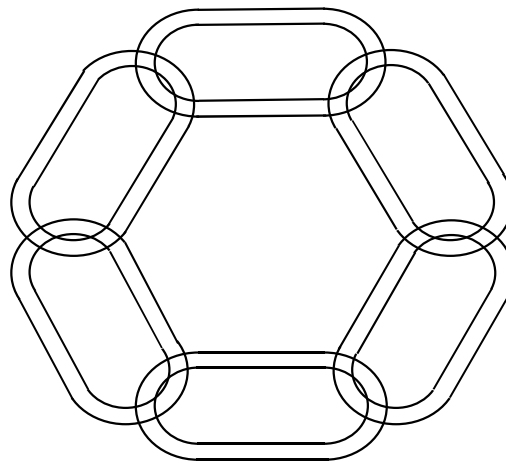




The Effective Management of Medical Equipment in Developing Countries

A Series of Five Papers



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January 1997

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The Effective Management of Medical Equipment in Developing Countries

Abstract

Despite major investments having been made in the rehabilitation of physical structures and capital assets, it is evident that the problems of hospital management have thus far received very little attention, in particular the management of physical infrastructure and equipment. This Series of Five Papers argues that the development of sustainable equipment management systems can only be brought about through deliberate investments in the development of specific skills and competences within an appropriate and supportive context of structures and resources.

The key issue addressed in this Series is the ineffective use and subsequent poor performance of medical equipment in hospitals and health centres in developing countries. While much of the literature related to equipment conservation in the health sector of developing countries addresses purely technical or engineering issues, this Series aims to add a management perspective onto the way in which health care equipment is acquired and used. Rather than being a purely technical manual concerned with the day-to-day running of engineering services, this Series addresses some of the managerial issues related to the conservation of equipment and the allocation of human, financial and material resources.

Health services in developing countries are provided by government, private, and traditional sectors. The private sector is generally divided between a number of religious, humanitarian and voluntary organisations and a variety of commercial enterprises. Both in the private and public sector, a large proportion of the technical equipment and machinery is, for one reason or the other, not available for use. Evidence suggests that certain developing countries perform better than others and there are many instances where the private sector performs significantly better than public sector institutions. This Series examines this variation in performance with the objective of identifying successful approaches to the management of medical equipment. As the long-term objective of all donor assistance to developing countries is to work towards indigenisation of managerial responsibility, through the development of local capacity and competence, this Series has been written in such a way that it will be useful to both private and public sector managers.

The target audience for this Series is quite broad. Medical equipment management in developing countries concerns indigenous health workers, administrators and engineers, but also foreign experts and overseas aid agencies. The principles of effective management and cost-effective resource allocation apply both to hospitals and health centres run by the private as well as those run by the public health sector.

Long term success, in terms of sustainable and on-going improvement of the operational performance of physical assets, requires specific commitments from indigenous health authorities. The way in which donor agencies can assist in this process is through the provision of funds for project development as well as by making available technical and managerial expertise, for an agreed period of time. However, in order to maximise the chance of success in the long term, indigenous health authorities are to take on overall responsibility for the design, implementation and evaluation of technical assistance programmes. Ideally, in order to ensure long term sustainability, foreign aid and donor support must not dominate the development process, but rather be subject to indigenous visions, initiatives and programmes.

The Effective Management of Medical Equipment in Developing Countries

A Series of Five Papers

**Paper 1
Introduction to the Series**

**Paper 2
Medical Equipment Performance:
A Comparison of Three Countries**

**Paper 3
The Development of
Health Care Technical Services (HCTS)**

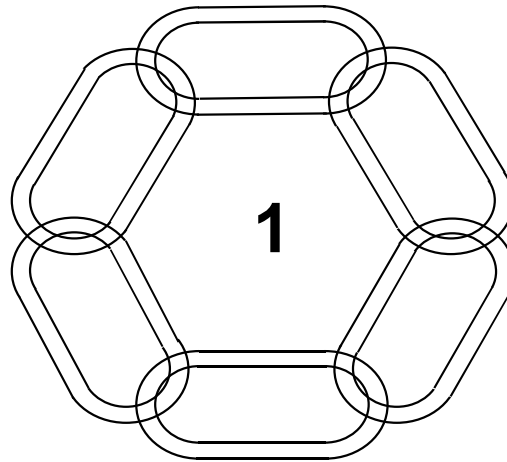
**Paper 4
The Development of
Medical Equipment Management Systems**

