIPMENT SELECTION AND ACQUISITION

The maintenance specialists felt that there is a need for equipment selection and procurement policy or guidelines. Inappropriately procured equipment is normally the beginning of maintenance problems, often rendering the equipment non-functional. According to the respondents, lack of equipment standardisation, poor management information support (inventory and asset management systems), poor logistics of spare parts and lack of ongoing training compound the problems of maintenance for technical personnel and users. This concurs with the study by the World Bank [1993a], which concluded that standardisation could simplify management and maintenance and reduce inventory costs.

The evidence gathered from the survey and field visits showed that the participation of clinical engineering staff in equipment selection and procurement is generally limited to the writing of technical specifications. The limitation is greater in smaller hospitals than larger ones, but even in the larger hospitals the participation of clinical engineering staff is limited to facility level. On major equipment acquisitions clinical engineers are sometimes invited to take part in tender adjudication, but this is an exception rather than policy.

9.5.5 MANAGEMENT OF EQUIPMENT PROCUREMENT

The specialists felt that there is a need for policy guidelines on equipment procurement. Well-managed equipment procurement can save both time and money, as a result of the shorter time required to train operating personnel and to install and commission equipment, lower frequency of breakdowns and accompanying inconvenience, shorter equipment down-time, smaller expenditure for parts and maintenance, and fewer preventive maintenance requirements. The equipment specialists in small hospitals considered their participation in equipment procurement unsatisfactory.

9.5.6 EQUIPMENT PROCUREMENT COMMITTEES AND THE TENDER BOARD

The specialists felt that equipment procurement committees and the tender board should give careful attention to special requirements such as equipment calibration, standardisation, and quality control, since few hospitals have certified and qualified staff to provide these services. Compatibility of new equipment with existing equipment is important, both for safety and for ease of integration into existing diagnostic, therapeutic or patient-monitoring systems. The standardisation of power sources, power connectors and other hardware leads to overall economy of operation and a higher degree of safety for the patient, despite a possible higher initial cost. Currently, the absence of government and industry standards has resulted in a variety of incompatible equipment connectors and devices that present potential safety hazards. Tender boards, as presently constituted, do not have the technical capacity to address all technical issues required for successful equipment selection and procurement.

9.5.7 EQUIPMENT PURCHASE PRICE VERSUS COST OF OWNERSHIP

The specialists felt that there was too much focus by the tender boards on purchase price, rather than the cost of ownership which encompasses all direct and indirect expenses associated with an item of health care equipment over its economic life [ECRI 1988]. It is estimated that the purchase price represents only 20% of the cost of ownership [David and Judd 1993]. Careful consideration of all life-cycle costs is absolutely essential to hospital administrators in determining the best equipment for their purposes. What seems to be the most expensive equipment in the beginning may prove to be less costly in the long run [Hawkins 1992, World Bank 1995a, Bronzino 1995, Kachieng'a 1998a].

9.5.8 EQUIPMENT LEASE

Some of the equipment specialists (from South Africa) indicated that certain equipment suppliers have started equipment lease services, mainly in the private sector. It is a growing trend world wide and an option worth considering, with advantages such as minimal initial capital outlay and quick availability [MSC 1992]. It is also becoming a business practice in the private sector to outsource services like computing and information systems to private services providers.

The decisions whether to lease or buy depend on the situation in an institution. However they should be based on analysis of comparable break-even costs between lease cost, ownership cost and the percentage of time the equipment will be productively employed over its useful economic life-span. The cost of leasing is usually limited to the monthly fee (with in built component costs), whereas ownership costs include maintenance, calibration, depreciation and storage, as well as the cost of having capital tied up in the equipment.

The main obstacle to leasing equipment in the government hospitals is that the Tender Boards have no system for leasing equipment. Even upgrading equipment meets a strong bureaucratic opposition at the tender boards. Some hospitals opt for new equipment purchases, rather than go through lengthy approval procedures involved in equipment upgrades. The consequence is that fairly functional items of equipment requiring inexpensive upgrades are replaced by new ones just to avoid unnecessary bureaucratic red tape.

9.5.9 EQUIPMENT MAINTENANCE

The survey data indicate that maintenance programmes consisting of a combination of both internal and contracted maintenance services was the most common in public health facilities. In recent years, in both Kenya and South Africa, there has been increased engagement of biomedical and clinical engineers for management of equipment maintenance services in hospitals, as indicated in this survey.

Specialists from large hospitals (26 experts) felt that there should be an "equipment alert information centre" where non-performing equipment can be reported or black-listed by clinical engineering departments. At present, equipment that has failed to perform in some public hospitals is sold to other unsuspecting public hospitals. The experts also felt that public hospitals should collaborate to share some essential maintenance services as is done in the private sector. They envisaged hospitals utilising a single or several specialised organisation(s) for equipment maintenance, calibration and training of maintenance staff. It was generally felt that state hospitals should use their 'market purchasing power' to negotiate for better maintenance contracts from external equipment maintenance service providers.

Equipment specialists felt that equipment manufacturers and suppliers control equipment maintenance through service contracts, and that they limit information about their products by providing poorly written service manuals. This lack of co-operation, from manufacturers, they felt, hinders cost-effective management of technology. Some suppliers also practice "sell and run" philosophy, where they do not provide after-sales back-up services. These practices impede effective transfer of HT from industrialised countries to African countries.

9.5.10 EQUIPMENT DONATIONS

Equipment donation has remained a controversial issue in African countries. Despite charitable intentions of the donors, hospitals rarely benefit from donated equipment, due to a variety of factors [Halbwachs and Issakov 1994, World Bank 1995a]. The World Bank Development Report of 1993, *Investing in Health Care,* concluded that even when donated equipment meets local requirements, very little of it ever becomes operational, for reasons - including missing or damaged parts, lack of disposable inputs and of user and service manuals, and problems with power supply. Another World Bank study [1995a] concluded that the greatest obstacle to improving health technology in Africa was "technology philanthropy" - the uncoordinated donation of equipment to African countries by foreign agencies and charities. A study by Scottish Overseas Health Support recommended that African countries should have "donation protocols," whereby the kinds of equipment to be donated would follow a model paralleling, for example, the selection of drugs by using essential drugs lists [World Bank 1995]. The development of a Standard Essential Equipment List (SEEL) is comprehensively discussed in Chapter 10.

Kachieng'a [1992] concluded in his study that equipment donations should be treated as investments since recipient hospitals have to bear the costs of ownership (maintenance, consumables, training etc.). Therefore, it is perfectly legitimate to ask donors to accept various conditions in making their "gifts". Donations should not be used as a gentle way of dumping useless equipment in developing countries. A wrong donation is always more expensive than a rejected one [Kachieng'a 1992].

9.5.11 TRAINING OF EQUIPMENT USERS AND OPERATORS

There was total agreement amongst all respondents that training of equipment users and operators reduces equipment downtime [Persson *et al.* 1993]. The main problem is lack of training funds and personnel to carry out continuous or periodic training on equipment. All hospital-based respondents noted that nurses are the primary users of health care equipment, and many of them feel inadequately trained in equipment operation. In spite of continuous inter-departmental transfer of nurses, there is no ongoing regular training of nurses in their "new" departments. Many nurses (64 persons) interviewed during the field visits believed that their training does not prepare them adequately for new technologies. In some instances nurses had not even been trained on a new technology before using it. Fitter (1987) states that inadequate training of nurses, especially those working in the intensive care units merits special attention world-wide.

The equipment specialists group estimated that 20-30% of maintenance calls is user-related. Many experts believe that the vast majority of equipment-related injuries are due to user error, rather than from equipment malfunction [ECRI 1993]. According to the 38 equipment maintenance experts, training efforts that attempt to teach too much about electronics have not been successful, but programmes that stress proper use of specific equipment, utilising a step-by-step approach, have resulted in a dramatic reduction in service calls.

9.5.12 EQUIPMENT DESIGN TRENDS AND SPARE PARTS

The specialists noted that in the last decade equipment design has gone from a high proportion of mechanical components to a high proportion of electronic components. The life cycle of most electronic-based health care equipment has shrunk from 10 years a decade ago to five years presently, due to rapid innovations in health care technology. However, within the five years life span, the equipment still requires frequent upgrading (soft & hardware) to increase either efficiency or capacity. Equipment maintenance experts felt that hospital administrators and the Tender Boards should re-position themselves technically to match these new equipment life cycle trends in order to remain competitive.

Increased use of modular electronic elements in health care equipment will require that fewer types of replacement parts be stocked for repair and service, compared with the many individual components now required. Faults in equipment designed using modular electronic elements can usually be diagnosed more easily and equipment can be repaired and returned to proper operating conditions more quickly than equipment of traditional design. Even though a single component costs less than a modular element consisting of many components, and even though more sophisticated testing and calibration instruments are necessary, nevertheless the labour required to isolate and replace one faulty component, and the longer downtime involved, make equipment designed to use modular elements well worth consideration.

9.6 CONCLUSION AND RECOMMENDATIONS

Management of expensive and sophisticated equipment in larger hospitals merits special attention in both Kenya and South Africa. A maintenance and repair service has two basic functions in a hospital. One is to preserve technical operability and the second is to provide information essential for equipment management, especially for deciding about the selection and procurement of equipment [Halbwachs and Issakov 1994]. Both functions are still in their infancy in the two countries covered in the survey [Kachieng'a. 1998a, Kachainga and Boonzaier 1999].

The data from this survey clearly suggest that, while health care equipment is one of the necessary components of a comprehensive health care system, pieces of equipment by themselves are scarcely sufficient without technical and budgetary support, including funding of training of both maintenance staff and equipment operators and users. Kenya and South Africa must develop human capital to manage their national technological stock more efficiently, if the losses in technological investments are to be reduced.

In addition, equipment maintenance budgets are too small to support national equipment stock. Internationally, 10 per cent of capital investment is generally allocated for equipment maintenance [World Bank 1993a]. However, the results of the technology needs survey (see chapter 8) have shown that, in Kenya and South Africa, equipment maintenance budgets are less than 4% for all categories of hospitals.

It is difficult to imagine a modern health care system devoid of technology, and its contribution to the fight against disease is crucial. However, there are dangers posed by both its overuse and under-use due to lack of technical and management expertise. Whichever applies, the economic penalties are high. There is need for practical recognition of technological experts as facilitators of better health outcomes in the hospital environment.

9.6.1 RECOMMENDATIONS

On the basis of the results of the survey presented in this chapter, the following recommendations are made:

1. The management of the technical infrastructure of the hospitals should be strengthened and appropriate equipment maintenance budgets, matched to actual equipment stock, should be allocated.
2. A standard equipment list should be compiled for hospitals of different sizes.
3. Operational research on the most cost-effective technologies should be supported and results be made available to facility managers. The Global Action Plan devised by WHO for management, maintenance and repair of health care equipment could provide the basic framework [Hailbwachs and Issakov 1994].
4. Staffing norms for clinical engineers and technicians should be established in Kenya and South Africa.
5. In South Africa a Scheme of Service for Clinical Engineers and Technicians similar to that which is operational in Kenya should be developed.
6. New Tender Board guidelines and protocols to facilitate equipment upgrades and lease should be compiled.
7. A well trained and motivated technical workforce (clinical engineers and technicians) is essential for public health care system to function. There is an urgent need to strengthen technological managerial capacity throughout the public health sector.
8. A strong Directorate of Clinical Engineering should be established in the Department of Health (South Africa) to be responsible for health technology planning and management, and to co-ordinate technology assessment programmes. There is also need for National Scheme of Service for technology managers, professional clinical engineers and technicians in South Africa. Kenya has established a Directorate of Clinical/ Medical Engineering.

CHAPTER 10

DEVELOPMENT OF A STANDARD ESSENTIAL EQUIPMENT LIST

Chapter 10 focuses on the development of a standard essential equipment list for Kenya and South Africa. The chapter explains the necessity for such an essential equipment list and discusses how it was developed in the context of the particular needs of health care services in these two countries.

> *Medical devices pervade our experiences with health care throughout our lives – from foetal monitoring equipment and ultrasound imaging before birth to life-support systems and even suicide machines when death is near. Medical care has become increasingly dependent on technology, and medical devices are the epitome of the trend.*
>
> **Susan Barlett Foote**
> *Managing the Medical Arms Race, 1992*

10.1 HISTORICAL PERSPECTIVE

Since the 1960s, the international community and foreign governments have supported health projects and programmes in Sub-Saharan Africa (SSA). The World Health Organisation, UNICEF and the World Bank have spear-headed the support for better health in the region. Most of the technical aid support has included health care equipment.

Programmes supported by the international donor community have included:

- Primary Health Care (PHC).
- The Global Programmes on Aids (GPA).
- The Tropical Diseases Research Programme (TDR).
- The Expanded Programme on Immunisation (EPI).
- The Acute Respiratory Disease Programme (ARD).
- Global Vaccine Programme co-ordinated by WHO.
- Essential Drugs List (EDL) for developing countries.

In the same period, African governments have also acquired health care equipment through technical aid projects and through direct purchases with loans or grants from external sources.

The equipment acquisition was done without prior assessment of health needs, or of local capacity for equipment repair and maintenance or of budgetary support to these services. As a result most of the equipment is non-functional and health services have been compromised due to insufficient equipment maintenance.

10.2 STATEMENT OF THE ESSENTIAL PROBLEM

While pieces of equipment alone are not sufficient to provide health care, they do play an important role in diagnosis, therapy, treatment and rehabilitation - in short restoring health to people. In recent years, there has been a tremendous increase in the number of pieces of equipment and devices; however there has not been a proportionate improvement in health outcomes [Bronzino1995, Kachieng'a 1998a].

As discussed fully in Chapter 9, sections 9.2, 9.5.4 and 9.6.10, many pieces of health care equipment are marketed with little attention for the different health needs and priorities of developing countries. Promotion activities of equipment manufacturers have created demands far greater than actual needs. Since over 40% of the total health budget in most developing countries is spent on health care technologies (including drugs) [WHO 1991a, Issakov 1994, World Bank 1995a], the result has been an increase in the cost of health care or reduction in funds available for other services.

The cost of health care has affected even the most affluent nations, and their governments are increasingly establishing control mechanisms to regulate the acquisition of expensive technologies [World Bank 1993a]. Such mechanisms include Certificate of Need regulations, cost-benefit and financial analyses.

Equipment problems in developing countries are characterised by limited economic resources, shortage of clinical engineers and technicians, and lack of organised equipment policies. These are exacerbated by the fact that equipment markets are not efficient, equitable or sustainable.

Cost-effective care is further compromised because individual public hospitals or clinics currently purchase essential drugs and essential equipment via more expensive routes, although they could procure in bulk at discounted prices. Because of such inefficiencies, insufficient maintenance, and waste, far more is being spent on equipment than is necessary, thus erroneously reinforcing the view that the answer to equipment problems in Africa is more money. Far greater progress is likely to be achieved through effective planning of acquisitions, together with efficient maintenance and effective management of existing equipment stocks [Kachieng'a and Boonzaier 1999]. At the same time, though, ways must be found to sustain the budgetary allocations earmarked for maintenance and equipment imports.

It is clear that for the optimal use of the available resources, equipment to be acquired must be limited to that proven to be effective, safe and meeting the health needs of the majority of the population. The selected equipment is referred to as "essential" equipment, indicating that it is of the utmost importance, basic, indispensable and necessary for the health of the population.

10.3 WHY A STANDARD ESSENTIAL EQUIPMENT LIST (SEEL)?

Most developed countries have instituted technology planning and assessment as a means of selecting effective technologies in health care [David 1993, Bronzino 1995, Rettig 1996]. Hospitals in these countries use planning methods and assessment tools to match clinical needs with technology requirements. They have established equipment assets management systems to monitor maintenance and operational costs on the basis of cost of ownership (CO) [David 1993, Goodman 1993], and returns on investment (ROI) [Harrington 1990, Hughes 1993, World Bank 1995a].

In the Sub-Saharan region, however, the enormous growth in health care technology during the last decade has not been accompanied by a concomitant growth in management capacity and control of resources [World Bank 1995a]. In addition, the ability of the international equipment industry to develop new HCT has vastly exceeded the technical capacity of most African countries to assess the clinical value and cost-effectiveness of such innovations.

According to the World Bank [1993a], developing countries account for US$5-billion, or 7%, of the US$71-billion spent each year on health care equipment world wide. The annual expenditure on equipment by Sub-Saharan Africa is estimated to be between 2% and 3% of the world wide bill. Approximately 6 000 distinct types of health care equipment and devices, and more than 750 000 brands, models and sizes, produced by perhaps 12 000 manufacturers world wide, are on the market.

Several studies have reported equipment problems in developing countries as follows:

- Poor equipment selection and procurement [Free 1992, Issakov 1994].
- Mismatch of technology and the available human resources and expertise [Banta 1986, Attinger *et al.* 1988].
- Incompatibility of new technology with existing technology stocks and services [McCord 1978, Free 1992].
- Inadequate planning of budgetary support for maintenance services and spare parts, training of users and clinical engineering staff [World Bank 1995a, Kachieng'a and Boonzaier 1999].
- Inadequate equipment policy and standardisation [World Bank 1993a].
- Lack of essential equipment list [World Bank 1993a, Kachienga *et al.* 1999].
- Poorly 'planned and managed' technology transfer [Bonair *et al.* 1989].
- Lack of national technology policy [Bonair *et al.* 1989, Kachieng'a 1998a].

This section of the thesis initiates the development of an essential equipment list as solution to some of these equipment problems in Kenya and South Africa.

10.4 RATIONALE

Prior to selection and procurement of any health care equipment for deployment in health system of a country, evidence should be collected to demonstrate that the equipment is, in the terminology of the WHO, appropriate. Not every piece of equipment that is desirable is needed [Tannenberger 1984]; not all that is needed is essential; and finally *not every item of equipment that is essential is affordable*. It is a basic economic reality that choices have to be made in the rationalisation of health care services [Banta 1986, Jennett 1986]. It is in the process of making choices that the SEEL becomes invaluable.

The concept of the SEEL is comparable with the ideal of the essential drugs list which was endorsed unanimously by the 1997 World Health Assembly, and actively used by bilateral and multilateral organisations supporting health care projects in many African countries [WHO 1997a, 1997b].

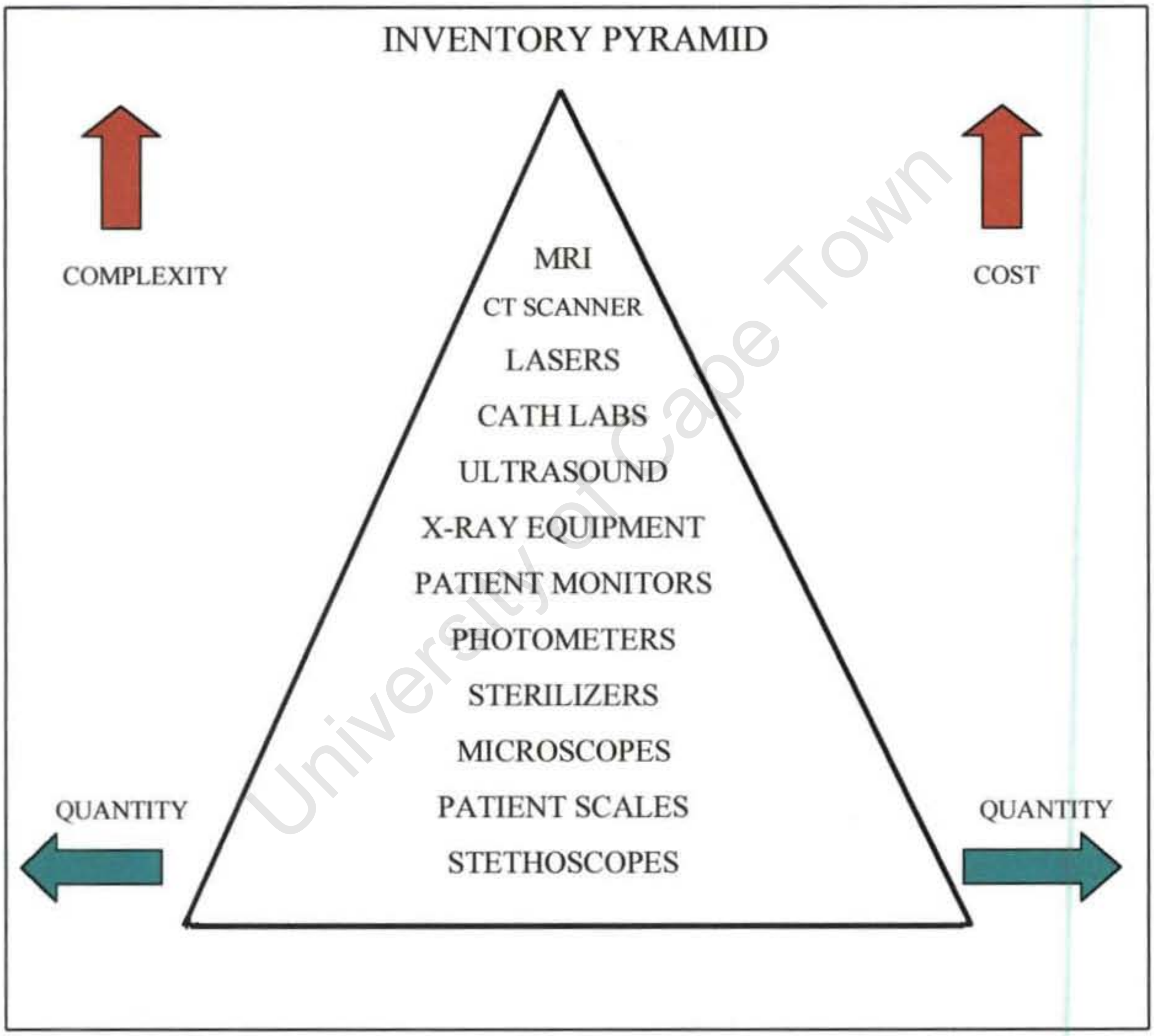
10.5 DEFINITION: ESSENTIAL EQUIPMENT

Essential equipment can be defined as that which supports the health care needs of the majority of the population. It should therefore be available at all times in adequate quantity and quality, in technically sound condition and at a medically acceptable standard for health care facilities.

The final version of SEEL will be in the form of a data base that can be updated periodically depending on national needs.

Figure 10.1 presents an equipment inventory pyramid for a modern hospital in the SSA region.

Figure 10.1:
Health care equipment inventory pyramid



Source: Modified from Gould [1998].