**Paper 5
Implications for Policy and Management**



The Effective Management of Medical Equipment in Developing Countries

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Introduction to the Series

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Paper 1

Introduction to the Series

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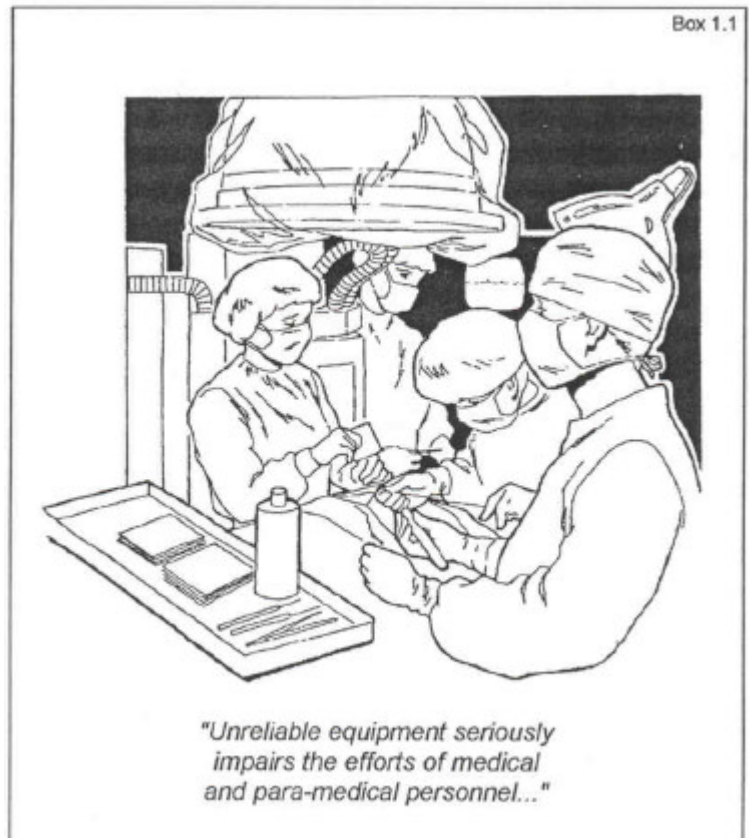
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1.1 Purpose and Structure of this Series

1.1.1 The Key Issue Addressed

The problem addressed in this Series of Publications is the ineffective use and subsequent poor operational performance of medical equipment in developing countries. The chronic lack of functioning medical equipment is generally regarded as an important contributor to the poor quality of health care delivery in those countries. A number of previous studies, conducted in low- and medium-income economies, indicate that as much as half of the equipment in urban and rural medical institutions is inoperable and not in use. As a result the efforts of medical and para-medical personnel are seriously impaired.

The World Health Organization decided in 1978 that a major social target of governments in the coming decades should be that "...all the citizens of the world would attain a level of health that would permit them to lead socially and economically productive lives" (World Health Organization, 1983:1)¹. Evidence suggests, however, that in 1996 health care provision in most developing



countries is still in a state of crisis. Despite progress having been made over the past few decades, the fact remains that a large proportion of the population in those countries does not have access to adequate health care. Recent statistics show that infant mortality in low-income economies is still as much as 10 times higher than in high-income economies. A person born in the UK can expect to live 20 years longer than someone born in Tanzania or Nepal. High incidence of disease and high mortality rates contribute to a poor quality of life. The economic consequences of poor health are also considerable, in that a poor state of health directly and indirectly contributes to the economic burden carried by many of the low-income developing countries. This concern is expressed in a recent publication by The World Bank, which comments on the health status of the population in Sub-Saharan Africa:

¹This resolution of the World Health Assembly, which was taken unanimously by all 152 member states of the World Health Organization, is more commonly known as 'Health for All by the Year 2000 (HFA/2000)'

High rates of disease and premature mortality in Sub-Saharan Africa are costing the continent dearly. Poor health causes pain and suffering, reduces human energies, and makes millions of Africans less able to cope with life, let alone enjoy it. The economic consequences are immense. Poor health shackles capital, reduces returns to learning, impedes entrepreneurial activities, and holds back growth of gross national product (World Bank, 1994a:viii).

Many factors are thought to be responsible for the ineffectiveness of health care provision in developing countries all over the world. One consequence of the international recession, which started in the 1980s, has been that many countries throughout the world have had to reduce the rate of growth in government expenditure for social services, including health and education. Cutbacks in health sector expenditure have contributed heavily, among many other things, to low expenditure on medical equipment. This highlights the importance of using as effectively as possible the existing stock of equipment which is already available in health institutions. The effective selection, choice and use of medical equipment is the main theme of this Series of Publications.

This particular problem of poor medical equipment performance is a special case of a more general issue, which is the widely varying effectiveness in using imported equipment and technical systems in developing countries. The objective of this Series is to examine, in some detail, a particular example of low effectiveness in using hardware-embodied technology in these countries. Thus, although this Series is about the effectiveness of using health care equipment, it is also concerned with the wider issue of the assimilation and absorption of technology.

1.1.2 Aims, Objectives and Target Group

The broader objectives of this Series are to:

- (i) obtain a clear understanding of factors contributing to differences in equipment effectiveness in the health sector of developing countries;
- (ii) develop a comprehensive and coherent framework for analysis, with the objective of contributing to the development of policies and strategies, concerned with the management of medical equipment in public and private institutions.

The specific aims of this Series of Publications are to develop clear guidelines for health planners, medical and para-medical staff in developing countries, regarding:

- (a) The Development of Health Care Technical Services
- (b) The Development of Medical Equipment Management Systems
- (c) The Development of a Medical Equipment Monitor, either on a national level or on the level of privately operating agencies
- (d) The Management of Human Resources Development
- (e) The Management of Foreign Aid

The target group for this Series consists of private and public sector health workers in developing countries and in particular health planners, administrators and medical equipment managers. In addition, many of the guidelines and recommendations are specifically aimed at foreign experts and other representatives of international aid organisations and voluntary agencies.

1.1.3 Structure of this Series

The five Papers in this Series have been presented in such a way that each Paper can be read and used in its own right. Whereas the five Publications follow a logical sequence and are to some extent inter-related, each Paper addresses a set of issues which will be of interest to a particular audience.

Paper 1 outlines the key issues addressed in this Series and gives some background information relevant to the acquisition and use of medical equipment in developing countries. Apart from stating the purpose of this Series, Paper 1 puts the medical equipment problem in developing countries into context by providing some insight into the international medical equipment market. This Paper concludes by giving an overview of the available literature and previous studies by various authors and international health workers and organisations.

Paper 2 contains a detailed case-study of three developing countries. The information contained in this Paper is a summary of recent surveys in Yemen in The Middle East, Ghana in West Africa and Costa Rica in Central America. The purpose of this Paper is to provide an indication about the extent of the medical equipment problem and the severity of the implications of the problem. The research data is also used to examine how the three countries have dealt with certain managerial issues such as equipment standardisation, equipment complexity and equipment obsolescence. The available data is further used to examine the difference in performance between hospitals of different size, geographical location and different type of ownership (public versus private).

Paper 3 is concerned with the development of Health Care Technical Services (HCTS), i.e. the support system for the acquisition, use and conservation of medical equipment. The systematic framework developed in this Paper is used to objectively assess and compare three very different developing countries.

Paper 4 is concerned with the development of the Medical Equipment Management (MEM) system. The systematic framework developed in this Paper is again used to objectively assess and compare three developing countries.

Paper 5, finally, reviews the Series of five Papers. The results and conclusions from the individual Papers are combined into a comprehensive model for the effective management of medical equipment and the effective allocation of resources. Paper 5 includes a discussion and guidelines regarding the effective management and utilisation of foreign aid.