10.6 METHODOLOGY

The original essential equipment list was developed in 1992 by the author, to equip Kenya's hospitals in a World Bank sponsored Health Facilities Rehabilitation Programme (HFRP) [World Bank 1991a, 1991b, 1991c]. The present cross-national study has been carried out using direct interviews corroborated by physical audits of equipment at various facilities, and perusal of tender and purchase documents. The interview pyramid used in the field data collection and interactive interviews is presented in Figure 10.2. Table 10.1 shows the field survey coverage in terms of facilities and experts interviewed.

The essential equipment survey was carried out in Kenya and South Africa from September 1996 to March 1998. Principal methods used were as follows:

- Field study – data collection through visits to hospitals (small, medium and large).
- Site visits – data collection through visits to different wards and departments, laboratories, medical stores, clinical engineering departments and purchase offices.
- Telephonic and interactive interviews on the equipment usage were carried out with physicians, matrons, sisters, nurses, clinical engineers, technologist and technicians.
- Telephonic and interactive interviews on equipment planning, selection and procurement were carried out with physicians, administrators, planners, clinical engineers and technicians, equipment committee officials and tender board officials.

10.6.1 DATA COLLECTION

- **Instruments**

    Purchase documents

    Tender documents

    Physical equipment audit

    Field visits and interactive interview

    Equipment manufacturers and supplier visits

    Price quotations from manufacturers

- **Data collection period**

    12 months

- **Interview Tool:**

    The Interview Pyramid

Figure 10.2:

Interview pyramid for development of Standard Essential Equipment Lists

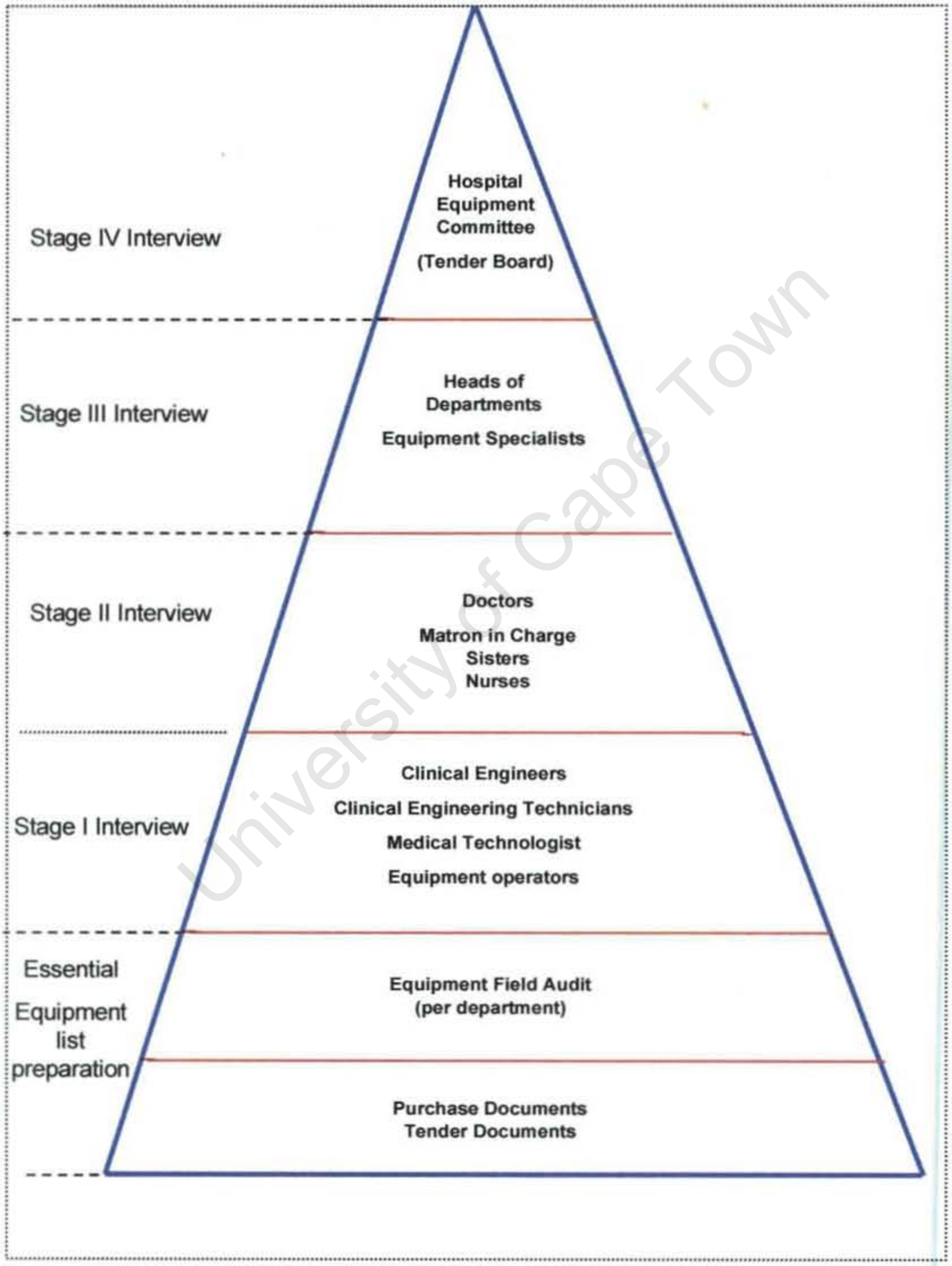


TABLE 10.1:

ESSENTIAL EQUIPMENT FIELD INTERVIEW COVERAGE BY HOSPITALS AND EXPERTS

Hospital Size (Beds)	Kenya	South Africa	Experts Interviewed
75–300	3	3	17
300–600	3	3	33
> 600	3	3	42
Total	**9**	**9**	**102**

10.7 ESSENTIAL EQUIPMENT LIST DEVELOPMENT

The physical equipment audit was done per department by the author and two research assistants with assistance from clinical engineering personnel, users, operators and medical staff. The interactive interviews with health professionals at all levels of the pyramid were structured around the core services offered by each department and the equipment required by the department to deliver these services effectively and efficiently. The essential equipment from the lower level was passed to the next level on the pyramid for ratification and comments. The feedback from the higher level was passed back to the lower level for consideration and comments. This process was repeated until there was significant agreement between the adjacent levels of the pyramid. Thereafter, the process was repeated at the other higher levels of the pyramid. In the development of SEELs all the interviews were interactive and consultative. The same procedure was used in all hospitals. Where data were suspect, revisits to facilities were made and repeat face to face interviews were conducted.

To avoid repeating the same equipment in the three hospital categories, an accumulative step-on system was developed so that equipment registered in the lower categories is not repeated in the upper categories. The step-on system is presented in Table 10.2. The total equipment contained in the block represents the standard equipment list for a particular department accumulated from all hospitals - small, medium and large.

The Standard Essential Equipment Lists for 20 hospital departments were developed. Table 10.3 shows the 20 hospital departments covered during the survey. Examples of essential equipment lists for Nuclear Medicine Department and Renal Unit are presented in Table 10.4 and 10.5, respectively. The complete SEEL for the twenty departments surveyed are presented in Appendix F. Although the equipment in the SEEL tables are presented as units, it should be

TABLE 10.1:

ESSENTIAL EQUIPMENT FIELD INTERVIEW COVERAGE BY HOSPITALS AND EXPERTS

Hospital Size (Beds)	Kenya	South Africa	Experts Interviewed
75–300	3	3	17
300–600	3	3	33
> 600	3	3	42
Total	**9**	**9**	**102**

10.7 ESSENTIAL EQUIPMENT LIST DEVELOPMENT

The physical equipment audit was done per department by the author and two research assistants with assistance from clinical engineering personnel, users, operators and medical staff. The interactive interviews with health professionals at all levels of the pyramid were structured around the core services offered by each department and the equipment required by the department to deliver these services effectively and efficiently. The essential equipment from the lower level was passed to the next level on the pyramid for ratification and comments. The feedback from the higher level was passed back to the lower level for consideration and comments. This process was repeated until there was significant agreement between the adjacent levels of the pyramid. Thereafter, the process was repeated at the other higher levels of the pyramid. In the development of SEELs all the interviews were interactive and consultative. The same procedure was used in all hospitals. Where data were suspect, revisits to facilities were made and repeat face to face interviews were conducted.

To avoid repeating the same equipment in the three hospital categories, an accumulative step-on system was developed so that equipment registered in the lower categories is not repeated in the upper categories. The step-on system is presented in Table 10.2. The total equipment contained in the block represents the standard equipment list for a particular department accumulated from all hospitals - small, medium and large.

The Standard Essential Equipment Lists for 20 hospital departments were developed. Table 10.3 shows the 20 hospital departments covered during the survey. Examples of essential equipment lists for Nuclear Medicine Department and Renal Unit are presented in Table 10.4 and 10.5, respectively. The complete SEEL for the twenty departments surveyed are presented in Appendix F. Although the equipment in the SEEL tables are presented as units, it should be noted that in hospital situation the actual equipment required will tailored to work load and patient traffic.

TABLE 10.2:

STEP-ON SYSTEM FOR DEVELOPMENT OF ESSENTIAL EQUIPMENT LIST

		Essential Equipment	Large Hospitals (Tertiary)
	Essential Equipment	Essential Equipment	Medium Hospital (Provincial)
Essential Equipment	Essential Equipment	Essential Equipment	Small Hospital (District)
Small Hospital (District)	Medium Hospital (Provincial)	Large Hospital (Tertiary)	

TABLE 10.3:

DEVELOPMENT OF SEEL BY DEPARTMENT AND HOSPITAL TYPE

No.	Department	Hospital Size		
		Small (District)	**Medium** (Provincial)	**Large** (Tertiary)
1.	Anaesthesia	X	X	X
2.	Central Sterile Supply	X	X	X
3.	General Wards	X	X	X
4.	Gynaecology	X	X	X
5.	Intensive Care		X	X
6.	Internal Medicine	X	X	X
7.	Logopaedics	X	X	X
8.	Nuclear Medicine			X
9.	Obstetrics	X	X	X
10.	Occupational Therapy	X	X	X
11.	Ophthalmology	X	X	X
12.	Paediatric	X	X	X
13.	Physiotherapy	X	X	X
14.	Radiation Therapy			X
15.	Radiology	X	X	X
16.	Renal Unit		X	X
17.	Surgery	X	X	X
18.	Surgical Sets	X	X	X
19.	Theatre	X	X	X
20.	Trauma	X	X	X

TABLE 10.4:

STANDARD ESSENTIAL EQUIPMENT LIST FOR NUCLEAR MEDICINE DEPARTMENT

Essential Equipment for Large (Tertiary) Hospital			
Nuclear Medicine Department	**Unit Price**		
Essential Equipment	**Rands**	**Ksh**	**US$**
Centrifuge	10 000	131 863	2 141
Computerised data processing system (LAN)	120 000	1 582 356	25 969
Dose calibrator	30 000	395 589	6 424
Film developer	70 000	923 041	14 989
Laminar flow cabinet	20 000	263 726	4 283
Radiation monitor	5 000	65 932	1 071
Radiation protection monitor (for safety of personnel)	5 000	65 932	1 071
Single-head Gamma camera with all attachments (with single photon emission computer tomography)	1 600 000	21 098 073	342 613
Well counter (for blood and urine samples)	150 000	1 977 944	32 120
Lean Budget Option — total capital investment	**2 010 000**	**26 504 454**	**430 407**
Dual-Head Gamma camera with all attachments	2 500 000	32 965 739	535 332
Treadmill (exercise machine for heart patients) — desirable	40 000	527 452	8 565
Full Budget Option — total capital investment	**4 550 000**	**59 997 645**	**974 304**

All prices are calculated at the exchange rates ruling on 24 September 1998

TABLE 10.5:

STANDARD ESSENTIAL EQUIPMENT LIST FOR RENAL UNIT

Essential Equipment for Medium/ Large Hospital			
Renal Unit	**Unit Price**		
Essential Equipment	**Rands**	**Ksh**	**US$**
Dialysis machines (6 suggested)	372 000	4 905 302	79 657
Re-use equipment	276 000	3 639 418	59 101
Reverse osmosis equipment	290 000	3 824 026	62 099
Apheresis equipment	264 000	3 481 182	56 531
Electronic weighing scale	36 000	474 707	7 709
Infusion pumps	30 000	395 589	6 424
Electronic bed scale	11 000	45 049	2 356
Defibrillator	23 000	303,285	4 925
Incubator	17 000	224 167	3 640
Hermeneutics	336 000	4 430 595	71 949
Blood warmer	11 000	45 049	2 356
Kitchen scale (0–5 kg)	400	5 275	86
Overhead projector (for teaching purposes)	6 000	79 118	1 285
TV + video recorder (patient self-care education/entertainment)	12 000	158 236	2 570
Computer + printer system + Internet access	62 000	817 550	13 276
Unit Budget	**1 954 000**	**25 766 021**	**418 415**
Renal Laboratory Equipment (may not be necessary if support from main laboratory is readily available)			
Na^+/K^+ analyser (if not available in main laboratory)	28 000	369 216	5 996
Microscope	11 000	45 049	2 356
Centrifuge	6 000	79 118	1 285
Refrigerator	2 000	26 373	428
Freezer	2 000	26 373	428
Laboratory Budget (if required)	**49 000**	**646 129**	**10 493**

All prices are calculated at the exchange rates ruling on 24 September 1998.

Note: Due to sophisticated technology involved and high capital investment required, renal departments are normally established at referral/tertiary hospitals. The running of a renal department requires highly trained and motivated support staff. Renal equipment requires specialised maintenance services covering mechanics, hydraulics and electronics.

10.8 RESULTS AND DISCUSSION

10.8.1 STANDARD ESSENTIAL EQUIPMENT LIST AND ESSENTIAL DRUGS LIST

The Standard Essential Equipment List (SEEL) has been developed to complement the essential drugs list which has been successfully used in several countries [WHO 1977, 1979, 1983, 1987b, 1988b, 1990, 1992, 1995 and 1997a], since its first printing in 1977 by the World Health Organization (WHO). Special essential drugs lists have been compiled for community clinics, and district, regional and teaching hospitals [WHO 1984, 1990, 1995]. The model list of essential drugs has been adopted by numerous international and bilateral agencies, and several countries are using the list for evaluating drug donations [WHO 1990, 1997b].

The World Health Organization (WHO) developed a small-scale essential equipment list in 1984; this was an emergency kit of drugs and clinical equipment to serve a population of 10 000 for three months [WHO 1984]. An updated version of the emergency kit, developed collectively by WHO, the Office of the United Nations High Commission for Refugees, UNICEF, Medicines Sans Frontiers, the International Federation of Red Cross and Red Crescent Societies, the Christian Medical Commission and others, has been tested out in several areas [WHO 1997b]. The essential equipment list is in line with World Health Organisation ideals of providing technical support to affordable and accessible health care services in African countries.

10.8.2 POTENTIAL BENEFITS FROM STANDARD EQUIPMENT LIST

The need for information and guidelines on selection of health care equipment in African countries has been stressed in a number of documents [World Bank 1993a, 1995a, WHO 1986, 1987, 1988, Issakov 1994].

The standard essential equipment list (SEEL) is a reference and resource document for health policy makers, planners, health care managers, health institutions, equipment committees and tender boards. Equipment manufacturers and suppliers also need SEEL for equipment quantification and the monitoring of demand gap.

As a reference and baseline document, the essential equipment list can provide guidelines for:

1. Budget allocation planning for equipment purchase and maintenance
2. Equipping new health facilities and rehabilitating old ones.
3. Re-allocation of public funds towards essential health care technologies supporting core health care services.
4. Equipment standardisation for various levels of health facilities [World Bank 1993a].
5. Evaluation of training requirements for clinical engineers and technicians (Kachieng'a 1998a].
6. Assistance in classification of health facilities (Kachienga 1998b).
7. Equipment lists for customs duty exemptions and for policy decisions such as tax exemptions to local equipment manufacturer (to encourage local manufacture or compensate for market losses).
8. Selection of equipment targeted for local or regional manufacture.
9. Selection of equipment targeted for technology assessment and service efficiency research.

10. Evaluation and screening of equipment donations and of health projects with equipment components.

11. Formulation of:

    - a national equipment procurement policy;
    - a national health care technology policy;
    - a national health care technology transfer policy;
    - equipment registration and licensing guidelines.

12. Selection of technologies for:

    - regional co-operation on health care technology assessment;
    - regional manufacture of essential basic health care equipment, e.g. equipment for primary health care.

10.8.3 FUNCTIONALITY OF STANDARD ESSENTIAL EQUIPMENT IN AFRICAN COUNTRIES

The effective usage and integration of SEEL in many African countries will depend on national governments, bilateral and multilateral organisations, donor agencies and non-governmental organisations supporting and investing in health care in Africa.

The SEEL is intended to be flexible and adaptable to different situations; which specific items of equipment are regarded as essential will remain an institutional or a national responsibility.

An equipment audit carried out in a 1175 - bed hospital in Cape Town revealed about 14000 pieces of equipment and devices with a capital value of over 150 million rands [Gould 1998].

This was considered an under-estimate because the hospital's assets management system was not operational. However, this urban, tertiary care hospital in Cape Town, South Africa, cannot be considered representative of African health care systems (see Chapter 6). Given the limitations in human resources and technical expertise which exist in African countries, it is not reasonable to expect that these countries can achieve substantial progress towards self-sufficiency in health care equipment assessment and management without support from and collaboration with WHO, World Bank, UNICEF, ISTAHC and other professional bodies and organisations.

As demonstrated by the equipment inventory pyramid in Figure 10.1, cost is a major consideration in the selection of some of the equipment for the list. However there are other influencing factors, such as comparative maintenance costs, local after-sales support, impact, accessibility for the majority of the population, pattern of prevalent diseases; level of facilities; level of care provided; training and experience of the available personnel (medical and technical); demographic factors, and short and long-term plans for technology transfer – that is, existing plans for local manufacture of the essential equipment.

The following considerations will inevitably influence the compilation and usage of the standard essential equipment list (SEEL):

Essential Equipment List and Primary Health Care

Most equipment in use today is designed for hospital- or clinic-based health care, not primary health care, which is not a problem in the developed countries where most items of equipment are researched and manufactured. Primary health care represents a unique technological challenge to developing countries. The technologies for primary health care in these countries must be focused on prevention of tropical diseases, nutritional deficiencies, promotion of hygiene and social health care education. A significant proportion of the technologies required will have to be developed and manufactured locally, nationally or regionally, in the countries which will ultimately use them.

The selection of equipment for primary health care must be determined nationally or regionally, since the training of the personnel charged to manage this care varies considerably from country to country. SEEL is posed to play a leading role in the selection of technology for primary health care.

Role of National Governments

Improving the impact of health care equipment and devices in health care in Africa requires a facilitating environment, in which public tender board officials, suppliers and distributors of equipment, and providers of health care act together to promote the effective use of equipment. This means making equipment available and affordable by hospitals and clinics. Governments have an especially important regulatory and leadership role to play in instituting and maintaining quality controls, disseminating information on the proper use of equipment and assessing its cost-effectiveness. Governments should also take the lead by establishing a National Equipment Licensing Agency to regulate and control the use of technology. There is also need for national programmes which identify suitable technologies for long-term technology transfer.

National equipment policies need a firm legal basis. Existing laws and regulations are concerned with quality control of drugs or new approvals. Equipment approval is compulsory only for radiological equipment and devices. There are no laws or regulations governing other health care technologies in Kenya or South Africa.

Health care equipment embodies much of the power of modern medicine and health care services. Governments need to make policies that improve and rationalise acquisition as well as promote local production and encourage better utilisation of equipment. In this way, they could not only enhance their own utilisation of equipment, but also assist the private sector. The following roles are suggested:

1. Through the development of a national standard list of essential equipment of established cost-effectiveness, governments can help health providers (hospitals – public and private) and health project managers to make better equipment choices.

2. Governments can eliminate the incentives that in many countries induce public hospitals to acquire expensive and sophisticated equipment that is costly and never fully utilised due to lack of technical expertise and maintenance funds. As has been stated in Chapter 3, World Health Organisation (WHO) estimates that less than half of all health care equipment in developing countries is usable [World Bank 1993a pp 138].

3. Investments in health care equipment can be further rationalised by rejection of most "donated equipment", new or used. The problems with equipment donations have been discussed in Chapter 9, sections 5.4 and 6.10, respectively.

4. It can design policies to encourage local manufacture of some essential equipment which has high local market demand, but lacks international demand; for example, equipment for primary health care.

5. It could intervene by means of tax exemptions to compensate for the manufacture of specialised health inputs.

6. It has a role in undertaking assessment of the health care equipment, which is a costly public good.

only for radiological equipment and devices. There are no laws or regulations governing other health care technologies in Kenya or South Africa.

Health care equipment embodies much of the power of modern medicine and health care services. Governments need to make policies that improve and rationalise acquisition as well as promote local production and encourage better utilisation of equipment. In this way, they could not only enhance their own utilisation of equipment, but also assist the private sector. The following roles are suggested:

1. Through the development of a national standard list of essential equipment of established cost-effectiveness, governments can help health providers (hospitals – public and private) and health project managers to make better equipment choices.

2. Governments can eliminate the incentives that in many countries induce public hospitals to acquire expensive and sophisticated equipment that is costly and never fully utilised due to lack of technical expertise and maintenance funds. As has been stated in Chapter 3, World Health Organisation (WHO) estimates that less than half of all health care equipment in developing countries is usable [World Bank 1993a pp 138].

3. Investments in health care equipment can be further rationalised by rejection of most "donated equipment", new or used. The problems with equipment donations have been discussed in Chapter 9, sections 5.4 and 6.10, respectively.

4. It can design policies to encourage local manufacture of some essential equipment which has high local market demand, but lacks international demand; for example, equipment for primary health care.

5. It could intervene by means of tax exemptions to compensate for the manufacture of specialised health inputs.

6. It has a role in undertaking assessment of the health care equipment, which is a costly public good.

10.9 CONCLUSION AND RECOMMENDATIONS

Equipment plays a strategic role in health care improvement, but poor management of equipment, insufficient maintenance budgets and insufficient technical expertise render equipment use in Kenya and South Africa highly inefficient. Hence, there is a great potential for increasing equipment utilisation while reducing ownership costs. Appropriate action to reduce waste is required at all stages of the equipment supply chain — selection, procurement, maintenance and replacement.

Despite high investment in health care technologies by both countries, common diseases continue to be a significant drain on human and economic resources, producing human suffering and higher health costs. One aspect of minimising both human and economic waste in these countries is by selecting and procuring appropriate health care equipment that meets the primary care needs of the populations.

The purpose of a standard essential equipment list (SEEL) is to provide a base-line document for planning, selecting, procuring, maintaining and managing health care equipment. From a financial management point of view, it is a budgeting tool for both capital investments and recurrent costs. It can be used for planning the training of equipment users, operators and maintenance technicians. It is also an essential document for an equipment asset management system.