1.2 Background to the Series

1.2.1 Medical Equipment: Terminology

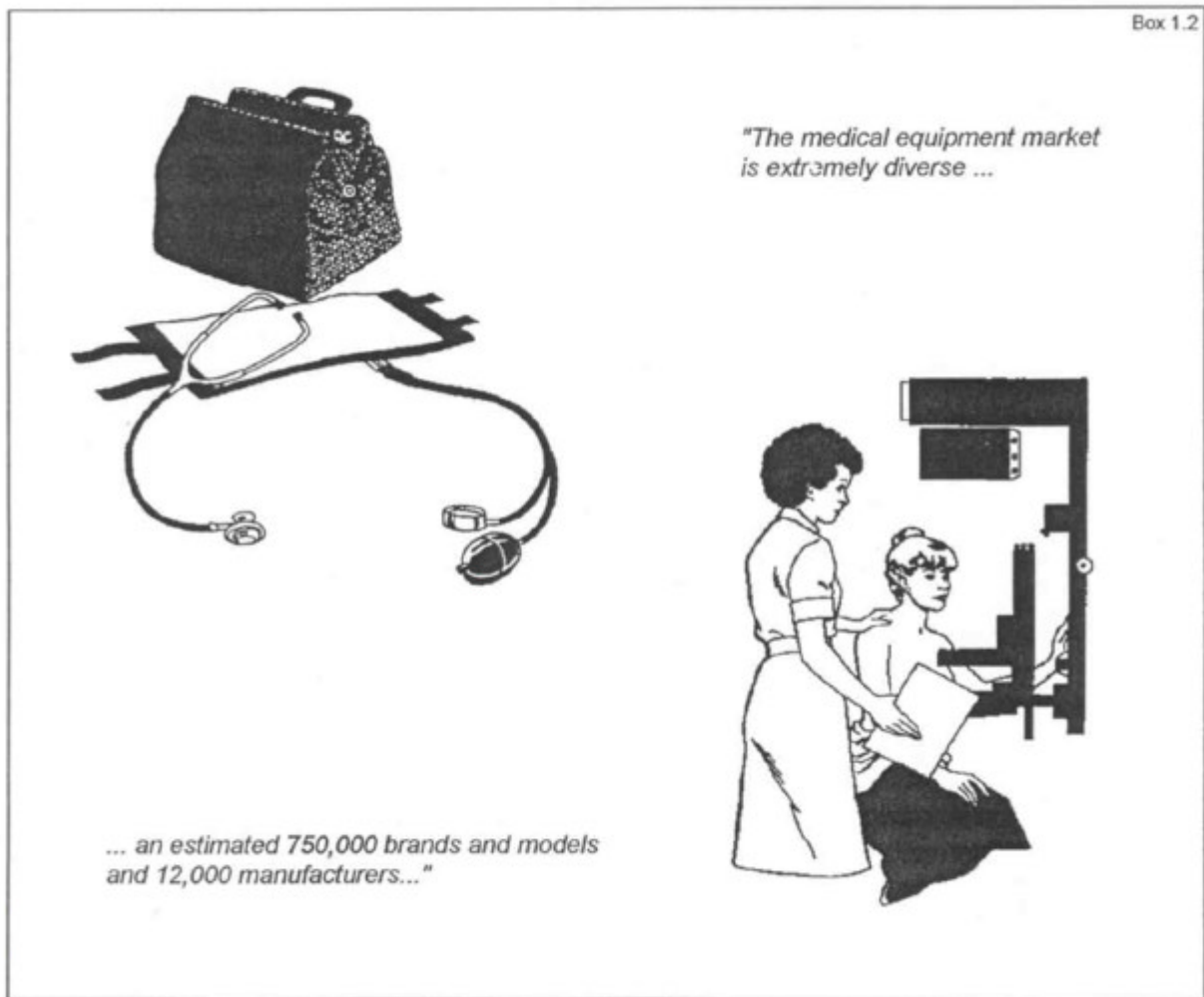
The term 'medical equipment' can be interpreted as including a wide range of instruments, equipment, machinery or apparatus used for medical and para-medical purposes. The literature provides us with a number of definitions for the term 'medical equipment'. Brown et al. (1986:i) describe medical equipment simply as being "... the equipment which may be found in hospitals, medical research and teaching institutions". This definition includes the entire range of mechanical, electrical and electronic devices used, directly or indirectly, for the delivery of health care. A more selective definition can be found in the relevant Health Equipment Information (HEI) publication of the Medical Devices Agency (MDA) of the Department of Health in London, which states that the term medical equipment comprises:

...any device, instrument, apparatus, implement, material substance, or other article (used singly or in combination), together with any accessory thereto, which is intended by the manufacturer for (a) diagnosis, prevention, monitoring, treatment or alleviation of human disease or injury, or (b) investigation or modification of human anatomy or of human physiological process; which does not achieve its principal intended action by pharmaceutical means, but which may be assisted in its functioning by such means (Medical Devices Agency: Health Equipment Information, Issue 98:28).

This Series of Publications is primarily concerned with strictly medical devices, such as those used in radiology departments, operating theatres, maternity wards, sterilisation departments, laboratories and pharmacies. Equipment not covered in this study are non-medical devices, such as those associated with the auxiliary supplies for medical facilities, such as electricity- and water supply, as well as transport, domestic and administrative equipment. A more detailed classification of medical- and non-medical equipment, used in hospitals, has been attached as Annex 1-1.