The global aim is to assist governments, donor organisations, and health facility managers to select and procure core equipment for core services. The need for SEEL is driven by economic necessity for cost-effective management of technological investments in health care systems.

The final goal of SEEL is to ensure that health care equipment at every level of health care delivery can be technically and financially supported, and cost-effectively utilised and managed without creating undue financial pressure at facility and national levels.

10.9.1 RECOMMENDATIONS

Equipment maintenance problems originate from poor equipment planning, procurement and deployment. The planning, selection, procurement and rational deployment of health care equipment in Kenya and South Africa is the real challenge to be met facing the inevitable large-scale technologilisation of health care in the two countries. It is in this broader context that the SEEL makes an important contribution by defining sets of equipment for specific service levels.

Future research should be directed towards the development of SEELs for primary health care. This is an area strategic importance for enhancing synergy between preventive and curative health care services. Preventive and curative technologies are not mutually exclusive in a sustainable health system.

Application of Standard Essential Equipment List

In the determination of applications of SEEL relevant to the specific health needs in a facility, several important concepts must be recognised:

1. Adoption of the essential equipment list is voluntary, unless, of course, the government regulatory or procurement authorities adopt them. The application of SEEL lies solely within the professional discretion of the user of the document.

2. Essential equipment lists reflect the collective expertise of equipment users – operators, technicians, technologists, nurses, doctors, and consultants who may consult with professional specialist societies on practices recommended by them.
3. The consensus recommendations embodied in the standard essential equipment list are intended to respond to clinical needs and ultimately to help to ensure cost-effective use of equipment in various health facilities. There is a limitation, however, in the sense that the recommendations apply generally to perceived conditions at an application point that may not remain static or be relevant to specific situations. The health care system is dynamic and SEEL will require regular revisions and updates to match changes in health care technology.

Professional Caution:

No single source of information serves to identify particular equipment as the most suitable for a given application. The SEEL should be used as one source, but the ultimate decision as to equipment safety and efficacy must take into account the specifics of its utilisation and, of course, cost-benefit considerations. The rationale accompanying SEEL is an excellent guide to the reasoning and data underlying its provisions.

CHAPTER 11

HEALTH TECHNOLOGY MANAGEMENT IN THE HOSPITAL ENVIRONMENT

Chapter 11 deals with management of health technology in the hospital environment. It explains the problems and constraints facing hospital administrators and clinical engineers in the public sector. The process of establishing a clinical engineering department in a hospital is explained in detail.

The rider must ride the horse, not be run away with.

Donald Winnicott, 1896-1971

Playing and Reality, 1971

The governments of Kenya and South Africa have tried various strategies to improve access, quality and cost-efficiency in the health care delivery systems of those two countries. However it is clear that the optimal approach has yet to be found. It has been recognised that health care technology is an important element of this transformation, and will continue to play a vital role [Walters and Bunn 1995, Kachieng'a 1998a, Kachieng'a and Boonzaier 1999].

Health service planners, hospital administrators, physicians and other health care professionals need to understand the forces that control health care delivery systems. Because technology and health care equipment plays such a significant role in hospital-based health care services, it is vital to understand technology management in order to be able to communicate effectively about it to policymakers and health care providers. There is not only a need for appropriate equipment. Suitable infrastructural arrangements are also required in order to make the role of technology more clinically efficacious and cost-effective. Strategic planning and management of technology directly contribute to improved patient health outcomes. The involvement of clinical engineers as technology managers in the hospital environment is thus critical in the delivery of hospital-based health care services.

11.1 HEALTH TECHNOLOGY MANAGEMENT

Technology management has been defined as *an accountable, systematic approach to ensuring that cost-effective, efficacious, safe, and appropriate equipment is available to meet the demands of quality patient care* [ECRI 1989]. Modern health care institutions, even in developing countries, are increasingly coming to the view that technology is an integral part of all major health policy decisions.

Technological innovations in the twentieth century have reshaped the field of medicine and the delivery of health care services. Although the art of medicine has a long history, recent advances in HT have provided a wide range of diagnostic, therapeutic, and rehabilitative tools and instruments that are now routinely used in the cure of specific disease and illness [Anbar 1984, Bronzino 1992]. In the process, modern hospitals have evolved as technologically sophisticated health care facilities serviced by technologically specialised personnel [Foote 1992, Bronzino 1995].

These changes have contributed significantly to the quality of health care provided by various health facilities, but have brought new challenges in HT management for both developing and developed countries [Banta 1990b, Menon 1993, Goodman 1993]. These include the development of the necessary infrastructure and human resources required to plan, deploy, manage and assess new technologies, and also the development of strategies required to manage cost containment [David 1993].

Thus to develop and implement a comprehensive HT management programme which delivers better health care services to the population while containing rapidly escalating costs, it is essential to apply system engineering and management principles, and to understand the dynamics of health care systems. What is required is an approach based on systematic planning, which includes both the technical aspects of maintaining equipment as well as the development of institutional policy regarding equipment acquisition, use, replacement, and disposal. In essence, the primary goal of a technology management programme is to ensure that the most cost-effective methods for the safe and effective operation of health care equipment are utilised [David and Judd 1993, Dyro 1993, Bronzino 1995].

This chapter focuses on management of health care technologies, from the point of view of the hospital-based clinical engineering department. It provides an overview of the major activities involved in establishing and supervising a clinical engineering department. It presents technical requirements for managing programmes in such areas as technology planning, acquisition and replacement; supervision of equipment repair, maintenance and management, and supervision service contracts. It also discusses the role of the clinical engineer in the management of health care technical support services as well as training users in the proper operation of health care equipment.

11.2 THE ROLE OF TECHNOLOGY IN HEALTH CARE

Modern health care delivery systems comprise intricate networks of highly trained professionals and pieces of equipment assembled with the objective of providing better health care to the public. The health care delivery system has thus been affected by the remarkable growth in the application of engineering principles and technology. Engineers' contributions to biomedical research have been of great value in gaining insight into basic biological and physiological processes. With their mathematical skills, physical science knowledge and analytical ability, engineers have been able to analyse such complex systems as bone structure and mechanics, conduction of nerve impulses and body fluid dynamics. They have contributed to selection of materials for surgical implants [Khalil and Waly 1988, Bronzino 1995], and many other problems of life sciences. Advances such as the development of diagnostic ultrasound, pacemakers, the artificial kidney, the application of computer-assisted ECG analysis, arrhythmia detectors, and the use of myoelectric controls for prosthesis have all made significant contributions to health care.

In most hospitals in developed countries, the use of computers in support of health care is an essential part of any health care delivery system. Hospitals and health facilities rely very heavily on computers to conduct daily activities [Bronzino *et al* 1990, Bronzino 1992]. Patient admission is done with the assistance of computers. Records can be updated and made instantly available. Requests for drugs can be sent to the pharmacy via computers and billing for all services can be done by computer. Laboratory analysis can be done more accurately and reported almost instantaneously.

Computers also serve the management of clinical engineering department in technology planning, and deployment as well as maintenance services, including monitoring costs of ownership. In addition computers are used in asset management and management decision support services (DSP) [Khalil and Waly 1988, Bronzino 1992, David and Judd 1993]. In most hospitals the repair and management of information technology systems has become the responsibility of the clinical engineering department [Pacela 1992, Dyro 1993, Bronzino 1995, Kachieng'a and Boonzaier 1999]. In large modern hospitals special department to information technology and computing services.

11.3 HISTORICAL OVERVIEW: DEVELOPMENT OF CLINICAL ENGINEERING

In the late 1960s and early 1970s, there was intense publicity in the USA and some parts of Europe surrounding the electrical safety of hospital patients. The electrical safety scare reached a peak when consumer activists, most notably Ralph Nader in 1971, claimed that "At least – 1200 Americans are electrocuted annually during routine diagnostic and therapeutic procedures in hospitals" [Nader 1971]. This concern was based primarily on the supposition that catheterized patients with a low-resistance conducting pathway from outside the body into blood vessels near the heart could be electrocuted by voltage differences well below normal levels of human sensation. Although no statistical evidence has ever been developed to substantiate these claims [Bruner and Leonard 1989], this outcry raised the level of consciousness of health care professionals with respect to the safe use of medical devices. In the process, concerns for electrical safety of such devices arose almost overnight [Bronzino 1995].

These concerns stimulated the initial development of health care equipment maintenance programmes under the guidance of clinical engineers and led to the creation of clinical (medical) engineering departments. From these beginnings, the levels of clinical engineering responsibility within the hospital environment have evolved to include traditional equipment maintenance functions such as electrical safety, equipment acquisition, equipment repair and maintenance, supervision of service contracts, computerised asset management systems and hospital information and telecommunication systems. Figure 11.1 shows the progressive development of the responsibilities of clinical engineering departments from 1970 – 1995, and provides a forecast of development trends from 1995 –2000.

Figure 11.1:

Cumulative development trend of clinical engineering departments from 1970 – 2000

Stage 5 (1995 – 2000)

- Centre for health technology policy
- Centre for health technology assessment
- Centre for health technology management
- Detailed technology cost and service analysis
- Support of strategic health technology planning
- Planning for health technology transfer
- Support for research, development & manufacture

Stage 4 (1990 – 1995)

- Integration of technology risk management and quality management
- Centre for integrating technology issues
- Guidance on integration of technology in facility construction

Stage 3 (1985 – 1990)

- Repair and service of complex technologies such as radiology and radiotherapy equipment.
- Support to computerised health systems
- Support to hospital communication systems

Stage 2 (1980 – 1985)

- Supervision service contracts
- Essential to the acquisition process
- Involvement with technology risk management

Stage 1 (1970 –1980)

- Electrical safety
- Maintenance and repair of basic electro-medical equipment
- Beginning of involvement in the acquisition of health care equipment process

Source: Developed from Bronzino [1995], and Kachieng'a and Boonzaier [1999].

11.4 WHO IS A CLINICAL ENGINEER?

Since entering the hospital sphere in 1970, clinical engineering departments have become the logical support centre for all health care technologies [Bronzino 1992, 1995]. As a result, clinical engineers have assumed additional responsibilities, which include, as discussed in section 11.6, management of high technology instruments and equipment, hospital computer and telecommunications systems, training of medical personnel in equipment use and safety, and the design, selection, and use of technology to deliver safe and effective health care services.

The American College of Clinical Engineering (ACCE) defines a clinical engineer *as one who enhances patient care by applying engineering skills in health care technology.* A clinical engineer should have at least a bachelor's degree in engineering or a related discipline or have acquired the knowledge, and skills of an engineer through accredited practice [ACCE 1991, Bronzino 1995].

Figure 11.2 illustrates the multi-faceted role played by clinical engineers. They must successfully interface with clinical staff, hospital administrators, regulatory agencies, maintenance services equipment vendors, etc., to ensure that the health care equipment within the hospital is safely and effectively utilised.

Hospitals that have established centralised clinical engineering departments to meet these responsibilities use clinical engineers to provide the hospital administration with objective opinions on equipment function, purchase, application, overall system analysis, and preventive maintenance policies. With the in-house availability of such expertise, the hospital is in a far better position to make more effective use of its technological resources [Pacela 1992, Bronzino1995, Kachieng'a and Boonzaier 1999].

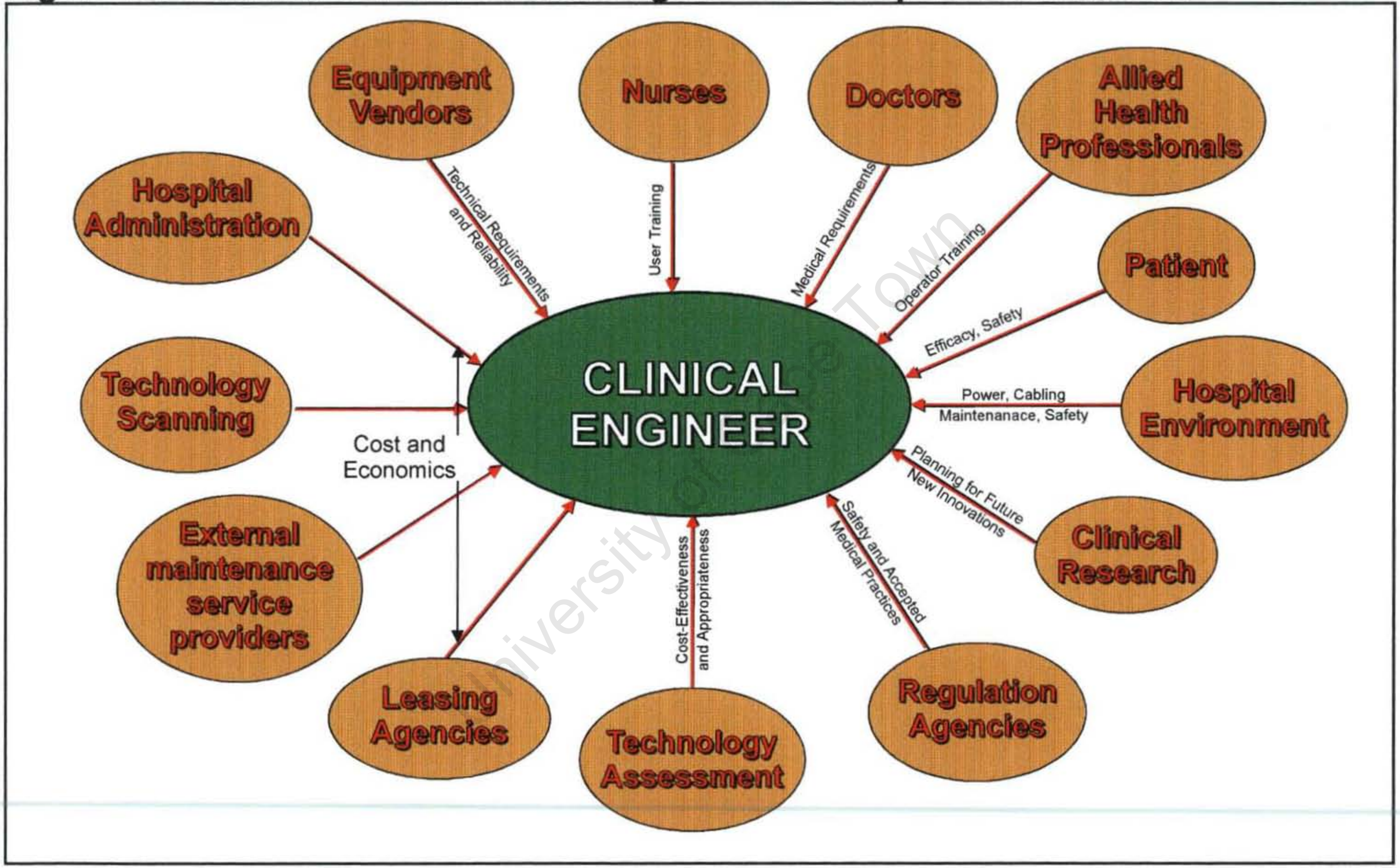
It is important to have competent clinical engineers as a part of the health care system. They can help to create a more unified and predictable market for biomedical equipment by providing health care professionals with needed assurance of safety, reliability, and efficiency in using new and innovative equipment. Better planning and deployment by clinical engineers can lead to a faster, more appropriate utilisation of new health care equipment and provide natural incentive for greater industrial involvement - a step that is an essential prerequisite to widespread utilisation of any technology [Pacela 1992, Coe and Banta 1992, Bronzino 1992].

Typical responsibilities of a clinical engineering department can be summarised as follows (see Figure 11.2) [Pecela 1992, Bronzino 1995, Kachieng'a 1998a]:

- Pre-purchase evaluation, writing specification and planning for equipment or system;
- Development of tender technical protocol and purchase specification;
- Design modification, or repair of sophisticated health care equipment or systems;
- Cost -effective management of health care equipment calibration and repair services;
- Safety and performance testing of health care equipment;
- Inspection of all incoming equipment (new and returning repairs);
- Establishment of performance bench mark of all equipment;
- Health care equipment inventory control;
- Co-ordination of outside services and vendors;
- Training of medical personnel in the safe and effective use of medical devices and systems;
- Hospital information system support (computer and network);
- Input to the design of clinical facilities where health care equipment is used, e.g. operating rooms, intensive care units;
- Input into development of health care technology policy; and
- Quality control of equipment and other technological services, such technical asset management.

Thus, clinical engineers not only provide extensive engineering services in health care delivery but also serve as a significant resource for the entire hospital.

Figure 11.2 . Interaction of a Clinical Engineer in a hospital environment



Source : Modified from Bronzino 1992, Kachieng'a 1998q and Kachieng'a and Boonzaier 1999

11.5 CURRENT ROLE OF CLINICAL ENGINEERING IN HOSPITAL ENVIRONMENT

Biomedical engineering, biophysics, and medical physics emerged as disciplines almost simultaneously, about 50 years ago. At the time, no real differences were apparent among the three disciplines [Schwan 1984]. With the dramatic role technology has played in shaping medical care, engineering professionals have become intimately involved in many medical ventures. As a result, the discipline of ***biomedical engineering*** has emerged as an integrating medium for two dynamic professions: medicine and engineering. Today, biomedical engineers assist in the struggle against illness and disease by providing materials, tools and techniques that can be utilised for research, diagnosis, and treatment by health care professionals.

One category of the biomedical engineering speciality, namely ***clinical engineering***, has become an integral part of the health care delivery team by managing the utilisation of health care equipment within the hospital environment [Bronzino 1992]. Clinical engineering is defined *as that specialisation of biomedical engineering that is devoted to the application of engineering methods and technologies in the delivery of health care services* [Bronzino 1992]. The field of clinical engineering has contributed significantly to health care systems by applying the knowledge obtained from biomedical engineering research to health care [Mulrea and Sivertson 1975, Keane 1980, Blasberg 1981, Jacobs 1982, Portugal 1982, Jafek 1983, Attinger 1984, Hales 1984, Bronzino 1992, David 1993].

The potential for clinical engineering has been proved in the solutions provided to some of the technology-based problems associated with health care delivery, the confidence given to hospital personnel that their equipment is reliable and effective, and the problem-solving orientation of the profession, which complements the physician's role [Oakes and Johns 1983, Bronzino *et al*. 1990, Goodman 1993]. Clinical engineering departments have immensely contributed to patient safety, equipment procurement and maintenance, and the management of health care technical support services. The combination of new technologies and different clinical demands require that clinical engineers' skills are constantly upgraded to enable them to work in multidisciplinary teams.

Two international surveys on the organisation and function of clinical engineering departments carried out by the International Federation of Medical and Biological Engineering (IFMBE) in 1988 and 1991 have revealed tremendous growth in clinical engineering departments since 1980s in developed countries, both in teaching and non-teaching hospitals [Frize 1990a, 1990b, Bronzino 1992]. The survey covered four geographic locations: Canada, the USA, three countries in the European Union (France, the United Kingdom (UK) and the Netherlands and two Scandinavian countries (Norway and Sweden). The two surveys concluded that clinical engineering departments have been accepted as important contributors to the health care delivery systems in such countries. In all the countries surveyed, clinical engineering departments had established roles, organisational structure, and budgeted financial support [Bronzino 1992].

There have, however, been problem areas in the gradual acceptance of the role of clinical engineering within hospital management [Schwartz 1984, Pacela 1992, Bronzino 1992]. These problems include defining the skill requirements, lack of understanding of the role of clinical engineering on the part of hospital administrators, and selecting appropriate hospital organisational structures for the clinical engineering function. In most industrialised countries many of these problems have been solved. This has resulted in increasing recognition of the role of clinical engineering by hospital administrators, a broad spectrum of employment opportunities for clinical engineers, and expansion of their technical leadership in hospital environment.

However, the complete acceptance of clinical engineers has not been achieved in most developing countries, although some countries, e.g. Kenya, have a Directorate of Clinical

Engineering in the Ministry of Health. Kenya also has a National Scheme of Service for clinical engineers and technicians, which ensures career development within the public sector.

11.6 FUTURE ROLE OF CLINICAL ENGINEERING IN THE HOSPITAL ENVIRONMENT

The role of clinical engineering is expanding due to increased use of HT in modern medicine and health care services [Bronzino 1992 p14, Goodman 1993]. Hospital-based clinical engineers still have the following as their primary concerns: patient safety, efficacy of instrumentation, and good management of hospital equipment. However, these basic concerns are being supplemented by new areas of responsibility, making the clinical engineer not only the chief technology officer, but also an integral part of the hospital management team [Frize and Shaffer 1991, Dyro 1993, Hughes 1993, Bronzino 1995].

These added demands are largely due to the economic pressures that hospitals now face [Walters and Bunn 1995]. Such financial constraints make it difficult for hospitals to plan acquisition and cost-effective use of expensive technologies such as CT scanners, surgical lasers, and other sophisticated equipment, which are now commonly used even in developing countries [Kachieng'a 1998a]. The need to improve technical efficiency and cost-effectiveness of health care systems and services has forced hospital administrators to turn to clinical engineers for advice in operational areas. In many hospitals, clinical engineers now provide professional technical assistance in the application and management of technologies that support patient care [Bronzino 1992 p25, Kachieng'a 1998a].

More recently, clinical engineers have taken on responsibilities in other areas. These are: support of personal computers and hospital telecommunications systems, and strategic planning of the use of information technology in hospital environment. Another trend in clinical engineering is toward management. Clinical engineers frequently manage resources including people, space, and budgets in the cost-effective application of technology. The new responsibilities of clinical engineering are discussed below.

Health Information Systems

A newly emerging area of clinical engineering is the development and maintenance of health information systems for clinical and management use in hospitals [Bronzino 1990, Bronzino 1995, Kachieng'a 1998a]. For example, patient care information systems can [Bronzino *et al* 1990 *et al.,* Subramanian and Villez 1990, Kachieng'a 1998a]:

- Provide clinicians with access to sophisticated and often widely dispersed resources;
- Simplify the assembly of patient-related data for review by all types of professional, and
- Assist health care professionals in making fundamental decisions about patient health care strategies.

Because quality of patient care depends on the rapid processing of accurate information about the patient's status, comprehensive computer-based health care information systems have been increasingly used in modern health care. Despite progress made so far, patient care could be further enhanced in many hospitals and other health care facilities by the adoption of more recent hardware and software data-processing systems.

Computer applications in a hospital environment include highly specialised systems to support data acquisition for the cardiac catheterisation laboratory, pulmonary function laboratory, clinical laboratory, intensive and coronary care units, and radiology services. In addition, the use of personal computers (PCs) has grown enormously in the recent years. PCs are increasingly used as integral parts of local area networks and hospital information systems [Bronzino *et.al.* 1990], the medical record processing and information network processing. Technical support to computer systems, which requires a high level of engineering expertise, does not fall within the traditional definition of clinical engineering. However, hospitals are

increasingly turning to their in-house expertise for information systems and relying less on external maintenance service providers for their health information systems.
In the process, several benefits have accrued to hospitals. The first is time: whether computers are used in direct clinical applications or in administrative work, downtime is expensive [Subramian and Villez 1990, Bronzino 1992 p25]. In-house servicing can provide faster and often more dependable repairs than servicing by an outside maintenance provider. Secondly, in-house service reduces the possibility that computer equipment will be damaged or lost. Finally, in-house service reduces the costs by permitting the hospital to avoid expensive service contracts for computers and peripheral equipment [Bronzino *et.al* 1990, Bronzino 1995].

The clinical engineer will not only be involved in the selection and implementation of hospital information systems, but will also be required to modify existing packages to meet customised needs of the hospital. Software customisation for newly acquired equipment or for upgrading existing systems will become a major activity in the future [David and Judd 1993, Bronzino 1992, 1995].

Hospital Telecommunication Systems

Clinical engineers play an important role in developing specifications for new telecommunication systems or modifying old systems to meet new hospital requirements. They provide technical support during the planning stage, assist in the development of project proposals for new systems and help to resolve any issues associated with the installation and testing of the new system. Thereafter the clinical engineer is responsible for maintenance and management of the telecommunication systems.

In modern health care facilities, telecommunication covers areas like paging, intercom systems and tele-video systems [Bronzino 1992 p26, Goodman 1993, Kachieng'a 1998a]. In some modern hospitals, transmission capability allows the hospital to send scans and reports to physicians at their offices or at other remote locations. Data, such as patient ECGs, can be transmitted from the hospital to a data analysis system at another location, and the results can be transmitted back. In developing countries, hospitals are also making increased use of facsimile (fax) machine transmissions.

Hospital Strategic Planning

Today's emphasis on cost control in health care requires that clinical engineers assist in the containment of costs associated with equipment. To accomplish this objective, clinical engineers are becoming increasingly involved in strategic planning, technology scanning, assessment, and equipment purchase review [David and Judd 1993, Goodman 1993]. In technology scanning, clinical engineers study the trends of technological developments and their future effects [Kachieng'a 1998a].

During technology assessment and equipment purchase review, the clinical engineer studies a request to buy a new system or device and ensures that the purchase request includes (1) needed accessories, (2) warranty information, and (3) training of users and maintenance personnel. This review process investigates whether the equipment is needed or whether there is a less costly alternative exists, and ensures that it will be properly integrated into the hospital's existing environment.

Clinical engineers can provide valuable technical assistance during the planning for and financial analysis of potential new technical services [Hawkins 1992]. In the planning, for example, of a new patient care area many design questions immediately come to mind such as: What is the best layout for the new area? How can the flow of the patients best be managed? These logistical considerations are also important in the efficient management of health care technology in the hospital environment.

In the future, clinical engineering departments will need to concentrate even more heavily on management, with the goals of increased productivity, maximum system efficiency and reduced costs. Clinical engineers will also need to keep up with the latest developments in medical instrumentation, computers and telecommunication systems and other technologies that affect the operation of the hospital [Bronzino 1990, Kachieng'a 1998a]. By expanding their technical horizons, therefore, clinical engineers can further contribute to the overall operation of the hospital and to ensuring high-quality patient care at a reasonable cost [Hughes 1993, Menon 1993, Bronzino 1995, Kachieng a and Boonzaier 1999].

11.7 ESTABLISHMENT OF A CLINICAL ENGINEERING DEPARTMENT

The establishment and management of a clinical engineering department in a hospital requires three major administrative steps [Bronzino 1992, 1995].

First the hospital appoints a qualified person as a director. Directors of clinical engineering usually function at the department-head level in the organisational structure of the institution and are provided with sufficient authority and resources (technical and human) to perform their duties efficiently and in accordance with engineering professional norms.

According to the World Health Organization (WHO) (Issakov *et al.* 1990), the job description for Clinical Engineering Director is as follows:

General Statement: "The clinical engineering director, by his or her education and experience, acts as a manager and technical director of the clinical engineering department. The individual designs or directs the design of equipment modifications that may correct design deficiencies or enhance the clinical performance of medical equipment. The individual may also supervise the implementation of those design modifications. The education and experience that the director possesses enables him or her to analyse complex medical or laboratory equipment for purposes of defining corrective maintenance and developing appropriate preventive maintenance or performance assurance protocols. The clinical engineering director works with nursing and medical staff to analyse new medical equipment needs and participates in both the pre-purchase planning process and the incoming acceptance testing process. This individual also participates in the equipment management process through involvement in the system development, implementation, maintenance and modification processes."

The role of clinical engineering director can be summarised as:

- To identify the clinical engineering services required by the hospital;
- To determine the costs (resources) associated with these services;
- To communicate these requirements effectively to hospital administration;
- To create a productive work environment.

The director of clinical engineering has a wide range of duties and responsibilities [Pacela 1992, Bronzino 1992, David and Judd 1993, Goodman 1993, Kachieng'a 1998a]:

- Works with medical and nursing staff to develop technical and performance specifications for equipment required.
- Once equipment is specified and the purchase order developed, generates appropriate testing of the new equipment.
- Does complete performance analysis on complex medical or laboratory equipment and summarises results in concise, easy-to-understand terms for the purposes of recommending corrective action or for developing appropriate preventive maintenance and performance assurance protocols.
- Designs and implements modification that permits enhanced operational capability. May supervise the maintenance or modification as it is performed by others.

- Must know the relevant codes and safety standards related to the hospital environment and the performance assurance activities.
- Is responsible for obtaining the engineering specifications for systems that are unusual or not commercially available.
- Supervises in-service maintenance technicians as they work to codes and standards and on preventive maintenance, performance assurance, corrective maintenance, and modification of new and existing patient care and laboratory equipment.
- Supervises activities and develops program policies and procedures for parts and supply purchase activities.
- Sets department goals, develops budgets and policy, prepares and analyses management reports to monitor department activity, and manages and organises the department to implement them.
- Teaches measurement, calibration, and standardisation techniques that promote optimum performance.
- Communicates orally and in writing with health care, maintenance, and administrative professionals on technology related issues.
- Develops written procedures and recommendations for administrative and technical personnel on equipment operations and management.

In order to supervise technology management programmes, the director of clinical engineering must be a skilled manager, communicator, educator, and planner. He or she should understand both technologies that are being developed and the rapidly changing hospital environment in which these technologies are being applied. These increased responsibilities, however, also bring opportunities. By virtue of their responsibility for technology management, clinical engineers can participate in the formulation of national technology policy.

In the second step of establishing a clinical engineering department, the hospital administration, in conjunction with the director (or head) of clinical engineering, defines the dimension and scope of responsibility of the clinical engineering department, which must conform to the overall strategic plan of the hospital. The declared objective of the clinical engineering department must indicate its technical capability and expertise, and whether it has the capacity for research and development of new equipment or technology assessment programmes.

In the third step, the director of clinical engineering determines the expected workload; requests adequate workspace (general and specialised workshops); hires qualified and experienced engineers and technicians, and purchases and installs test and calibration equipment. In modern hospitals, there is need for a computerised asset and inventory management system to facilitate the management of all facets of equipment life cycles.

Table 11.1 summarises the major functions of a hospital-based clinical engineering department. It must be emphasised that, although the functions of the clinical engineering department that are listed in Table 11.1 are all important, the list is not exhaustive, because in practice clinical engineering departments are modelled to support the strategic goals of a particular hospital or region, which may include support for clinical research as well as technology assessment.

TABLE 11.1:

FUNCTIONS OF A HOSPITAL-BASED CLINICAL ENGINEERING DEPARTMENT BASED ON THE EQUIPMENT LIFE CYCLE

- **Equipment Technical Pre-purchase Assessment**
- **New Equipment Inspection/ Acceptance Testing**
- **New Equipment Installation and commissioning**
- **Equipment Inventory Control (manual/computerised)**
- **User Training Management**
  - Equipment Operation
  - Electrical Safety
- **Equipment Performance Assurance Inspection**
  - Performance Testing
  - Preventive Maintenance
  - Routine Calibration
  - Electrical Safety Testing
- **Equipment Corrective Maintenance**
  - Administer Service Contracts
  - Monitoring equipment warranty
  - Technically Supervise and Oversee Vendor Maintenance
  - Perform In-house Equipment Repairs
- **Equipment Condition Review**
- **Equipment Cost of Ownership Review**
- **Equipment Replacement**

Source: Enhanced from Bronzino [1995] and Kachieng'a [1998a].

11.8 COMMENTS AND DISCUSSION

Many African countries utilise much of their financial resources to import new health care technologies in an attempt to catch up with developed nations. Unless a major initiative in planning, deployment and management is undertaken, this tendency instead becomes an obstacle to effective health delivery [Kachienga and Boonzaier 1999]. It should be recognised that new and costly developments in medical practice are not always better than older and less expensive procedures [Banta 1986, Khalil and Waly 1988, Goodman 1993]. Even in developed countries, the effectiveness of many technologies currently used in health care is being questioned [Goodman 1993, Rettig 1996].

The transfer of health technology from industrialised countries to developing countries is not a simple process because it requires the build-up of an infrastructure that can support the new technology and make it sustainable. Although this principle seems to have been recognised to a certain extent by African countries in planning their industrial development, it has, unfortunately, been less recognised by them in their attempts to modernise health care delivery systems [Banta 1986, Coe and Banta 1992, Serpa-Florez 1993, Kachieng'a 1998a].

A number of problems that arise in the process of technology transfer need immediate attention. Most notably, the training and development of clinical engineers and technology managers competent to plan and manage technology transfer are urgently needed. By and large most African countries do not have an organised plan for education, training and placement of these professionals who are so essential in the delivery of health care delivery services.

Building human capacity in clinical engineering and technology assessment is a difficult endeavour that requires years of meticulous planning and execution [Pacela 1992, Menon 1993, Bronzino 1995]. Delays in the implementation of such a policy can only exacerbate the problems in African countries, especially as technological innovations proliferate in health care systems.

11.9 CONCLUSION AND RECOMMENDATIONS

To modernise and sustain health care systems and services in African countries, especially Kenya and South Africa, a number of programmes need to be implemented by health policy planners. These programmes require direct contribution by biomedical and clinical engineers, and also supportive infrastructure (technical and financial) to facilitate effective planning and management of health technology transfer.

The following list of proposals is not intended to be a totally comprehensive list of the programmes needed. However it represents the author's visualisation of priority areas requiring immediate attention, by the two countries. They are based on project management, clinical experience and hard data in Kenya and South Africa, and project and field experience in Zimbabwe, Mozambique, Malawi and Tanzania (see prologue).

These recommendations are as follows:

1. The problem of HT utilisation in health care requires participation by many people from various disciplines, including health policy makers and planners, physicians, clinical engineers and other technical and non-technical staff.

2. A complete survey of the scope and magnitude of clinical engineering services requirements is a good starting point to provide guidelines for development of educational and training programmes, and staffing norm for clinical engineers, and technicians needed in the country (see staffing norm Appendix E).

3. A master plan for training clinical engineers and other technology experts should be developed. The plan should detail both human resources and facilities needed for effective clinical engineering services and technology transfer, the level of education required for defined services and the institution(s) responsible for education and/or training. Any requirement for special facilities or services should be tied to this master plan to enhance programme synergy.

4. The master plan should address the entire problem of developing infrastructure needed to absorb and support modern changes in HT and the professional outlook of new human resources requirements.

5. The master plan and job descriptions should be developed through a joint effort of those concerned. Typically the involved groups include the Ministry of Health, Ministry of Education, medical research institutes, universities and professional societies and groups.

6. In African countries, for educational programmes in biomedical and clinical engineering to make any contribution, they have to serve the immediate needs of transfer of health care technology. Linking human resource development to the country's needs is essential for sustainability of the health care system.

7. It is essential to develop definite career structures for biomedical and clinical engineering professionals within the public sector and the health care facilities. This enhances the continued flow and retention of qualified professionals and trainees in the public sector.

8. Incentive schemes that will attract and keep technical professionals should be implemented. These include monetary incentives and incentives for professional development.

9. Strong association and close co-operation between the clinical engineering profession and the medical profession is essential to the development of biomedical engineering and clinical engineering.

10. Practical training and hands-on experience must be emphasised in the training of biomedical and clinical engineers.

11. Applied research, taking into consideration local situations, has the most positive impact in serving the immediate needs of African countries.

It is obvious that conditions and experiences will differ from one country to another and each country must thus tailor its master plan to suit its particular health care system. The essential feature is that each country must develop its health care technical support master plan to deal effectively with the problems of technology transfer and technology usage in its own health care system.

CHAPTER 12

PROPOSED HEALTH TECHNOLOGY POLICY FRAMEWORK

Chapter 12 integrates all the diverse factors, observations and information from all the previous chapters to facilitate the formulation of a health care technology policy framework for Kenya and South Africa.

> *There is nothing more difficult to carry out, nor more doubtful of success, nor more dangerous to handle than to initiate a new order of things. For the reformer has enemies in all who profit from the old and only lukewarm defenders in all those who would profit by the new order.*
>
> **Niccolo Machiavelli, 1469-1527**
>
> *The Prince, 1961(Republished)*

The people entrust the state with the development of a health system that meets their needs. The public health sector provides a leading role in this respect by developing policies and priorities that reflect that needs of people, by setting standards and norms, and by ensuring that supportive legislation and regulation are adopted. National laws set the basis for collective action for health, protect the vulnerable and disadvantaged from adverse economic effects, and define the boundaries and expectations of government in respect of its partners [WHO 1997a]. Conflicts over values are particularly stark in health policy arena [Fuchs 1993]. It is within these premises that health care technology policy should include measures that ensure appropriate use of technology in a clinical setting as well as protection of patients from harmful technologies. With globalisation and privatisation of economies in Kenya and South Africa, the need for health care technology policy is increasing.

The challenge in the design of a National Health Technology Policy lies in developing ways both of encouraging the creation of new technologies within the country and importing technologies, on the one hand, while at the same time exercising an enlightened control over the diffusion and utilisation of technology on the other [NSF 1983, IOM 1985, Banta and Andreasen 1990, Fuchs 1993]. The pursuit of these apparently contradictory objectives requires a delicate balance between, national health needs, which require the acquisition of technology, and the need for a rational development plan for the health care system, which is based on the principles of optimising the use of technologies already existing in the country. The concept of development of national technology policy framework to guide rational utilisation of technology in health care is supported internationally [Banta 1986, Perry and Pillar 1990, Coe and Banta 1992, Fuchs 1993, Serpa-Florez 1993, WHO 1997a].

The aim of this chapter is to gather and collate all the information and data presented in previous chapters, which influence effective planning, deployment, management and assessment of technology in health care systems, with the purpose of designing a framework for health technology policy applicable to Kenya and South Africa. Recommendations given in the earlier chapters are revisited and from these the basis of the policy framework is logically deduced.

12.1 LITERATURE REVIEW

Policy-oriented analysis in health care has a long history. As early as the eighteenth century, statistics and probability techniques were used, although rarely, in support of medicine and public health [Banta 1982]. Cotton Mather, an American clergyman, carried out an early test of the efficacy of smallpox inoculation in 1721 [Shryock 1969]. John Lind's trial of cures for scurvy in 1747 was another early piece of policy-relevant research [Lambert 1978]. In 1759 Benjamin Franklin published an account of the success of vaccination in Boston. His report contains mathematical analyses of the results of vaccination. It is also an early example of a medical 'review article,' and in many respects is a policy analysis [Franklin 1759].

These historic steps in the development of policy analysis seem to have general applications in the enhancement of health care services [Banta 1982, Banta and Andreasen 1990, Fuchs 1993]. Advances in the development of health technology policy in the USA, the Netherlands, Sweden and Canada stress the importance of a more scientific approach to the applications of technology in health care, including the evaluation of factors such as costs and patients' preferences [Klarman 1974, Banta 1982, Banta and Andreasen 1990, GCCHC 1992, Goodman 1993, Fuchs 1993, Bronzino 1995, Ziekenfondsraad 1998, Kachieng'a and Boonzaier 1999].

12.2 WHY HEALTH TECHNOLOGY (HT) POLICY?

Policy has been defined by Anderson [1966] as "any set of values, opinions and actions which moves decision making . . . in certain directions." Policy is generally thought of as rational and directed to specific goals and objectives [Rivlin 1971, Titmuss 1974].

White and Murmaghan [1973] identify two points of potential usefulness for technology policy or technology assessment research policy: provider–consumer interaction and governmental decision making. Banta [1982] cautions that it should be noted that there are different levels of policy making in health care systems, from a broad decision to address a particular problem to the mainly administrative decisions required to carry out broad policy. He states that, in the case of health care, policy is normally geared towards rational decision-making. The question then is, to what extent can health technology policy influence or contribute to the delivery of health services in Kenya and South Africa?

12.2.1 AFRICAN PERSPECTIVE

In most African countries, the state carries the burden of managing disease and illness; therefore it appears that to achieve rational distribution of health technology, the government must drive the change through some form of policy or legally binding guidelines [Kachieng'a and Boonzaier 1999].

The need for health technology policy for African countries is driven mainly by the need to achieve greater equity in the distribution of essential HT amongst different regions within the country, and also between urban and rural areas [Kwankam 1992, DOH 1997, Kachieng'a 1998a, Kachieng'a and Boonzaier 1999]. There is the further necessity to develop policy that will facilitate the monitoring, regulation and cost-effective utilisation and management of health technologies. Although data required for an inventory of high-tech health care equipment in the public and private sectors is lacking in both Kenya and South Africa, preliminary evidence indicates that the distribution of health care technologies is urban-biased and not equitable amongst regions. For example, Table 6.9 (chapter 6) shows the disparity in the use of CT scanners amongst the provinces and between the public and private sectors in South Africa. As stated in chapter 6, similar disparities are observed in the distribution of Magnetic Resonance Imaging Scanners, cardiac catheterisation units and radiotherapy equipment [DOH 1997].

There is a perception that the quality of health care is linked to the sophistication of the technologies used in delivering that care. Concerns about the allocation of health care resources have increased the visibility and focus of health care technology as a policy issue. These concerns relate not only to resource allocation within the health sector of a country's economy but also to the allocation of resources to health care in comparison to other sectors [Benatar 1996, Kachieng'a 1998a].

The other underlying reason for the development of strict policy is the perception that the availability of technology induces indiscriminate usage, thus driving up the cost of health care without commensurate benefit to patients [Van Rensburg 1996].

During this research, a number of issues emerged:

1. Neither Kenya nor South Africa systematically evaluates new health technology, with the exception of vaccines and drugs. The result is that many technologies that are well established and in general use have never been systematically assessed.

2. The performance of a full technology assessment is often hampered by a lack of information concerning efficacy, effectiveness, or even safety of the various technologies. Data concerning costs are also seldom available. Both countries lack any organised mechanism or policy to develop the necessary data and do not even

recognise its desirability. Until now basic assessment activities have been directed mainly towards the process for structural planning within provinces and districts.

3. It has been observed that certain forms of evaluation of health technologies, such as cost–benefit and cost–effectiveness analysis, offer the most satisfactory basis for the establishment of technology policy. Performing an analysis of costs and benefits is very helpful to decision-makers because the process of analysis gives structure to the problem, allows an open consideration of all relevant effects of decisions, and forces the explicit testing of key assumptions.

4. It has been observed that both Kenya and South Africa have special problems as far as technology assessment is concerned. These countries do not have the resources and personnel to do independent technology assessments and therefore they must rely to a considerable extent on the data generated in industrialised countries. However, because results generated elsewhere are often not applicable to the local situation, trials may have to be done locally and the results evaluated on the basis of indigenous conditions. This requires a certain level of internal capability in technology assessment. Appropriately trained personnel are generally lacking in both countries and such skills need to be developed, either by the individual countries or regionally.

5. Finally, there is consensus that health technology "is not merely a collection of equipment, instruments and apparatus, but all devices, drugs and procedures used by health professionals including the organisation or structure in which they are used" [McGregor 1994]. Therefore, there is need for organised policy guidelines for effective use of technological systems within the health care systems of the countries concerned.

From the above observations, it is evident that there is a need to monitor, regulate, control and manage technologies in modern medical practice and health care services. Most industrialised countries have some form of mechanism or policy that regulates the use of technology in health care. For example, New Zealand established a policy in 1992 and Israel created a mechanism to control health technology in 1994 [DOH 1997]. In Kenya and South Africa, there is no formal mechanism for reviewing overall needs for health technologies, for deciding policy, for setting priorities and for allocating resources. As a result, sales pressures, current technological fashions and personal interests may determine the acquisition of new technologies rather than assessment of needs from the public health point of view. In both countries, there is only a mechanism for controlling drugs and radiological equipment.

12.2.2 HEALTH TECHNOLOGY POLICY OBJECTIVES

The objectives of such a health technology policy can be summarised as follows:

Macro-level Objectives (National Level)

1. To promote equity in access to and distribution of health care technologies and highly specialised technology-supported services.
2. To promote good clinical practice through the use of guidelines for the utilisation of health technologies and highly specialised technology-supported services.
3. To develop the capacity for the assessment of health technologies in order that policy can be guided by evidence.
4. To develop a framework for planning and managing short-term and long-term technology transfer.
5. To develop a framework for health technology innovations, development, and manufacture.

Micro-level Objectives (Facility Level)

1. To provide guidelines for the development of sustainable infrastructural support systems (technical and financial) for purchased health technologies, especially for the maintenance of health care equipment, devices and instruments.
2. To provide guidelines for planning technology programmes and investments that ensure optimal use of equipment resources.