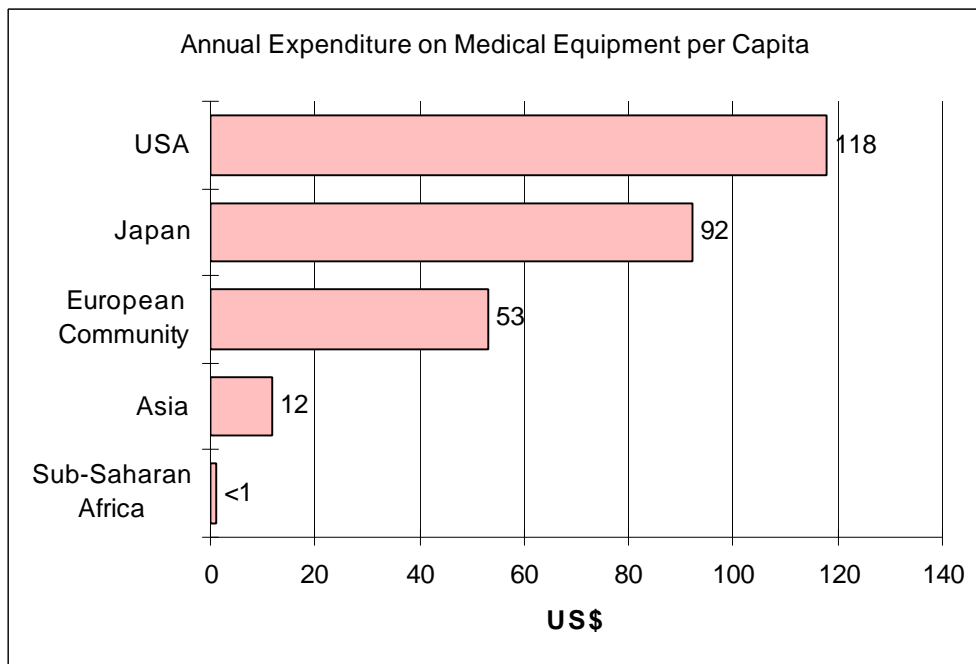
1.2.2 The International Medical Equipment Market

The international medical equipment industry is extremely diverse. The spectrum of available devices ranges from the most elementary mechanical apparatus, such as the hand operated table-top centrifuge, to the most sophisticated diagnostic and therapeutic equipment, such as computer tomography. It is estimated that the range of medical devices incorporates approximately 6,000 generic entities and an estimated 750,000 or more brands and models, ranging from simple articles to very complex systems. These devices are produced by an estimated 12,000 manufacturers world-wide (World Bank, 1993:138). World trade in medical equipment is dominated by three countries; Germany, the USA and Japan, who combined account for over half of total exports of both medical instruments and electro-medical equipment (Bloom and Temple-Bird, 1988:12).



It is further estimated that currently developing countries account for approximately \$5 billion, or 7 percent, of the \$71 billion spent annually on medical equipment world-wide. Although precise figures are generally not available, a significant proportion of funding for medical equipment is provided by international donor organisations. The global estimate on medical equipment purchases includes medical and dental supplies, surgical instruments, electro-medical and X-ray equipment, diagnostic tools and implanted products (World Bank, 1993b:137-38). The huge discrepancy between the 'North' and the 'South', with regard to the availability of resources, will be obvious when one considers that low- and middle-income-economies represent some 85 percent of the world population.

Considering the low per capita purchasing capacity for medical equipment in developing countries, it is crucial that existing resources are used effectively. The effective use of technology in circumstances where financial and other resources are severely restricted is the overall theme of this Series.



Source: South African Medical Research Council, 1994

Fig 1-1 International Expenditure on Medical Equipment

In order to illustrate this contrast between countries in 'The North' as opposed to those in 'The South', Figure 1-1 gives an indication of the international expenditure per capita on medical equipment.

1.2.3 Brief Review of Previous Studies

Many studies have been carried out by international health workers and consultants, addressing the specific problem of poor medical equipment performance in developing countries. It is outside the scope of this Series to provide a detailed assessment and analysis of the available material. However, a comprehensive list of references has been attached for those readers wishing to elaborate on certain aspects of the issue. This Section gives a brief summary of what various authors have contributed to the understanding of the problem.

The material contained in this Series of Publication mainly focuses on only one of three interconnected problems about medical equipment in developing countries, which are:

(i) The limited total volume of equipment

The previous Section has outlined the size of the world market and the global distribution of medical equipment. It is obvious that the total stock of equipment available for developing countries is minimal, especially in comparison with the high-income economies. This inevitably restricts the health care that can be provided.