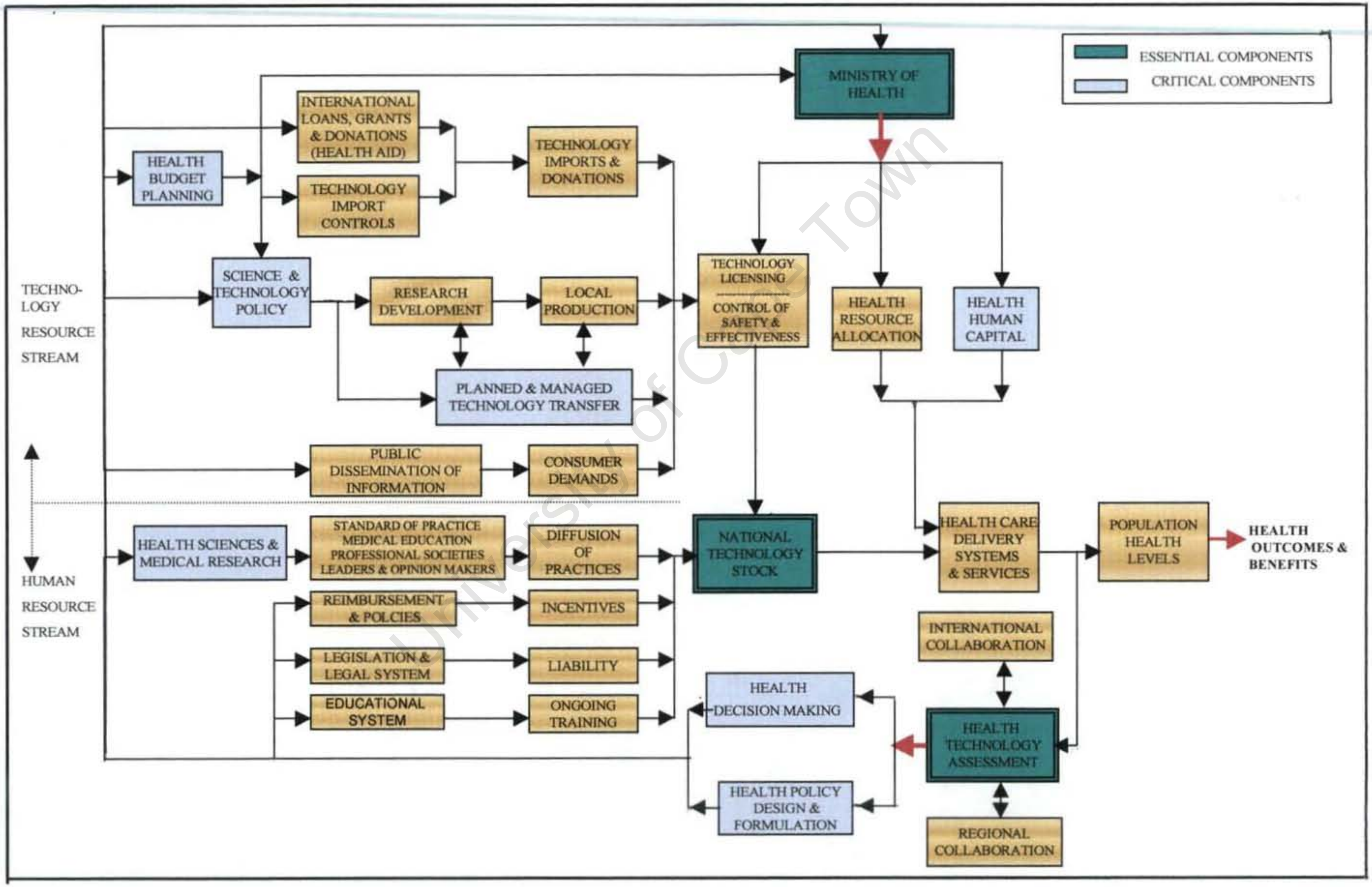
12.3 HEALTH TECHNOLOGY POLICY FRAMEWORK

The purpose of the framework is to bring all major components of health technology activities into a conceptual policy setting and provide a guiding principle in the short- and long-term planning, deployment, use, management and assessment of technology. A point that deserves greater attention, however, is that the framework must be geared to facilitate the flow of data from health technology assessment (HTA) research through the health care system. It will then have decisive influences on health policy and management decisions.

Figure 12.1 illustrates the proposed health technology policy framework. The variable of greatest importance is the *impact* of health care delivery on population health levels. This output is the result of the complex way in which health personnel manage the technological stock available in the country. Both the technological stock and human resources in the health care system are broadly conceptualised to include preventive measures, curative services, public health education and informative campaigns. To enhance clarity, only the most important cause–effect relationships are indicated in Figure 12.1.

It should be noted that different time lags apply in influences channelled through the *education system*. The structure and the performance of both human resources and the available *technological stock* in the health care system are the result of several determinants, which are also influenced by other sectors, as represented in the block diagram. Health Technology Assessment (HTA) is depicted as a set of analytical methods contributing to decision-making and the design and formulation of policy in a large number of sectors, indicating the multiple channels that can be used to promote and facilitate changes in *health care delivery*. Although HTA takes as an ideal output the *population health levels*, it can also be elicited by specific problems of safety, quality, or the cost of health care.

Figure 12.1:
Proposed national health technology policy framework



It should be noted that, for the purpose of assembling its technological stock, a country could either import or produce its health care technology. "Planned and managed technology transfer" is indicated as an essential function in the building of the national technology stock. Depending on financial resources, *health authorities (Ministry of Health)* determine the extension and profile of the technological stock, subject to restrictions imposed by concerns of safety or effectiveness. In a country with a comparatively strong private health care sector, such as South Africa, the *resource allocation* block is also influenced by the *incentives* for the adoption of new technologies, especially incentives for local manufacturers of essential equipment for primary health care.

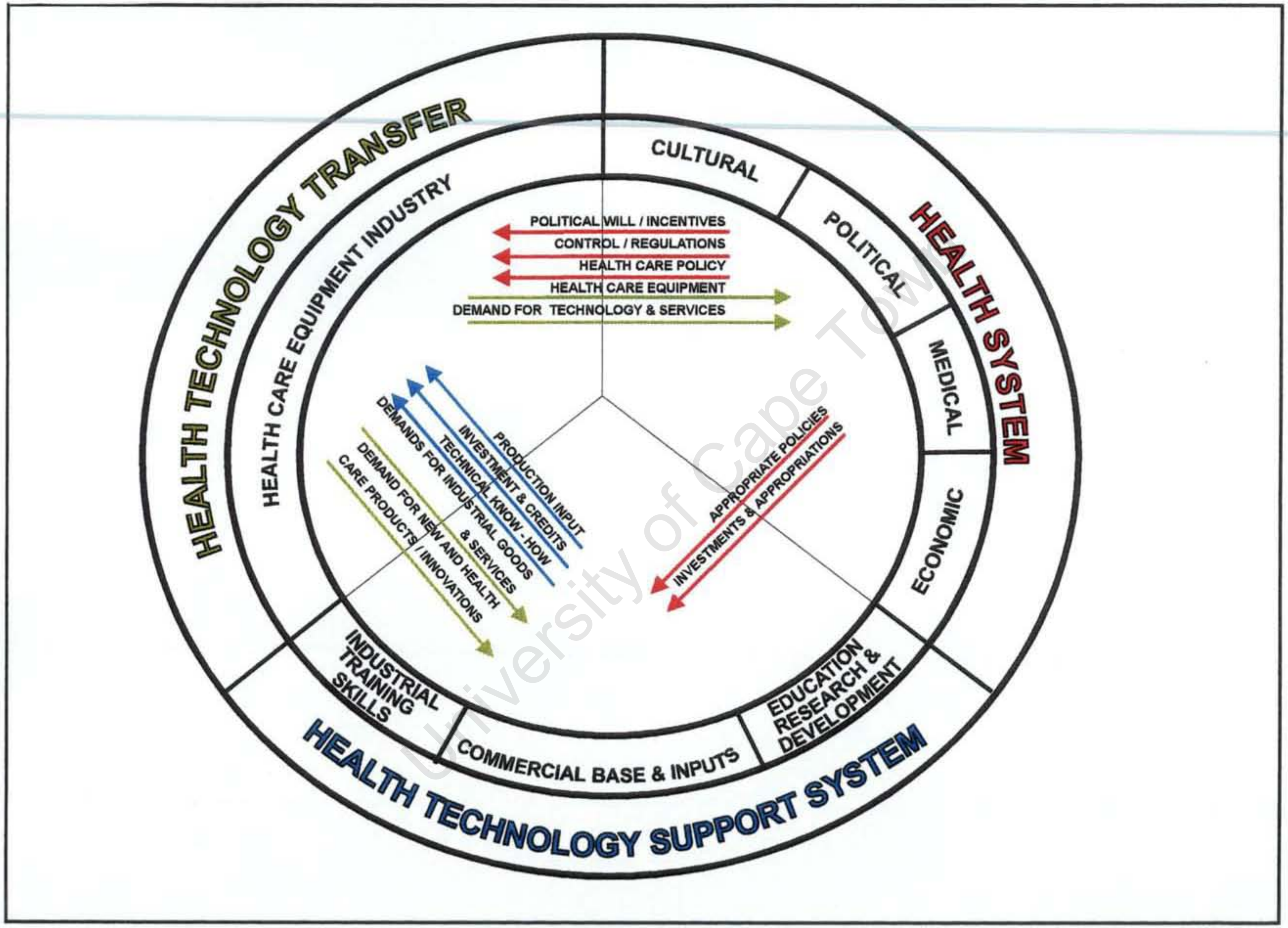
On the basis of interrelations depicted in Figure 12.1, before a technology assessment in health care is considered in Kenya or South Africa, it would be possible to analyse its potential impact taking into account the stage of development and the responsiveness of the different sectors or stakeholders involved. It could be reasoned that at least one clear pathway of influence should be identified before the decision is made to carry out the assessment. The success that can be predicted for implementing the recommendations of an assessment is likely to be directly proportional to the number of channels of influence that can be identified *a priori* [Attinger and Paneria 1988].

Considering the stage of development of the two countries, it is observed that they can benefit from HTA studies because of the ongoing research activities and the established industrial production units. In both countries there is ongoing production of basic health care instruments and devices in efforts to reduce imports and increase local production (see chapter 5 section 5.5). For example, Prof. Laurie Adams of the Biomedical Engineering Department, University of Cape Town, in collaboration with the Medical Research Council (SA) has developed a Neurosurgical Stereotactic Guidance System (The Cape Pointer). The instrument won a national award, and is already in use in most leading hospitals in South Africa [TBDG 1998]. In this regard, HTA is important in identifying the priorities for local development of technology, matching the priorities of the health sector to the existing infrastructure and industrial capability.

Figure 12.2 depicts the interrelationship of the health care equipment industry and other sectors of the national economy. The purpose of this dynamic model is to facilitate technology transfer and local manufacture of essential basic equipment and medical products. As mentioned earlier, developing countries will have to develop some technologies to meet their specific requirements, such as primary health care.

It is easier to achieve the control and regulation of the technological stock than it is to influence health care professionals and regulate their appropriate and efficient use of technology in the delivery of care. Considering the situation in Kenya and South Africa, this aspect of the problem is of greater concern than the regulation of the technological stock. The most effective pathways of influence, according to studies done in other developing countries, are through the creation of adequate *incentives* by public care providers, and by controlling and enhancing education concerning the *diffusion of correct practices* [Attinger and Paneria 1988, World Bank 1995a, Kachieng'a and Boonzaier 1999]. However, avenues such as consumer demand and liability suits are almost non-existent in African countries. The absence of these factors has to be taken into consideration, because many assessments in industrialised countries are launched with envisaged impact through the public dissemination of information or in conditions where malpractice suits are a major source of concern.

Figure 12.2 The dynamics of health technology transfer



12.4 COMMENTS AND DISCUSSION

It is generally accepted that better management of health technology should lead in the first instance to a more appropriate use of the technology and a more efficient and effective health care delivery system [Evans 1982]. Health technology policy framework is a tool that can be used to help decide how to limit expenditures while maintaining or improving health. Like any other tool, though, its impact depends on the way it used. The challenge for a technology policy is to develop a responsible and constitutionally viable mechanism to manage health care technology [DOH 1997, Kachieng'a 1998a].

The priority for the orientation of health services in a scenario of limited resources demands strong support from a technology assessment programme which will identify those health care technologies that can give the maximum impact within prevailing conditions. It has been observed that HTA activities in both countries should be focused on improving health levels in the population.

What the study advocates, therefore, is a shift from the technology-oriented activity of industrialised countries to problem-oriented HTA activities in African countries.

The above observations do not rule out technology assessment studies that deal with a selected technology which is of interest to a particular nation. It is emphasised, however, that in general there is a very distinctive priority applying to HTA work that cannot be separated from the observed mortality patterns and underdevelopment of health care services in Kenya and South Africa.

The observation that it is not realistic to transfer assessment results from developed countries to African countries, because of greater need for emphasis on problem-oriented assessment activities in the latter, implies that Kenya and South Africa are faced with a formidable challenge to develop the methodology for technology assessment that best suits their particular needs and capabilities.

A corollary of the need for a problem-oriented approach is that HTA studies in Kenya and South Africa will have to consider the impacts in these countries of technologies which have not raised much interest in industrialised nations, such as technologies for primary health care, the prevention and treatment of tropical diseases and nutritional deficiencies, and promotion of hygiene and health education.

Health technology policy in Kenya and South Africa must thus recognise the special problems of developing countries, in particular the countries of Sub-Saharan Africa. In this context it should be emphasised that the framework proposed here could, with minor modifications, be applied to other developing countries in the Sub-Saharan Africa region.

12.5 CONCLUSION

The design of a policy framework should not be the end of the of research in this field, because it does not address the hard questions that society has yet to face. Callahan (1990) points out that changing the mechanics of the system is no substitute for examination of the psychological, moral, and political assumptions that lie below it. In the final analysis, the most important issues in the use of technology in health care are neither questions of science and technology nor simply questions of policy reform [Banta 1982, Banta et al. 1983, Banta 1984a, Banta and Andreasen 1990, Bronzino 1995, Kachieng'a and Boonzaier 1999]. The underlying issues reflect political and moral values concerning how we want to live and how we want to die, as individuals and as a society. We need an ongoing discussion of moral values that concern equity, resource allocation, and responsibility for adverse outcomes, to name just a few.

Health technology is an integral part of this moral debate, because technology is inseparable from modern medical practice [DOH 1997]. Indeed, consideration of the moral consequences has not kept pace with the ever-increasing capabilities of health care equipment and devices. Life-support equipment can keep human beings 'alive' indefinitely, but is the artificial extension of life justified by moral or ethical principles? Does the existence of the equipment demand its use? Should economic resources be relevant to these considerations [Foote 1992].

Many technical policies are restricted by their narrow jurisdictions. Additional forums must be created where the people who will have to live with these important decisions can participate and help in working towards a consensus on pivotal questions [White 1982, Evans 1982, Banta and Andreasen 1990, Kachieng'a and Boonzaier 1999]. Bruer [1982] states "neither the data of the scientists nor the values of the ethicists are alone sufficient to close policy debate." Health technologies are critical weapons in the fight against disease and illness. As a developing society, we must encourage the flow of effective innovations. However, the challenge is to promote sufficient and useful technologies while recognising the limitations of our resources. Overuse and misuse induce excess demand, waste valuable resources, and may indeed harm the patients — the very people the technology was designed to assist and protect. The welfare of the patient is and must remain the chief *raison d'être* for any medical procedure, including technology, old and new.

CHAPTER 13

CONCLUSIONS AND RECOMMENDATIONS

Chapter 13 consolidates all the observations and recommendations arising from the research to provide overall conclusion and recommendations of this thesis. The implications of these recommendations for health care policy, are briefly discussed.

It is one thing to analyse past and present problems, quite another to make practical proposals for the future. Yet for men of affairs and of actions, as distinct from historians, recrimination about the past is justified only as part of an attempt to reduce the risk of repeated past mistakes in the future. What new problems science and technology may pose for medicine in the future cannot be known. But that is no excuse for postponing discussion of the principles that should guide us in dealing with them.

Bryan Jennett

High Technology Medicine: Benefits and Burdens, 1986 p 221

13.1 PERSPECTIVE

This study is intended to be a pioneering contribution to research in health technology assessment (HTA) in Sub-Saharan Africa, focusing on public hospitals in Kenya and South Africa. The dissertation has collated much of the scattered empirical data currently available, and made an analysis of the problems in planning, deployment, use and management of health technology (HT) in state health facilities in the two countries. The results of the study demonstrate that HT is poorly planned, inappropriately deployed and inefficiently utilised in both Kenya and South Africa. Also, the utilisation of technology in health care services is strongly influenced by differences in the organisation of health services and the allocation of resources in different facilities.

The statistical analysis systematically pulls together all the presently available empirical data on the use and management of health care equipment in Kenya and South Africa. While rules of evidence and laws of logic have been used to reach reasonable conclusions, the practical realities that exist in the hospital environment have not been disregarded. The aim is to extract 'salient features' of technology in the health systems of the two countries.

The hospitals studied are by no means representative of all health facilities in the areas under study. There is, however, a general trend of conflicting demands in that technology-embodied health care services are not situated where the capacity to benefit is greatest. Lower levels of health expenditure tend to be associated with the poor regions in both countries, as compared to more affluent regions and urban areas. Thus, the regions, where the health of the population gives greater cause for concern, are under-serviced with regard to essential health care technologies.

Currently, an individual's level of access is determined by a wide range of variables, such as personal wealth, employment benefits, membership of medical insurance groups, availability of government-sponsored services or local welfare programmes, geographic region (urban or rural), and other factors. Needy persons with low levels of access to validated health care technologies often have no recourse but to accept the charity of their fellow citizens or support from non-governmental organisations (NGOs). Such charity or support is rarely sufficient. In short, there is need for distributional equity in the use of essential health care technologies in Kenya and South Africa.

The results from this study indicate that with large patient populations, urban hospitals, including teaching hospitals, are better able to support high technology curative services through efficient technology management and adequate budgetary support than rural-based hospitals. Rural hospitals should share technologies through regional centres if the services are to remain affordable and cost-effective in their present environments. Further research should investigate technological distributional equity between urban and rural hospitals, and the role of mobile units.

One specific finding is the observation that the collaboration between individual human resource categories - such as clinical engineers and technicians, physicians and nurses - or the way in which these professional groups are organised, balanced and deployed, may be more important than their total numbers. People's perceptions of what technology can achieve in health care is a major determinant in the use of services, but other contributing factors include the accessibility and affordability of services, availability of technology assessment information and state budgetary allocations to services.

This study is not value-free; but by the same token it does not reflect any one ideology or value system. Every effort has been made to display the data and discover their meaning objectively and sensibly. Analytical methods used in this study are drawn from the various disciplines involved - such as engineering, capital investments financing, statistics, economics and health sciences - and the results of the study reflect the best interdisciplinary compromises and views. Because such wide multidisciplinary consultations have taken place, the study has been thoroughly documented, and it is earnestly hoped that the richness of the raw and secondary data will inspire other researchers to analyse or supplement the data in new and different ways, bringing their own insights to bear on the complex problems addressed by this dissertation. Minor limitation of the research was its confinement to public sector due lack of funds. In portions of the survey the sample sizes were small. Also, inclusion for private hospitals in the survey would have provided data for comparative analysis of technical and allocation efficiencies.

Perhaps the most important methodological questions relate to the validity of cross-cultural and cross-national comparisons themselves. This study has, through both methodological analyses and substantive results, demonstrated great consistency, across the two countries studied, among such diverse measures as participation of clinical engineering departments in the tender adjudication, patient length of stay, use of computers in hospitals, non-functioning of equipment, equipment maintenance budgets, and distribution of clinical engineers and technicians. It therefore seems reasonable to conclude that most of the cultural differences between the two countries are embedded in societal values and in organisation of health services rather than in the way in which individuals and populations perceive their health and their health needs, including the use of technology. This is not to say that differences between the two countries are not shown in the variables measuring technology use. However, it is argued that they may be less influential and less amenable to societal manipulations than are resources and systems factors in the interest of equating needs for and use of services. Minor limitation to research was that in some cases, sample sizes were small and the value of some arguments could not be fully tested.

The complexity of technological requirements in health care demands continuing collaborative, multidisciplinary research and the pooling of knowledge and skills across the borders of African countries. The fact that cross-national comparative studies of the kind described here can be carried out successfully extends the scope of analysis and opens a greater range of possible approaches to health care service problems in Sub-Saharan Africa than had been previously thought possible.

13.2 SUMMARY OF CONCLUSIONS

This dissertation has attempted to identify important concepts and relationships between technology and the delivery of health care services and, where possible, to assess, measure, quantify and analyse them statistically. The objectives have been to influence health care policy decisions, raise the level of empirical research and advance the understanding of complex, strategic and competitive roles played by technology in different forms of health care institutions. To this end, engineering logic and statistical evidence have been used without ignoring common sense.

However, far more important are the opportunities afforded to draw conclusions, to ask questions, and to stimulate discussion arising from problems in the use of HT in Kenya and South Africa. Indeed, it is these practical applications of technology that frequently provide the greatest insights and identify opportunities where, with more refined data from a larger number of samples and larger study areas, principles might be more firmly established. From this platform, a body of theory could be established to guide the organisation of technology in health care systems in the Sub-Saharan region.

No claim is intended or implied that the observations or conclusions drawn from this study are absolute. This has been a static study of a dynamic process. However, the absence of information in areas such as technology planning, deployment, management and assessment - particularly in the context of the need for researched information to guide critical decision-making processes and the formulation of health policies - make it worthy of attention.

With these considerations in mind, the major findings arising from this research involving HTA in public hospitals in Kenya and South Africa can be summarised as follows:

13.3 MAJOR RESEARCH FINDINGS

1. Health care equipment maintenance problems which can compromise health outcomes originate from poor planning, deployment and management.
2. Poorly selected and inappropriately deployed equipment is an economic burden to hospitals, since the intended medical services are not provided. The costs are thus higher than those involved for appropriate equipment.
3. Acquisition of health care equipment is not planned on the basis of evidence of relative advantage with regard to outcome, cost of ownership or returns on investment.
4. Tender Boards lack the technical expertise to make clinical and technical evaluations required for HT acquisition.
5. Existing methods of financing and procurement of health care technologies provide incentives for additional use of expensive technologies and reward the use of hospital-based curative technologies. There is no emphasis on investment in technology for primary health care.
6. Problems associated with the use and management of HT are more critical in large hospitals than small hospitals. Public hospitals need technical support and guidance in high-technology health care equipment procurement and management.

7. HTA as a policy instrument and planning tool has not gained recognition in Kenya and South Africa. The planning, deployment, management and assessment of HT is not integrated into health care policy and planning.

8. Both the Kenyan and the South African governments place undue emphasis on technological interventions without equal efforts being directed at qualitative and quantitative measurement of health outcomes in relation to such interventions. There is need for *qualitative* and *quantitative* assessment of the health outcomes of various technological interventions to compare their relative merits, and to justify financial investments in such technologies.

9. The amount of useful data in existence for policy decision making on technology-related health issues is inadequate. Technology assessment studies are needed to generate data for policy decisions on the use of technology in Kenya and South Africa.

10. The role of technology assessment is likely to increase with budgetary and fiscal constraints in African health care systems, and such systems are more likely to control technology acquisitions through assessment methods.

11. Information from the few assessment studies that have been performed to date in Kenya and South Africa is not adequately disseminated, mainly because there is no institution or agency to co-ordinate assessment programmes and disseminate the results to health professionals, policy planners and the public. The usefulness of much of the assessment data and analyses is compromised because of insufficient communication among decision-makers, analysts, technology assessors and health service managers.

12. There are currently only a few international collaborative efforts (mainly driven by WHO) to develop an information data bank on the effects of health care technologies, and there is inadequate sharing of the information collected in individual African countries.

13. There is no direct collaboration in technology assessment between the public and private sectors in Kenya and South Africa. Better technology assessment synergy would be achieved if the two sectors were to collaborate in assessment research. The advantages of such collaboration include not only shared costs but also objective reports that can be widely distributed to the medical and business communities.

14. HTA activities should be problem-oriented and geared towards limiting health expenditures while improving health care services.

15. The evidence and documented experiences with HTA in Kenya and South Africa indicate that assessment studies will necessarily have to consider the impacts of technologies which have not raised much interest in the industrialised nations. These include technologies for primary health care, prevention of tropical diseases and nutritional deficiencies, promotion of hygiene, provision of safe and clean water, and health education.

16. The total investment in HT research relevant to the needs of developing countries is inadequate in relation to its potential benefits. Only about 5% of the US$ 30 million global investment in 1986 went to health problems unique to developing countries [World Bank 1993a]. International financing and support is needed for HT research when benefits transcend national borders and the research cannot be undertaken by the private sector at socially optimal levels. Such collaborative research should be based in African countries to enhance the building of research capacity.

13.4 FUTURE HCTA DIRECTIONS

The purpose of this thesis was to analyse the problems associated with the use of health care technologies in Kenya and South Africa, and to suggest changes in planning and management of technology in health care systems.

The directions that HTA should take towards future improvement are as follows:

1. Hospital management as a special field requiring specific techniques is virtually neglected in the public sector. The weakest link between technology-embodied interventions and health outcomes is management. The most immediate cost containment action is to enhance management of the existing technological stock and resources.

2. More effective systems for technology planning, deployment and management must be developed; infrastructure that facilitates efficient and effective use of health care technologies is essential.

3. Each country should establish an institution or organisation responsible for HTA, including qualitative and quantitative assessment health outcomes in relation to technological interventions. This does not imply that such an agency or organisation should conduct all the HTA studies in that country, but rather that it should be responsible for co-ordinating HTA activities. Thus, it could perhaps serve as an information clearing-house, provide technical assistance, advise on research priorities, interpret results, synthesise the results of studies and disseminate information to governments, business, research institutions, health facilities (public and private), professional medical organisations and all other interested parties. Presently, pieces of information for various research units or organisations are not easily available; no single one office monitors, collects, indexes, and disseminates such information.

4. Licensing and regulatory organisations for HT should be strengthened to cover all equipment, including CT scanners, MRIs and other high-tech technologies.

5. A standard essential equipment list should be developed for all major categories of health facilities.

6. SEELs for Primary Health Care is an important area for future research work.

7. Financing systems should be used more rationally to support both curative and primary health care technologies. Financial incentives that encourage physicians and health institutions to overuse or unnecessarily invest in technology should be removed.

8. The public health sector should ensure that national health technical workforce policies: address the long-term needs for clinical engineers; nurture and develop institutional and individual leadership for technology; strengthen managerial capacity in technology management and assessment throughout the health sector; and improve the infrastructural and institutional (hospitals) environment within which the health technical workforce performs.

9. The efficacy of technical services is strongly dependent on the professional competence of those who provide them; the raising of professional standards and performance is thus of cardinal importance in improving the effectiveness and efficiency of health care technical support services. The lack of technical expertise in Kenya and South Africa is one of the contributing factors to the high proportion of non-functioning equipment. The training of technology managers, clinical engineers and technicians is vital. Clinical engineering departments should be established in major hospitals to manage equipment planning, procurement and maintenance and to supervise maintenance works by external maintenance service providers.

10. Prioritising HTA in Kenya and South Africa implies the identification of those health technologies which can lead to the maximum impact within the prevailing conditions — lack of technical expertise and resource constraints. Kenya and South Africa should therefore focus their future HTA research on problem-oriented endeavours.

11. Regional (intra-African) and international sharing of research results should be increased, as should collaboration in research. This suggestion would be greatly facilitated if each country had an assessment agency. A body such as the World Health Organisation (WHO) and its regional offices could serve as a co-ordinating centre for assessment research.

12. Modern medical education predisposes physicians to liberal use of technologies by emphasising the importance of thorough diagnosis and encouraging excessive faith in the efficacy of therapeutic technologies. However, without assessment information to indicate how best to help the patient, the physician is handicapped in decision making. The way future physicians are trained will be one of the most important factors in orienting their thinking concerning the use of health care technology. There is need to expose medical students to technology assessment, health economics and health care system management.

13. The particular assessment requirements of African countries must be addressed. Most HTA now takes place in developed countries, but the needs of African countries are, if anything, even more critical. The resources, experience and expertise of industrialised countries should be turned towards assisting African countries to establish an assessment capability. There is need for international collaboration between developed and developing nations to facilitate HTA expertise transfer.

14. Universities in Kenya and South Africa, especially with medical schools whose academics engage in clinical research, have a vital role in furthering the goals of appropriate use of technology. Academic clinicians are a bridge between laboratory research, where technologies are developed and clinical practice, where these technologies are applied in treating patients. Academic clinicians are particularly suited to doing clinical assessment of health care technologies, and academic clinical departments should devote more time to the assessment and application of HT on a broad scale.

15. Local manufacture of basic and essential health care equipment (for primary health care) should be supported by African governments, international agencies and foreign governments. International agencies could stimulate local technology research and product developments by providing information on potential markets for new products, target population, and technical requirements of desirable technological innovations. A priority in this area that requires international support is the research and development of low-cost and efficient diagnostic techniques for primary health care services.

16. African governments and international agencies also need to give more support to technology assessment, and to management of new technologies, including their incorporation into existing health care systems. For example, African governments should reduce or eliminate taxes or duties on imported essential health care technologies and products earmarked for primary health care services.

17. The survey tools and concepts found in Chapters 8, 9 and 10 should be appropriately modified for investigating problems in the health care systems of other African countries.

13.5 IMPLICATIONS FOR HEALTH CARE POLICY

One of the objectives of this thesis is to assist in bridging the gap between HT utilisation and health policy, so that investment in technology should improve the efficiency of public health services and lead to better health outcomes. There is a policy vacuum in technology acquisition and diffusion in Kenya and South Africa.

Stimulated by concerns about the quality, effectiveness, and escalating cost of health care, interest in health technology assessment is growing [Jennett 1986, Fuchs 1993, Rettig 1996]. Health technology assessment has become a powerful health policy tool that can be used for managing health resources and limiting health expenditures while improving quality of services [Banta *et al.*1983, Fuchs 1993, Kachieng'a and Boonzaier 1999]. In public sector HTA can offer governments a rational basis for deciding which health interventions provide better health outcomes in a cost-effective manner. Information from HTA studies can be used in the planning, selection and procurement of essential technologies and development of SEELs for different health facilities. Data from HTA studies can also be used in allocating realistic equipment maintenance budgets.

Health technology assessment is essentially a heuristic process. It is a means of negotiating the social contract between health policymakers, health care providers, health insurance companies, and health care receivers and payers (patients). This is a form of what Sir William Petty, the Seventeenth Century physician, statistician, and economist called 'political arithmetick' [White 1982]. It is therefore essential that for HTA concepts to form integral part of health policy, there is need for 'political will' from the governments of Kenya and South Africa.

The ongoing health system reforms and restructuring in Kenya and South Africa has created an important role for HTA [Kachieng'a 1998a, Kachienga and Boonzaier 1999]. In addition, the two governments are implementing cost containment policy in the delivery of health services. It is because of these observations that HTA should play a strategic role in health policy and planning of health services in Kenya and South Africa.

Finally, use all health technology is associated with risks. These risks must be balanced against expected benefits, but such decision making is hampered by the lack of assessment information. The quality of care provided and costs associated with the financing of that care are intimately connected with the ability to reach judgements about the value of specific health technologies. Efforts to contain costs and monitor the quality of medical increasingly rely on HTA [Rettig 1996]. In industrialised countries HTA is instrumental in developing health policy and setting medical aid reimbursement scales [Fuchs 1993, Rettig 1996,Hollandia 1996].

The challenge to health policy is to develop institutional and scientific resources capable of undertaking comprehensive assessment of health technologies, combined with incentives and constraints that will ensure that these assessment results influence future research and development decisions in socially desirable directions [Kachienga and Boonzaier 1999]. The gap between what is technically possible and what is economically feasible will probably widen; thus, the demand for guidance concerning the cost-effectiveness and implications of alternative health interventions is likely to grow [Fuchs 1993, Kachieng'a 1998a].

The implications for health care policy in the planning and implementation of the findings generated by this research must arise from two underlying assumptions. The first assumption is that in all societies, individual and collective decisions are made about the nature and use of health care technologies and the allocation of resources to meet needs perceived by the population. Secondly, it is assumed that useful information about the interrelationships among these factors should improve personal and societal decision-making [Kaitaranta and Purola 1973, Banta and Andreasen 1990, Foote 1992].

It must also be acknowledged that there is not now, nor is there ever likely to be, an "ideal" plan for HT, nor an ideal health care system. However, there is a continuing search in all societies for improved ways of managing health care resources and services so that the health needs of people can be met as effectively and efficiently as possible [Lalonde 1974, Rettig 1996].

Health care systems are unique in every country; they are amenable to change, and it is for each society to assert its values and create its services in relation to its needs. This study has attempted to distinguish and assess patterns of need and uses of technology; alternative arrangements of resources, and the implicit effects of different values and value systems on the use of resources. It has sought to inform and illuminate patterns of health care in Sub-Saharan Africa, more specifically in Kenya and South Africa, and to suggest ways in which increased empirical knowledge can be brought to bear on the policy decision-making process.

The need for assessing health or medical benefits arising from technology, and for relating them to costs as part of overall societal concern that value be received for money, should dominate all thinking about health care policy. Health planners and policy analysts will especially need to keep in mind the requirements for continuous assessment and monitoring of the efficacy, safety and effectiveness of health care technologies and the efficiency of all health care services. This is especially true with regard to rational technological support of both preventive and curative services.

To "assess" means to evaluate in relation to a set rules or hierarchy of values. Some goals in medicine and health care are more valued than others, both by individuals and collectively by a society or a country. It is the task of policymakers and health care managers to discern and articulate the values for their constituents and possibly also to guide them in the light of information available. It may also be their task, or more broadly the task of the government, to enunciate visions of the possible and to specify means of attaining the practical, if not the desirable.

Education of doctors, clinical engineers, nurses and even patients about the benefits and limits of health care technology becomes the central means and the essential medium for improving the condition and for lightening the burden of illness which besets all humanity, especially in Sub-Saharan Africa, and specifically in Kenya and South Africa.

Despite the focus of this research on health care technology and health services, the author is mindful of the fact that health services are only one of the factors determining health status. It seems unlikely that health sciences will ever develop - or that health services by themselves can ever provide - the means of counteracting or even containing all the ravages of lives spent in destructive personal and interpersonal behaviour or in deprivation. The most powerful antidote to ill health and disease may well be education, fundamental education at the primary level in basic human biology and psychology, the essential means for understanding and applying what people know about health and healthful living, for example, in the prevention of the proliferation of the HIV virus.

The role of education in health care and in society cannot be gainsaid. Governments throughout the world spend huge amounts of money to ensure a good education for their citizens. An educated nation is not only more healthy, but also more productive. It is also easier to govern because it understands the policies of governance, rules and regulations in that society.

Health sciences and health technologies have already succeeded in preventing some illnesses and controlling the consequences of others. In the foreseeable future, therefore, investments in health science research and technology assessment will probably exert an increasing claim on scarce resources. Equally costly, if not more so, are the failures, as a result of ill health, to achieve human aspirations and potentials. Assessment of information about needs; effective technological intervention, and the relating of these to health outcomes form part of a cybernetic system that should govern the allocation of scarce resources in the health care system.

Because of the strategic role technology plays in health care and of the complexity of the problems associated with its use and management, it is the conviction of the author of this dissertation that more will be learned by working in concert than in isolation, either within single disciplines or within individual countries. By pooling technology assessment resources, theories, concepts, knowledge, information and methods across disciplines and across geographical boundaries, we are likely to discover how technology can best add value in the fight against disease and illness. Ultimately we may even be able to develop a universal knowledge bank in the worldwide struggle to enhance physical, mental and social well-being of humanity.

EPILOGUE

Crafty men condemn studies;
Simple men admire them, and
Wise men use them.

Francis Bacon, 1561-1626

Advice is like snow. The softer it falls the deeper it sinks.

Samuel Coleridge, 1772–1883.

Naturally, this thesis makes no pretence at being an exhaustive document to guide technology planning, deployment, use, management and assessment in Kenya and South Africa. The more modest intention is to convey critical research observations, insights, findings, information and assessment data for the improvement and enhancement of health technology investments, applications and use in the two countries.

The research has shown that health care systems in both countries are beset with problems: technical, financial and management inefficiency, increased costs of health care, and declining health services and outcomes. It is hoped that this scientific contribution will assist in the reversal of these unfortunate trends. The data generated from this study and the recommendations made could contribute significantly to the formulation of health policies and the development of strategies which would stimulate efficient planning, deployment, use and management of technology. The eventual outcome should be improvement in health care services, thus reducing economic waste and the burden of disease and illness in the two countries. The developed strategies and recommendations made in this thesis are not the final answer, but they are a starting point for public debate on health care choices.

Restructuring of health care systems in Kenya and South Africa to meet the health needs of their populations and the deployment of new and appropriate technologies will pose economic, technical and management challenges. The results from the surveys provide information and guidelines; from these, it is hoped that recommendations will be made towards to appropriate technological choices, and the planning and management of technology which enhances delivery of health services in these countries. How this research will assist in transforming health care policies in the two countries will depend on the political will of the respective governments to initiate the application of the recommendations. In addition, pressure from bilateral and multilateral bodies, such as the USAID, GTZ, UNESCO, World Health Organisation, World Bank and African Development Bank, may have to be exerted on African governments to motivate them to use assessment data for making informed decisions in providing health services. Health technology assessment in African countries does not yet impact on health care policy as much as it should. Consequently there are policy vacuums which lead to misuse and mismanagement of scarce health resources.

Health care funding in both countries is declining in real terms. Technology is a major contributing factor to the ever-rising health costs. Strategic integration of technology into the health care policy and services may be the only option for achievement of better health and economic development in Kenya and South Africa.

My promotion of health technology assessment research in Kenya and South Africa is motivated not only by knowledge of the problems that can be solved in this way or the recommendations that can inform policymakers, but also by the need to create awareness of the important role played by technology in modern medicine and health care services. It is important to highlight economic waste due to poor planning, inappropriate deployment and under-use of technology in general, and health care equipment in particular.

Technology commands recognition in proportion to its contributions to health care systems, which are strategic and competitive, not optional. Scarcity of resources in both countries dictates that health care services must be efficiently and cost-effectively provided, but at the same time remain accessible and affordable for the majority of the population.

This thesis recognises that advances in health technology will certainly continue; the challenge is how to ensure that the balance between the benefits and the burdens associated with health technology will become favourable as far as possible in the future, and that the use of technology in health care should enhance and not diminish human health in Kenya and South Africa. In anticipation of future innovations in technology, the author has proposed a health care technology policy framework (Figure 12.1) to guide the management of all phases of the technology creation spectrum - innovation, development, diffusion, utilisation and obsolescence.

It should be recognised that the implementation of *appropriate technology* must be preceded by *appropriate research*. Sustainable health care systems cannot depend solely on imported technologies. The Kenyan and South African governments should encourage 'planned and managed technology transfer' and provide incentives for local manufacture of basic essential health care equipment. To facilitate this, a model that indicates and provides interrelationships between the equipment industry and other sectors of the economy, including research and development institutions, has been provided (Figure 12.2).

There is much to be learnt from cross-national health technology research, of the type presented in this thesis. By comparing and contrasting different problems, and different approaches to common problems, each can benefit from the strengths of others. *In health care each of us need all of us*. African countries all have immensely similar patterns of disease and illness (see chapters 1 & 3) and therefore regional co-operation in health research should be encouraged, not only to share research costs but also data.

Facts and figures, even in the limited form allowed by this dissertation, are always a powerful aid to the understanding of particular situations and the designing of solutions to alleviate the problems. In health care, as in most endeavours, good information facilitates sound decision making.

It is hoped that this study will stimulate the growing appreciation by governments in Sub-Saharan Africa, as well as by donor organisations supporting health care programmes and projects in the region, that while African countries need to retain a foothold in scientific medicine, their health care problems can only be solved by using the established technologies cost-effectively and efficiently. However, at the same time they do still need to develop new technologies, or appropriately modify old ones, to meet their specific health needs, especially in the area of preventive and primary health care that is so important under African conditions.

What did I hope to accomplish in this thesis? I wanted above all to bring out the complexity of the subject of health technology assessment in an African context. It is not intended to create a sense of doom but rather to emphasise prudence and the need to know more. Knowledge about the indicators for use of technologies must be increased, and those indicators should take into account the health benefits to be gained and the risks to be encountered in any technology. Further, the use of technology should be examined not only in terms of cost-effectiveness but also in the context of social values and impacts. In essence, the key to better use of technology is clearly better information. The present lack of such information is a serious constraint on good decision-making.

I have recommended directions for improvement in the ways that health technologies are planned, deployed, used, managed and assessed. However, I have not suggested final solutions because I do not believe that these issues are amenable to immediate and final resolution. African society should strive continually to know more about the possible impacts of appropriate and inappropriate use of health care technologies on both the health status of its populations and on national economies, taking into consideration the conditions pertaining in each country.

And finally, I have hoped to underscore the complex relationship of health care technology to society. Modern medicine is closely interlinked with science and technology. Both parts are necessary and both operate within society's cultural, political, economic and ethical systems. Solutions, therefore, will not come from physicians alone, nor biomedical engineers, health economists, health planners, ethicists, or any other single professional group. Problems with technological investments in health care in African countries are being successfully identified through a complex co-operation of disciplines and groups. Solutions will only come gradually, through continued collaborative, interdisciplinary effort. By virtue of interconnection of various disciplines, the collective intellectual power of multidisciplinary health professionals is harnessed to solve complex problems in health care. Indeed, the most outstanding message to be drawn from this thesis is the evidence it accumulates that multidisciplinary collaboration is the *sine qua non* of successful management and assessment of health technology.

This thesis, I believe, will help to increase understanding of the complex relationship between technology and health care. And that understanding will in turn help us *all* to better apply the power of technology to the great challenge of eradicating disease and illness, and improving people's lives.

Making rational judgements about future applications and developments in health technology will continue to require not only numerical statistical evidence but also a broad appraisal of the society of which the technology is a part. It is along these lines that I hope this thesis has succeeded in creating awareness and pointing some directions, if not destinations.

REFERENCES

ABEL-SMITH B (1986). The world economic crisis, Part 1, Repercussions on health. *Health Policy and Planning*;1 (3): 202-213.

AFRICAN DEVELOPMENT BANK (ADB) (1993). *Kenya: Health Rehabilitation Study ADF/BD/WP/93/33.* Nairobi: African Development Fund Publication.

AFRICAN NATIONAL CONGRESS (1994a). *A National Health Plan for South Africa.* Prepared by the ANC with technical support of WHO and UNICEF. Johannesburg: Umanyano Publications.

AFRICAN NATIONAL CONGRESS (1994b). *The Reconstruction and Development Programme: A Policy Framework.* Johannesburg: Umanyano Publications.

AMAX-NEEF M (1992). *From the Outside Looking Inside: Experiences in Barefoot Economics, 2nd Edition.* New Jersey: Dag Hammaskjold Foundation & Zed Books Ltd.

AMERICAN COLLEGE OF CLINICAL ENGINEERING (ACCE) (1991). *Board Meeting Minutes*, American College of Clinical Engineering, 24 February, Houston, Texas.

ANBAR M (1984). Penetrating the black box: physical principles behind health care technology. In: *The Machine at the Bedside*, Reiser S.J. & M Anbar M (eds): 23-35. New York: Cambridge University Press.

ANDERSON N, MARKS S, ZWI A (eds) (1988). Health, apartheid and the front-line states. *Social Science Medicine*; 27: 667-681.

ANDERSON OW (1966). Influence of social and economic research on public policy in the health Field: A review. *Milbank Memorial Fund Quarterly*; 44: 11–89.

ATTINGER EO (1984). Impacts of the Technological Revolution on Health Care. *IEEE Transactions on Biomedical Engineering*; BME 31 (12): 736-743, December 1984.

ATTINGER EO and PANERIA RB (1988). Transferability of health care technology assessment with particular emphasis on developing countries. *International Journal of Technology Assessment in Health Care*; 4: 545-554.

AURELIUS M (1961). *Meditations* (Republished by M Stainforth, 1961). Harmondsworth: Penguin Classics.

BACON F (1876). *Bacon Essays (1561-1626).* Imprints in 1876, publisher not found.

BADER MB (1977). The International Transfer of Medical Technology: Analysis and a proposal for effecting monitoring. *International Journal of Health Services*, 3: 443-458.

BANTA HD (1982). Technology assessment and policy making. In: *Resources for health*. HD Banta (ed). New York: Praeger.

BANTA D (1984a). The uses of modern technologies: Problems and perspectives for industrialised and developing countries. *Bulletin of Pan American Health Organization*, 18(2): 139-150.

BANTA D (1984b). Embracing or rejecting innovations: clinical diffusion of health care technology. In: *The Machine at the Bedside*. SJ Reiser, & M Anbar (eds): 65-92.New York: Cambridge University Press.

BANTA D (1986). Medical technology and developing countries: The Case of Brazil. *International Journal of Health Services;* 16: 363-373.

BANTA HD (1990). Future health care technology and hospital. *Health Policy*; 14: 61-73.

BANTA HD, BEHNEY CJ and WILLEMS JS (1981). *Toward Rational Technology in Medicine,* p1. New York: Springer Publishing Company, Inc.

BANTA D, BURNS AK, BEHNEY CJ (1983). Policy implications of the diffusion and control of medical technology. *Annals AAPS;* 468: 165-181.

BANTA D and ANDREASEN PB (1990). The political dimension in health care technology assessment programs. *International Journal of Technology Assessment in Health Care*; 6: 115-123.

BARNUM H and KUTZIN J (1993). *Public Hospitals in Developing Countries: Resource use, Cost, Financing.* Baltimore: Johns Hopkins University Press (for the World Bank).

BATTISTA RN (1989). Innovation and diffusion of health related technologies. *International Journal of Technology Assessment in Health Care*; 5: 277-248.

BATTISTA RN (1990). Innovation and diffusion of health care related technologies: A conceptual framework. *International Journal of Technology Assessment in Health Care;* 5: 227-248.

BENATAR SR (1986). Medicine and health care in South Africa. *New England Journal Medicine*; 315: 527–32.

BENATAR SR (1990). A unitary health service for South Africa. *South Africa Medical Journal;* 77: 441-447.

BENATAR SR (1992). Transition towards a new South Africa. *South Africa Medical Journal;* 81: 295-298.

BENATAR SR (1996). Health care reforms in the New South Africa. New *England Journal of Medicine;* 336 (12): 891-895.

BENATAR SR (1997). Inside Story: Quick-fix solutions are damning Medical Care. *Personal Communication,* 18 November 1997.

BENEDICT R (1935). *Patterns of Culture*. London: George Routledge.

BICE TW AND WHITE KL (1971). Cross-national comparative research on the utilisation of medical services, *Medical Care*; **9**: 253–271.

BLASBERG RG (1981). Application of quantitative autoradiographic measurements in experimental brain tumour models. *Seminars in Neurology*; 1: 217-218, September.

BLECHER M, McINTYRE D (1994). *Research expenditure in South Africa: 19991/92. National Health Expenditure Review Technical Paper No. 6*. Durban: Health Systems Trust.

BLIX H (1979). Science and technology in North-South context: A Swedish Perspective. *Development Dialogue;* 1: 5-11.

BLOOM G and TEMPLE-BIRD C (1988). *Medical Equipment in Sub - Saharan Africa: A Framework for Policy Formulation*. Research Report 19. Institute of Development Studies. Brighton: University of Sussex.

BONAIR A, ROSENFIELD P, TENGVALD K (1989). Medical Technology and Developing Countries: Issues of technology development, transfer, diffusion and use. *Social Science and Medicine*; 28 (8): 769-781.

BOS E, VU M, MASSIAH E, BULATAO RA (1994). *World Population Projections: estimates and projections with related demographic statistics*, 1994-95. Baltimore: The John Hopkins University Press (for the World Bank).

BOURNE DE, PICK WM, TAYLOR SP (1990). A methodology for resource allocation in health care for South Africa, Part III. *South African Medical Journal*; **77:** 456-459.

BUTLER AJ (ed.) (1898). *Bismarck, The Man and the Statesman (1815-1898).* London: Smith.

BRADSHAW D, LAUBSHER R, SCHNEIDER M (1995). *Estimated cause of death profile for the nine provinces based on the 1990 data*. Technical report: Centre for Epidemiological Research in Southern Africa.

BRADSHAW D and BUTHELEZI G (1996). Health status. *South African Health Review:* 19 – 32.

BRIDGMAN RF (1976). Foreword. In: *Health Care: An International Study.* Robert Kohn and Kerr L. White, (eds). New York: Oxford University Press.

BRONZINO JD (1992). *Management of Medical Technology*. Boston: Butterworth–Heinemann.

BRONZINO JD (ed.) (1995). *The Biomedical Engineering Hand Book.* Washington: IEEE Press.

BRONZINO JD, SMITH VH, WADE ML (1990). *Medical Technology and Society: An Interdisciplinary Perspective*. Cambridge: The MIT Press.

BRUER JT (1982). A philosophical view of cost-effectiveness analysis. In: *Resources for Health: Technology Assessment for Policy Making*; H. David Banta (ed.): 126–129. New York: Praeger Scientific.

BRUNER MJR and LEONARD PF (1989). *Electricity ,Safety, and the Patient - Year Book.* Chicago: Medical Publishers.

BUNGE C, MISORE A, MOGAKA O (1992). *MOH/GTZ Project review report: procurement of spare parts for medical equipment in Kenya.* Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) GmbH, Eschborn.

BUNTING I (1994). *Public expenditure on the education and training of medical personnel. National Health Expenditure Review Technical Paper No. 7.* Durban: Health Systems Trust.

CALLAHAN D (1990). *What Kind of Life: The Limits of Medical Progress*: 100-101. New York: Simon and Schuster.

CARROL JD (1971). Participatory technology. *Science*; 971: 647- 653.

CAVER ME (1990). Technology management in the health care environment: Yesterday, Today, Tomorrow: Part 1, *Biomedical Instrumentation Technology;* 24: 320-326.

CHETTY K (1994). *An integrated analysis of health facilities in the nine provinces of South Africa. HEU Working Paper No. 13.* Cape Town: Health Economics Unit, University of Cape Town.

CENTRAL BUREAU OF STASTISTICS (CBS) (1994). *Economic Survey* 1994. Ministry of Planning and National Development (MPND). Nairobi: Government Printer.

CENTRAL BUREAU OF STATISTICS (1995). *Statistical Abstract 1995.* Ministry of Planning and National Development (MPND). Nairobi: Government Printer.

CENTRAL BUREAU OF STATISTICS (CBS) (1996). *Economic Survey 1996.* Ministry of Planning and National Development. Nairobi: Government Printer.

CENTRAL BUREAU OF STATISTICS (CBS) (1997). *Economic Survey 1997.* Ministry of Planning and National Development. Nairobi: Government Printer.

CENTRAL STATISTICAL SERVICE (CSS) (1993). *Population Census 1991:Geographic Distribution of the Population.* Pretoria: Government Printer.

CENTRAL STATISTICAL SERVICE (CSS) (1995). *Republic of South Africa (RSA) in Brief.* Pretoria: Government Printer.

COE GA and BANTA D (1992). Health care technology transfer in Latin America and the Caribbean. *International Journal of Technology Assessment in Health Care*; 8(2): 255-267.

COLERIDGE S (1911). *Coleridge Essays 1772-1883*. Imprints in 1911, publisher not found.

COLLOTON JW (1989). Imperatives for new initiatives in health services research, *Hospital & Health Care Administrations*; 3: 295-298.

CROMWELL J, HEWES HT, KELLY NL and FRANKLIN S (1987). Comparative Trends in Hospitals Expenses, Finances, Utilisation, and Inputs, 1970-81, *Health Care Financing Review*; 9(1): 51-69.

D'ARCY PF (1984). Appropriate Technology: Essential Medicines in the Third World. *British Medical Journal*; 289: 982-984.

DAVID Y (1993). Technology evaluation in a US hospital: The role of clinical engineering. *Med. & Biol. Eng. & Comp*; 31: HTA28 – HTA32.

DAVID Y and JUDD TM (1993). *Medical Technology Management.* Biophysical Measurement Series. Washington: Space Labs Inc.

DAVIES NE and FELDER L H (1990). Applying brakes to the runaway American health care system: A proposed agenda. *Journal of the American Medical Association*; 1: 73-76.

DELOITTE and TOUCHE (1994a). *Documentation of capital expenditure on new health care projects. National Health Expenditure Review Technical Paper No. 3*. Durban: Health Systems Trust.

DELOITTE and TOUCHE (1994b). *Donor funding in health care in South Africa. National Health Expenditure Review Technical Paper No. 4*. Durban: Health Systems Trust.

DEPARTMENT OF HEALTH (DOH) (1994). *Incidence of notable conditions in South Africa in 1993*. Pretoria: Department of Health.

DEPARTMENT OF HEALTH (DOH) (1997). *A health Care Technology Policy for South Africa*. Discussion paper. Pretoria: Department of Health.

DEVELOPMENT BANK OF SOUTHERN AFRICA (1994). *South Africa's nine provinces: A human development profile*. Halfway House: DBSA.

DEVLIN B, JUDGE K, KNOWLES D, MAXWELL R (1997). *King's Fund Report - Academic Centres in Western Cape: A partial diagnosis and a tentative prescription*. Cape Town: Kings Fund and Department of Western Cape.

DICKEY DM (1990). Surviving and growing in the '90s: Managerial methods for hospital–based Biomedical Engineering/ Clinical Engineering Departments. *Biomedical Instrumentation Technology*; 24: 345-354.

DOHERTY J (1994). *The distribution of health expenditure between levels of care: A literature review. National Health Expenditure* Technical Paper No. 2. Durban: Health Systems Trusts.

DOHERTY J, VAN DEN HEEVER A (1996). *Issues in Resource Allocation: An Inter-provincial Formula in Support of Equity*. Johannesburg: Centre for Health Policy.

DORRINGTON RE, ZWARENSTEIN M (1988). Some trends in health care expenditure (1970 to 1985). In: Owen CP (ed.). *Towards a National Health Service: Proceedings of the 1987 NAMDA Annual Conference*. Cape Town: NAMDA Publications.

DU TOIT J, FALKENA H (1994). *The Structure of the South African Economy*, Halfway House: Southern Book Publishers (for ABSA Bank).

DURAND-ZALESKI I and JOLLY D (1990). Technology assessments in health care. Decision makers and health care providers: What they need to know. *Health Policy*; 15: 37-44.

DYRO JF (1993). Focus on University hospital and health sciences centre SUNNY at Stony Brook Biomedical Engineering Department. *Journal of Clinical Engineering*; 18(2): 165-174.

EMBASSY OF THE FEDERAL REPUBLIC OF GERMANY (EFRG) (1995). *Kenya – German development co-operation:* Nairobi: Press and Information Department of the German Embassy.

EMERGENCY CARE RESEARCH INSTITUTE (ECRI) (1988). *Special Report on Devices and Dollars*. Philadelphia, PA.

EMERGENCY CARE RESEARCH INSTITUTE (ECRI) (1989). Technology Management: Preparing Your Hospital for the 1990s, *Health Technology*, 3:111-115.

EMERGENCY CARE RESEARCH INSTITUTE (ECRI) (1993). *Special Report on Technology Management*. Philadelphia, PA: ECRI.

ENGELKES E (1993). What Are the Lessons from Evaluating Primary Health Care Projects? A personal View. *Health Policy and Planning;* 8(1): 72-77.

ELLIOT D and ELLIOT R (1976). *The control of technology*. London: Wykeham Publications Ltd.

ERINOSHO OA (1991). Health care and medical technology in Nigeria. *International Journal of Technology Assessment in Health Care* 7(4): 545-552.
EUROPEAN ECONOMIC COMMUNITY (EEC) (1986). Proposal for basic principles derived from an evaluation of ACP-EEC *Health Projects and Programmes*, VIII/EV/1266(86)-EN, paragraph, C9.1. Brussels: ECC.

EVANS JR (1982). Some implications of technology assessment for less-developed countries. In: *Resources for Health: Technology Assessment for Policy Making;* H. David Banta (ed.): 209–215. New York: Praeger Scientific.

FALLON P, DA SILVA L (1994). *South Africa: Economic Performance and Policies. Discussion Paper 7*. Johannesburg: The World Bank, Southern Africa Department.

FARBER SJ (1982). On the necessity of a scientific basis for choice. In: *Resources for Health: Technology Assessment for Policy Making;* H. David Banta (Ed.): 44-46. New York: Praeger Scientific.

FITTER M (1987). *The impact of new technology on workers and patients in the health services: physical and psychological stress*. European Foundation for improvement of Living and Working conditions. Office for Official Publications of the European Communities, Luxembourg.

FODOR J (1988). Major equipment purchases: A committee approach. *Health Progress*, 10: 2-14.

FOOTE SB (1992). *Managing the Medical Arms Race*. Los Angeles: University of California.

FOURIE J, STEYN K (eds.) (1995). *Chronic disease lifestyle in South Africa: review of research and identification of essential health priorities*. MRC Technical Report 1995.

FRANKLIN B (1759). *Some Account of the Success of Inoculation for the Smallpox in England and America*. [From the Library of the U.S. Surgeon General's Office- republished in 1959]. London: W. Strahan.

FREE MJ (1992). Health Technologies for the Developing World. *International Journal of Technology Assessment in Health Care;* 8:(4): 632 -634.

FRENK J, BOBADILLA JL, SEPULVEDA J, CERVANTES LM (1989). Health transition in middle income countries: new challenges to health care. *Health Policy and Planning*; 49 (1): 29 –39.

FREUND PJ (1986). Health care in declining economy: the case of Zambia. *Social Science and Medicine*; 23 (9): 875-88.

FRIZE M (1990a). Results of an International Survey of Clinical Engineering Departments. Part I: Role, Resources and Recognition, *Med. Biol. Engin. Comput.*; 28: 153-159.

FRIZE M (1990b). Results of an International Survey of Clinical Engineering Departments. Part II: Budgets, Staffing, Resources and Financial Strategies, *Med. Biolog. Engin. Comput.*; 28: 160-165.

FRIZE M and SHAFFER M (1991). Clinical Engineering in Today's Hospital: Perspectives of the Administrator and the Clinical Engineer, *Hospital & Health Services Administration*; 36(2): 285-305.

FUCH VR (1993). *The Future of Health Policy*. Cambridge, Massachusetts: Harvard University Press.

GALBRAITH J K (1977). *The New Industrial State*. New York: New American Library.

GALTUNG J (1967). Some aspects of comparative research. *Polls*; 2(3): 1-19.

GOODMAN CS (1993). Technology assessment in health care: a means for pursuing the goals of biomedical engineering. *Med. Biol. Eng. & Comput.*; 31: HTA3-HTA10.

GOODMAN GR (1991). Technology assessment, transfer, and management: The implications to the professional development of clinical engineering. *Journal of Clinical Engineering*; 16(2): 117–121.

GORDON G J and TAN KT (1992). Technology Assessment and Equipment Planning in Kaiser Permanente, Northern California Region. *Journal of Clinical Engineering;* 17(3): 209–213.

GOULD WR (1998). *Clinical Engineering Management in South Africa.* Presentation to the Engineering Council of South Africa.

GOVERNMENT COMMITTEE ON CHOICES IN HEALTH CARE (GCCHC) (1992). *Choices in health care*. HK Rijswijk: The Netherlands Government.

GOVERNMENT COMMUNICATION and INFORMATION SYSTEM (GCIS) (1998). *South African Year book 1998, 5th Edition*. Pretoria: ABC Press on behalf of Government Printer.

GOVERNMENT OF KENYA (GOK) (1986). *Sessional Paper No. 1 of 1986 on Economic Management for Renewed Growth.* Ministry of Planning and National Development. Nairobi: Government Printer.

GOVERNMENT OF KENYA (GOK) (1994a). *Sessional Paper No. 1 of* 1994 *on Recovery and Sustainable Development to the year 2010*. Ministry of Planning and National Development. Nairobi: Government Printer.

GOVERNMENT OF KENYA (1994b). *National Development Plan 1994–1996*. Nairobi: Ministry of Planning and National Development Publication.

GOVERNMENT OF KENYA, IMF/WORLD BANK (1996). *Kenya - Economic Reforms for 1996 – 1998: The Policy Framework Paper.* Joint GOK/IMF/WORLD BANK Document. Ministry of Planning and National Development (MPND). Nairobi: Government Printer.

GREEN A (1992). *An Introduction to Health Planning in Developing Countries.* Oxford: Oxford University Press.

GREEN GH and SINGER HW (1984). Sub - Saharan Africa in depression: the impact on the welfare of children. *World Development;* 7: 283-295.

GRIFFIN CC (1992). *Health care in Asia: A comparative study of cost and financing.* Washington DC: The World Bank.

HAILEY DM and ROSEMAN C (1990). Health care technology in Australia and New Zealand: Contrasts and Co-operation. *Health Policy;* 14(1990) 177-189.

HALBWACHS H and ISSAKOV A (1994). *Essential Equipment for District Health Facilities in Developing Countries.* GTZ, Division of Health, Population & Nutrition. Eschborn: GTZ.

HALES D (1984). High-tech medicine: A space-age arsenal. *Medical World News*: 62-79, January 9.

HANCOCK G (1989). *Lords of Poverty.* London: Mandarin.

HARRINGTON DP (1987). Medical engineering at the New England Medical Centre, *Medical Electronics*; 4: 9798.

HARRINGTON DP (1990). How hospitals purchase instrumentation. *Medical Electronics*; 1: 94-97.

HARRINGTON DP (1991). The Developing World and Biomedical Equipment. *Journal of Clinical Engineering*; 16(6): 448 -452.

HASPER K (1991). Centralised maintenance responsibilities: A case study. *Journal of Clinical Engineering*; 16(3): 191-206.

HASSET JJ (1984). Technology's front line: the intensive care unit. In: *The machine at the bedside*. S.J Reiser & M. Anbar (eds.): 95-104.New York: Cambridge University Press.

HAWKINS FG (1992). A review of issues in hospital technology acquisition. *Journal of Clinical Engineering*; 17(1): 35-41.

HELLMAN S AND VOKES EE (1996). Advancing current treatments for cancer. *Scientific American,* September 1996: 118-123.

HERMESSE J (1984). *Cost-effective health technology at home as an avenue for reducing national health expenditures*. Paper presented at the Second Joint Meeting of the European Health Policy Forum and the World Health Organisation on Advanced Technology at Home: Financing Cost-effective Alternatives, Brussels, 1-2 March.

HOFFMANN B (1977). *Albert Einstein.* Norwich, UK: Paladin.

HOLLANDIA LIFE REASSURANCE COMPANY (1996). *The AIDS Epidemic in Africa: An Overview.* Fifth Report, November. Cape Town: Hollandia.

HU T (1991). Medical technology transfer in major Chinese hospitals. *International Journal of technology assessment in Health Care*; 7(1): 3-11.

HUGHES JD (1993). Strategies for technology management in clinical Engineering. *Journal of Clinical Engineering*; 18(2): 149-157.

INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA) (1991). *Quality Control Nuclear Medicine Instruments. International Atomic Energy Agency.* Report IAEA-TECHDOC; 602: 10-15.Geneva: IAEA.

INTERNATIONAL LABOUR ORGANIZATION (ILO) (1987). *World Recession and Global Interdependence*. Geneva: ILO.

INSTITUTE OF MEDICINE (IOM) (1985). *Assessing Medical Technologies.* Washington: National Academy Press.

ISSAKOV I (1994). *Equipment management and maintenance in developing countries*. A Key Note Address to Regional Workshop on Health Care Technology in Sub-Saharan Region: Challenges and Opportunities. Geneva: WHO- National Health Systems and Policies Unit, Division of Strengthening of Health Care Services.

ISSAKOV A, MALLOUPAS A, McKIE J (1990). *Manpower Development for Health Care Technical Services*. Report of the World Health Organisation, WHO/SHS/NHP/90.4, 1990.

JACOBS LM Jr (1982). Uses of technology in emergency medicine. *Medical Instrumentation (Editorial)*; 16 (4).

JAFEK B (1983). Imaging the brain. *Electron Imaging*; 20-28, July 1983.

JAROS GG and BOONZAIER DA (1993). The economics of medical technology. *South African Medical Journal*; 84: 420 – 422.

JENNETT B (1986). *High technology medicine: benefits and burdens*. New York: Oxford University Press.

JENNETT B (1988). The role of the universities in assessing technology and disseminating information. *International Journal of Technology Assessment in Health Care*; 4: 47-48.

JOHNSON BW (1989). *Design and Analysis of Fault-Tolerance Digital Systems*: 172-173. Reading Mass: Addison-Wesley.

JOHNSON H A (1991). Diminishing returns on the road to diagnostic certainty. *JAMA*; 265: 2229-2223.

JOYCE P (1996). *South Africa*. London: New Holland (Publishers) Ltd.

KACHIENG'A MO (1982). Editorials: Biomedical Engineering Insight - The Ultimate Artificial Heart. *Medicom,* September-October 1982, 5(5): 99-100.

KACHIENG'A MO (1991). *Health Care Equipment in Status in Kenya (Public Health Facilities). Appraisal Report*: Nairobi: Ministry of Health, Medical Engineering Unit.

KACHIENG'A MO (1992a). An Overview: Procurement of Health Care Equipment for Public Health Facilities. *Medicus,* May 1992: 20-23.

KACHIENG'A MO (1992b). *Establishment of Medical Engineering Division in the Ministry of Health (Kenya).* Talanta Consultants Publication, Nairobi.

KACHIENG'A MO (1992c). *National Scheme of Service for Medical Engineers, Technologists and Technicians – for Ministry of Health (Kenya).* Talanta Consultants Publication, Nairobi.

KACHIENG'A MO (1998a). Health Care Technology in Public Health Institutions in Kenya. *East Africa Medical Journal*; 75: 10 –14.

KACHIENG'A MO (1998b). *An Analysis of Health Care Equipment Maintenance Budgets in Groote Schuur and Tygerberg Hospitals* (pilot research). Unpublished. Biomedical Engineering Department, University of Cape Town.

KACHIENG'A MO, KEMPE L, OBURA A, STAHL L (1992). *Technical Health Systems in Kenya: management of maintenance and repairs services of health care equipment.* A paper presented to the 12TH International Congress of Federation of Hospital Engineers (IFHE). Bologna, Italy, 24 – 30 May 1992. Nairobi: Joint Publication: Ministry of Health and Mombasa Polytechnic.

KACHIENG'A MO and STAHL L (1992). Proposed Staffing Norm for Medical Engineers, Technologists and Technicians in Public Health Facilities. MOH/GTZ Publication, Nairobi.

KACHIENG'A MO and BOONZAIER DA (1999). Health care technology assessment: South African health care system in transition. *South African Medical Journal* (in press – February 1999 issue).

KACHIENG'A MO, BOONZAIER D, FATAAR AB, BONIASZCZUK J and BOLTMAN G (1999). Assessing the use of nuclear medicine technology in Sub-Saharan Africa: The essential equipment list. *Journal of Nuclear Medicine Technology;* 27:1-5 (March).

KAITARANTA H and PUROLA T (1973). A system-oriented approach to the consumption of medical commodities. *Social Science and Medicine*; **7**: 531–540.

KEANE BP (1980). Microelectronics technology. *Medical Instrumentation (Editorial)*; 14(6).

KAHLIL TM and WALY SM (1988). *Planning of Health care Technology Transfer.* Proceedings of The First International Conference on Technology Management held in Miami, Florida on 17-19 February, sponsored by UNESCO. Geneva: Inter-science Enterprises Ltd.

KING RC (1987). Technology and the doctor-patient relationship. *International Journal of Technology Assessment in Health Care*; 3: 11-18.

KLARMAN HE (1974). Applications of Cost–Benefit Analysis to the Health Services and the Special Case of Technologic Innovation. *International Journal of Health Services*; 4: 325–352.

KLASEN S, DOHERTY J (1995). Preliminary analysis of the Living Standards Survey (conducted by SALDRU and the World Bank), based on tabulations prepared by Carlo del Ninno.

KLECZKOWSKI BM (1985). *Approaches to planning and design of health facilities in developing areas, Vol. 5 Cross national analysis of case studies.* WHO Offset Publications No. 91. Geneva: WHO.

KLEIN R (1976). The Rise and Decline of Policy Analysis: The Challange of Health Policymaking in Britain. *Policy Analysis;* 2: 459–475.

KLUGMAN B (1996). Demographics and population policy. *South African Health Review, 1996.*

KLOPPER JML, TAYLOR SP (1987). The health and wealth of South Africa. *South African Medical Journal*; 72: 799-801.

KOHN R and WHITE KL (1976). *Health Care: International Study.* World Health Organisation/ International Collaborative Study of Medical Care Utilisation. New York: Oxford University Press.

KWANKAM Y 1992). *An integrated approach to health care technology in developing countries: the case of Cameroon.* A paper presented to the 12[TH] International Congress of Federation of Hospital Engineers (IFHE). Bologna, Italy 24 – 30 May 1992.

LALONDE M (1974). *A new perspective on the health of Canadians.* Ottawa: Government of Canada.

LAMBERT S (1978). *Modern Medical Mistakes.* Bloomington: Indiana University Press.

LAURENT A (1982). Health financing and expenditures, Rwanda and Togo. *Third World Series 2.* Geneva: Sandoz Institute for Health and Socio-economic studies.

LUTHORA KL (1987). *Health Care Financing in Developing Countries: An Overview of Issues.* Proceedings of Regional Seminar on Health Care Financing.

MACHIAVELLI C (1961). *The Prince,* (A translation by George Bull, reprinted 1961). London: Penguin Classics.

MAKAN B, VALENTINE N, KIRIGIA J (1996). Wisdom in gradual reorientation. *Idasa Budget Watch*; 2(2): 4.

MANDELA N (1994). *Inaugural Speech*, May 1994. Pretoria: Government of South Africa.

McCORD C (1978). Medical technology in developing countries: useful, useless, or harmful. *The American Journal of Clinical Nutrition*; 31: 2301-2213.

McGREGOR M (1989). Technology and allocation of resources. *The New England Journal of Medicine*; 320: 118-120.

McGREGOR M (1994). Technology Evaluation in Sub-Saharan Africa. Can the Canadian Experience be of Use? *South African Medical Journal*; 84: 585-586.

McINTYRE D (1990). *Public sector Health Care Expenditure in South Africa, 1970-1990. Health Economic Working Paper No. 1*. Cape Town: Health Economics Unit, University of Cape Town.

McINTYRE D (1994). *User fees for public sector health services in South Africa: Revenue generating potential and equity implications*. HEU Working Paper No. 6. Cape Town: Health Economics Unit, University of Cape Town.

McINTYRE DE, DORRINGTOND RE (1990). Trends in the distribution of South African health care expenditure. *South African Medical Journal;* 78: 125-129.

McINTYRE D, OWEN P (1994). *Commentary on the 1994/95 Health Budget*. Johannesburg: Health Policy Co-ordinating Unit.

McINTYRE D, BLOOM G, DOHERTY J, BRIJLAL P (1995). *Health expenditure and finance in South Africa*. Durban: World Bank and the Health Systems Trust.

MEDICAL SYSTEMS CONSULTANTS (MSC) (1992). *Capital Assets Management-An Executive Overview, course material*. St Louis, MO: JANNX Medical Systems Consultants.

MENON D (1993). Technology assessment and biomedical engineering education. *Med. & Biol. Eng. & Comput.*; 31: HTA 33-HTA 36.

MILLS AJ (1991). *The cost of the District Hospital - A study for Malawi*. Working Paper Series 742.World Bank, Population and Human Resource Department, New York: Oxford University Press.

MINISTRY OF HEALTH (MOH) (1990a). *Health Information System 1990.* Nairobi: Ministry of Health Publication.

MINISTRY OF HEALTH (MOH) (1990b). Prevent*ive and Primary Health Care Resource Gap Study*. (Zero-based Budgeting Study). Nairobi: Ministry of Health Publication.

MINISTRY OF HEALTH (MOH) (1991). *Health Information Systems 1989*. Nairobi: Ministry of Health Publication.

MINISTRY OF HEALTH (MOH) (1993a). *Strategic Action Plan for Financing Health Care*. Nairobi: Ministry of Health Publication.

MINISTRY OF HEALTH (MOH) (1993b). *Five-year Implementation Plan for Financing Health Care in Kenya*. Nairobi: Ministry of Health Publication.

MINISTRY OF HEALTH (MOH) (1993c). *National Hospital Insurance Fund. Strategic Plan - Executive Summary Draft*, D. Kraushaar (ed). Nairobi: National Hospital Insurance Fund.

MINISTRY OF HEALTH (MOH) (1993d). *Task Force Recommendations on Health Technical Services for Government Health Facilities*, M. O. Kachieng'a (ed). Nairobi: Ministry of Health Publication.

MINISTRY OF HEALTH (MOH) (1994a). *Health Information System 1993 to 1994*. Nairobi: Ministry of Health Publication.

MINISTRY OF HEALTH (MOH) (1994b). *Kenya's Health Policy Framework*. Nairobi: Ministry of Health Publication.

MINISTRY OF HEALTH (MOH) (1995). *Kenya's Health Policy Framework Implementation and Action Plans*. Nairobi: Ministry of Health Publication.

MINISTRY OF HEALTH (MOH) (1996). *Expenditure and Financing of the Health Sector in Kenya, February 1996.* Nairobi: Ministry of Health Publication.

MINISTRY OF FINANCE (MOF) (1996). *The 1996/97 Estimates of Recurrent Expenditure of the Government of Kenya for the Year Ending 30th June, 1997. Volume 1, Votes R01 - R16.* Nairobi: Government Printer.

MINISTRY OF HEALTH (MOH) (1997). *Biomedical engineering and maintenance services in Kenya*, J M Nyamu (ed). Nairobi: Medical Engineering Services Directorate.

MINISTRY OF PLANNING AND NATIONAL DEVELOPMENT (MPND) (1994). *Development Plan* 1994-1996. Nairobi: Government Printer.

MORGAN P (1990). *Rural Supplies and Sanitation.* London: Macmillan Education Ltd.

MULLER JH and JAROS GG (1994). Editorial: Need for a National Health Care Technology Assessment Centre. *South African Medical Journal*; 84: 189–190.

MULREA KC and SIVERTSON SE (1975). Biomedical Engineering in Health Care - Potential versus reality. *IEEE Transactions on Biomedical Engineering*; BME-22: 114-119.

MUMFORD L (1934). *Technics and Civilisation.* New York: Harcout Brace Jovanovich.

MWANGI JK (1996). *Kenyan health expenditure with a focus on: preventive, promotive and primary health care. Trends and projections for the period 1979/80 to 1998/99.* Nairobi: Planning Division of Ministry of Health, Nairobi.

NADER R (1971). Ralph Nader's most shocking expose. *Ladies Home Journal;* 88:98, 176-179.

NATIONAL AIDS AND STDs CONTROL PROGRAMME (NASCOP) (1996). *Aids in Kenya: Background, Projections, Impact Interventions, 3rd Edition.* Ministry of Planning and National Development. Nairobi: National Council for Population and Development.

NATIONAL SCIENCE FOUNDATION (1983). *The Process of Technological Innovation: Reviewing the Literature.* Productivity Improvement Research Section; Division of Industrial Science and Technological Innovation. Washington, D.C.: US Government Printer.

NAYLOR CD (1988). Private medicine and the privatisation of health care in South Africa. *Social Science Medicine;* 27: 1153-1170.

NCAYIYANA D (1997). The equity gap debate (Editorial). *South African Medical Journal*; 5: 87.

OAKES JB and JOHNS (1983). The role of Clinical Engineering in health care delivery. *IEEE Transactions on Biomedical Engineering*; BME-20: 225-227.

OFFICE OF TECHNOLOGY ASSESSMENT (OTA), U.S CONGRESS (1982). *Strategies for medical technology assessment*. Washington, D.C.: U.S. Government Printing Office.

OJANY FF and OGENDO RB (1986). *Kenya: A Study in Physical and Human Geography.* Nairobi: Longman.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD) (1989). *Development Co-operation in the 1990s.* Paris: OECD.

OSENYA EO (1998). *HIV/AIDS Prevalence Patterns in Sub-Saharan Africa.* Paper presented at Workshop on Senzitisation and Tripartite Review of Population and HIV/ AIDS Education at the Workplace. Nairobi.

OVER M (1992). *The Macro-economic Impact of AIDS in Sub-Saharan Africa.* Africa Technical Department, Population, Health and Nutrition Division, Technical working paper. Washington DC: World Bank.

PACELA AF (1992). 1992 survey of salaries and responsibilities for hospital biomedical/clinical engineering and technology personnel. *Journal of Clinical Engineering*, 17(3): 215-231.

PATH (1992). *Developing and Introduction of Technologies for Health in the Developing World.* Programme for Appropriate Technology in Health (PATH). Seattle, Washington: Path.

PATON JS and NYAMU JM (1996). *MOH/GTZ Project Evaluation Report of July 1996, PROJREP.WPS.* Health Facility Maintenance Management Project PN 94.2276.7 – 00.00: Nairobi: MOH/GTZ Publication.

PERRY S and CHU F (1992). Selecting medical technologies in developing countries. In: *Health, Nutrition, and Economic Crises*, D.E. Bell & M.R. Reich (eds.). Dover: Aurburn House Publishing Co.

PERRY S and MARX ES (1992). What Technologies for Health Care in Developing Countries? *Health Forum*; 13: 356 - 362.

PERRY S and PILLAR BA (1990). A national policy for health care technology assessment. *Medical Care Review*; 47:4.

PERSSON K, EKBERG K and LINDEN (1993). Work organisation, work environment and the use of medical equipment: a survey study of the impact on quality and safety. *Med. & Biol. Eng. & Comput.*; 31: HTA 33-HTA 36.

POACHED D (1982). Medical equipment in Third World Countries, Editorial, *Journal of Tropical Medicine and Hygiene*. 85:183-185.

POINCARE H (1929). *The foundations*. New York: Science Press.

PORTUGAL FH (1982). Medical Imaging: The technique of body art. *High Technology Magazine*:78-79, November-December.

POWER D (1994). *Child health services in the 'new' South Africa – A dream.* Inaugural Lecture. Cape Town: University of Cape.

PRAGE L (1987). Procurement, Operation and Maintenance of Scientific Equipment in Developing Countries, Part 1. SAREC /International Foundation for Science (IFS) Publication. Stockholm: IFS.

PRESIDENT'S SCIENCE ADVISORY COMMITTEE (1972). *Improving Health Care through Research and Development*. Report of the Panel on Health Services Research and Development of the President's Science Advisory Committee. Washington, D.C.: Government Printing Office.

PRICE M (1988). The consequence of health service privatisation for equality and equity in health care in South Africa. *Social Science Medicine;* 27: 703-716.

REACH (1988a). *Nairobi Area Health Care Study. Resources of Child Health Project*. United States International Development/ Nairobi, November 1988. Arlington: John Snow.

REACH (1988b). *Nakuru Provincial and Districts Hospitals Study. Resources of Child Health Project*. United States International Development/ Nairobi, November 1988. Arlington: John Snow.

RENNIE J (1995). The Uncertainties of Technological Innovation. *Scientific American*. September 1995.

RETTIG R (1996). *Health Care in Transition: Technology assessment in the private sector.* Rand Corporation, Agency for Health Care Policy and Research, 24 July 1996. Web site: http//aspe.os.dhhs.gov/health/zstechas.htm.

REISER SJ (1984). The machine at the bed side: technological transformation of practices and values. In: *Machine at the Bedside: Strategies for using technologies in patient care;* pp3-17. SJ Reiser & M Anbar (Eds.). New York: Cambrige University Press.

RIVLIN A (1971). *Systematic Thinking for Social Action.* Washington, D.C.: The Brookings Institutions.

ROSS SA, WESTERFIELD RW and JAFFE JF (1993). *Corporate Finance*, 3rd *Edition*: 194 -195. Boston, Massachusetts: Irwin.

SACKS O (1990). *Awakenings*, pp 266. London: Harper Collins.

SCHWAN HP (1984). The Development of Biomedical Engineering: Historical Comments and Personal Observations. *IEEE Transactions on Biomedical Engineering;* BME-31 (12): 730-736, December 1984.

SCHWARTZ MD (1984). The Emerging Field of Clinical Engineering and its Accomplishments. *IEEE Transactions on Biomedical Engineering*; Vol. BME-31(12), December.

SELSKY DB (1991). Biomedical equipment information management for the next generation. *Biomedical Instrumentation Technology*; 25(1): 24-32.

SERPA-FLOREZ F (1993). Technology transfer to developing countries: Lessons from Colombia. *International Journal of Technology Assessment in Health care*; 9(2): 233-237.

SHRYOCK RH (1969). *The Development of Modern Medicine*. New York: Hafner.

STEVENS SS (ed) (1951). Mathematics, Measurements, and Psychophysics. In: *Handbook of Experimental Psychology*: 1-49. New York: Wiley.

SUBRAMANIAN S and VILLEZ P A (1990). A computerised parts inventory management system, *Biomedical Instrumentation & Technology*; 24 (5): 328-334.

SUBRAMANIAN S and VILLEZ PA (1991). A computerised purchase order management system, *Biomedical instrumentation and technology*; 25(3): 202-209.

TANNENBERGER S (1984). When must a new approach to treatment be introduced. *International Journal of Technology Assessment in Health Care*; 4: 113.

TECHNOLOGY AND BUSINESS DEVELOPMENT GROUP (TBDG) (1998). *Annual report 1998*. Medical Research Council. Cape Town: Medical Research Council (SA).

THOMAS L (1974). *The Lives of a Cell*. London: Penguin Books.

TITMUSS RM (1974). *Social Policy: An Introduction*. New York: Pantheon Books.

TYSON TR (1989). Synergism in technology assessment. *International Journal of Technology Assessment in Health Care;* 5(4): 477-479.

URBAN FOUNDATION (1991). *Population Trends: Demographic Projection Model*. Johannesburg: Urban Foundation.

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP) (1983). *Human Resource Development for Primary Health Care*. Evaluation Study No. 9. New York: Oxford University Press.

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP) (1997). *Human Development Report 1997.* New York: Oxford University Press.

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP) (1998). *Human Development Report 1998.* New York: Oxford University Press.

VALENTINE N, McINTYRE D (1994). *A Review of Private Sector Health Care Expenditure in South Africa*. National Health Expenditure Review Technical Paper No. 9. Durban: Health Systems Trust.

VAN RENSBURG HCJ (1996). Can we support high-tech research in South Africa? *South African Medical Journal*; 86: 516–521.

VAN RENSBURG HCJ, FOURIE A (1988). Privatization of South African health care: in whose interest? *Curatio 1988;* 11 (3): 1-6.

VAN RENSBURG HCJ, FOURIE A (1994). Inequalities in South African health care, Part II. *South African Medical Journal;* 84:99-103.

WAGNER HN Jr. (1996). The future of nuclear medicine. *Seminars of Nuclear Medicine*, Vol. XXVI No. 3 (July): 171–179.

WALTERS NM and BUNN AE (1995). *Hi-technology medical equipment: cost implications for medical care in South Africa*. Cape Town: Medical Research Council (SA).

WAY PO, STANEKI KA (1994). *The impact of HIV/AIDS on World Population*. US Bureau of Census, US Government Printing Office. Washington DC: Government Printer.

WELINSKY GR (1988). Cost containment affects access to new technology, *Hospitals*, 7:16.

WELSH D (1997). *South African Politics: A Beginner's Guide*. Cape Town: Omega Investment Research.

WINNICOT D (1971). *Playing and Reality*. London: Travistock Publications.

WHITTAKER S and BURNS D (1997). *Quality of health service provision in hospitals and occupational health services in a developing country: A South African experience*. The Council for Health Service Accreditation of South Africa. Paper presented to the International Federation of Hospital Engineers Congress.

WHITESIDE A and BARNETT T (1996). HIV and AIDS. *South African Health Review:* 165-171.

WHITE KL (1982). Political arithmetic: Integration of cost-effective analysis into health systems. In: *Resources for Health*: *Technology Assessment for Policy Making*: 156–161. H. David Banta (ed). New York: Praeger Scientific.

WHITE KL and MURNAGHAN JH (1973). Health Care Formation: Analysis, Information and Research. *International. Journal. Health Services*; 3: 81–89.

WORLD BANK (1980). *Health Sector Policy Paper*. World Bank Publication. New York: Oxford University Press.

WORLD BANK (1987). *Policy Study: Financing Health Services in Developing Countries -Agenda for Reform.* World Bank Publication. New York: Oxford University Press.

WORLD BANK (1990). *Poverty*: World Development Report (1990). World Bank Publication. New York: Oxford University Press.

WORLD BANK (1991a). *Kenya Health Rehabilitation Project*. Report No. 9174-K4 (For Official use only), (7 October 1991). Nairobi: World Bank Regional Office.

WORLD BANK (1991b). *Kenya - Human Resources: Improving Quality and Access.* Report No. 9023-KE, 28 June 1991. Nairobi: World Bank Regional Office.

WORLD BANK (1991c). *Kenya: Food and Nutrition*. Report No. 8531-K. (15 March 1991). Nairobi: World Bank Regional Office.

WORLD BANK (1991d). *The Challenge of Development.* World Development Report (1991). The World Bank Publication. New York: Oxford University Press.

WORLD BANK (1993a). *Investing in Health.* World Development Report 1993. The World Bank Publication. New York: Oxford University Press.

WORLD BANK (1993b). The Demand of Water in Rural Areas: Determinants and Policy Implications. (World Bank Water Demand Team). *World Bank Research Observer* 8(1): 47-70.

WORLD BANK (1995a). *Better Health in Africa: Experiences and Lesions Learned.* World Bank Publication. New York: Oxford University Press.

WORLD BANK (1995b). *Strengthening the effectiveness of aid: Lessons for donor*. The World Bank Publication. New York: Oxford University Press.

WORLD BANK (1998). *Knowledge for Development*. World Development Report 1998/99. The World Bank Publication. New York: Oxford University Press.

WORLD HEALTH ORGANIZATION (WHO) (1977). *The Use of Essential Drugs*. Seventh Report of WHO Expert Committee. WHO Technical Report Series No. 615. Geneva: WHO.

WORLD HEALTH ORGANIZATION (WHO) (1979). *The Use of Essential Drugs*. Seventh Report of WHO Expert Committee. WHO Technical Report Series No. 641. Geneva: WHO.

WORLD HEALTH ORGANIZATION (WHO) (1983). *The Use of essential Drugs*. Seventh Report of WHO Expert Committee. WHO Technical Report Series No. 685. Geneva: WHO.

WORLD HEALTH ORGANIZATION (WHO) (1984) *The Use of Essential Drugs.* Seventh Report of WHO Expert Committee (including Model list of Essential Drugs). WHO Technical Report Series No.721.

WORLD HEALTH ORGANIZATION (WHO/AFRO) (1985a). *Where are we in primary health care*? Brazzaville: WHO Regional Office for Africa.

WORLD HEALTH ORGANIZATION (WHO)(1985b). *The Use of Essential Drugs.* Second Report of WHO Expert Committee. WHO Technical Report Series No. 722. Geneva: WHO.

WORLD HEALTH ORGANIZATION (WHO) (1986). *Interregional Meeting on the Maintenance and Repair of Health Care Equipment*, Nicosia, Cyprus, 24-28, November 1986.

WORLD HEALTH ORGANIZATION (WHO) (1987a). *Global Action Plan on Management, Maintenance and Repair of Health Care Equipment*, WHO/SHS/NHP/87.8. Division of Strengthening of Health Services, World Health Organisation. Geneva: WHO.

WORLD HEALTH ORGANIZATION (WHO) (1987b). *The Use of Essential Drugs.* Seventh Report of WHO Expert Committee (including Model list of Essential Drugs). WHO Technical Report Series No. 769. Geneva: WHO.

WORLD HEALTH ORGANIZATION (WHO) (1988a). *Guideline for Country Situational Analysis on Management, Maintenance and Repair of Health Care Equipment.* WHO Publication No WHO/SHS/ NHP/88.3. Geneva: WHO.

WORLD HEALTH ORGANIZATION (WHO) (1988b). *The Use of Essential Drugs*. Third Report of WHO Expert Committee. WHO Technical Report Series No. 770. Geneva: WHO.

WORLD HEALTH ORGANIZATION (WHO) (1990). *The Use of Essential Drugs*. Fourth Report of WHO Expert Committee. WHO Technical Report Series No. 796. Geneva: WHO.

WORLD HEALTH ORGANIZATION (WHO) (1991a). *Development of indicators for monitoring progress towards Health for All by the year 2000*. Geneva: WHO.

WORLD HEALTH ORGANIZATION (WHO) (1991b). *The Public Private Mix in National Health Systems and Role of Ministries of Health*. WHO Publication No. WHO/SHS/ NHP/91.2. Geneva: WHO.

WORLD HEALTH ORGANIZATION (WHO) (1992). *The Use of Essential Drugs*. Seventh Report of WHO Expert Committee (including Model list of Essential Drugs). WHO Technical Report Series No. 825. Geneva: WHO.

WORLD HEALTH ORGANIZATION (WHO) (1993a). *Women, Health and Environment: An Anthology*. Geneva: WHO.

WORLD HEALTH ORGANIZATION (WHO/AFRO) (1993b). *Regional Committee Meeting Proceedings, 43 rd Session (Statements by delegates)*. Brazzaville: WHO Regional Office for Africa.

WORLD HEALTH ORGANIZATION (WHO) (1995). *The Use of Essential Drugs*. Sixth Report of WHO Expert Committee. WHO Technical Report Series No. 850. Geneva: WHO.

WORLD HEALTH ORGANIZATION (WHO) (1997a). *Health for all in the 21st Century*. 1977 World Health Assembly Report. Geneva: WHO.

WORLD HEALTH ORGANIZATION (WHO) (1997b). *The Use of Essential Drugs*. Seventh Report of WHO Expert Committee (including Model list of Essential Drugs). WHO Technical Report Series No. 867. Geneva: WHO.

WORLD HEALTH ORGANIZATION and DEUTSCHE GESELLSCHAFT FüR TECHNISCHE ZUSAMMENARBEIT GmbH (WHO/GTZ) (1990). *Maintenance strategies for public health facilities in developing countries*, WHO/SHS/NHP/90.2. H. Halbwachs, R. Korte (eds.). Geneva: World Health Organization, Division of Strengthening of Health Services.

YACH D, SEAGER J, WATERMEYER G (1991). Understanding the global context of urbanisation and health in South Africa. *South African Medical Journal;* 79:413-414.

ZIEKENFONDSRAAD(1998). *Health Care Technology Assessment in the Netherlands*: http://www.ziekenfodsraad.nl/inv-med/h-care-nl.html.

ZWARENSTEIN MF, PRICE MR (1990). The 1983 distribution of hospitals and hospital beds in the RSA by area, race ownership and type. *South African Medical Journal;* 77: 448-452.

APPENDICES

APPENDICES