(ii) The unequal distribution of the stock of equipment

The geographical and socio-economic distribution of medical equipment is closely linked to the distribution of health care facilities and services in general. In most developing countries, these patterns of distribution are highly unequal. Whereas more than half of the population in many low- and middle-income economies is rural, health care and other amenities are available mostly in urban areas. In reality, in most developing countries, more than half of the limited public sector financial resources are spent on national-, teaching- or regional tertiary-care hospitals, which make a relatively small contribution to the reduction of predominant diseases. Consequently there are wide disparities between urban and rural health indices. Infant mortality in rural areas is, for instance, often 2-5 times as high as in urban areas (Anyinam, 1989). A number of studies show that around 40-60 percent of the health budget in Africa is spent on a few hospitals in and around capital cities. In Kenya, for example, it was found that a full 40 percent of all health expenditure was on National Kenyatta Hospital, while rural health centres received only 1.4 percent of total government funds for health (Alubo, 1990).

(iii) The poor performance of the installed stock of equipment

As indicated earlier, a large proportion of the existing stock of equipment in health facilities is not operational. The health care literature provides numerous examples of the poor performance of medical equipment in developing countries. It is estimated, for example, that in Brazil 20 to 40 percent of the \$2 billion to \$3 billion worth of public sector medical equipment is not functioning (World Bank, 1993:138). A recent case study in Cameroon shows that 20 to 40 percent of their medical equipment stock is not operational (Cameroon, 1993). McKie estimates that 60 percent of the equipment in medical units in a typical Third World country is not usable (McKie, 1990). In an earlier publication McKie indicates that the problem of poor operational performance of equipment is more evident in public sector health facilities and less severe in privately owned medical institutions (McKie, 1987:37).

A study of 17, out of a total of 76, Public and NGO hospitals in Uganda revealed that only around 20 percent of the inventory was in good working order, while it was estimated that perhaps another 30 percent of the faulty stock would be worth repairing. Extrapolated over all the hospitals in Uganda, this would mean that about half of the US\$ 15 million investment in such assets had been wasted and almost a third of the total inventory was providing no benefit. The total lack of investment in basic equipment maintenance for many years makes this example an 'extreme case' (Porter, 1987).

Although estimates, as to what proportion of equipment in developing countries is not functioning, vary considerably, all sources agree that poor performance of the existing equipment is an important contributor to the health crisis in developing countries. Poor performance of installed equipment clearly exacerbates the already serious constraints on providing effective health care, caused by the low total volume of medical equipment available in these countries and the highly unequal distribution of that equipment.

There are many references in the literature which suggest reasons for poor performance of medical equipment in developing countries. The reasons given are multiple and often complex. McKie, for example, attributes the medical equipment problem in developing countries to poor management of health care technology. He states that "... shortcomings in managerial procedures and practices are familiar and often described, however the root causes of the disease are seldom probed". He also speaks, in this respect, of a "disease with multiple causes" (McKie, 1987:37).



In this Section an attempt has been made to categorise suggested causative factors and associated prescriptions for solving the problem. Suggested reasons for, and solutions to, the problem appear to fit into one of five categories:

- (i) Policy. The problem is a direct consequence of the absence of specific policies, with regard to the management of physical assets. Numerous studies emphasise the need for a comprehensive public and private sector policy on the management of health care equipment.
- (ii) Utilisation. The problem is thought to be due to ineffective use of the equipment (timely equipment maintenance and replacement are regarded as part of this utilisation process).
- (iii) Context. The problem is said to be caused by certain aspects of the environment, or context, into which the equipment is introduced and used. Inadequate financial resources, shortage of staff in terms of quantity and quality and poor management of foreign aid are examples of contextual issues contributing to the problem.
- (iv) The Technology. The problem is inherent in the technology and related to certain technical features of the equipment. The fast changing technology in the international equipment market, and the sophistication of modern equipment are regarded as reasons for poor equipment performance in developing countries. The enormous diversity in makes and models of equipment is regarded as an important contributor to the problem.
- (v) Acquisition. The equipment problem is thought to originate from imperfect selection and purchasing procedures.

It appears that the existing literature related to the equipment problem does not provide a comprehensive and systematic framework related to factors influencing equipment performance. Many authors provide an extensive list of reasons, and most of them suggest corresponding ways for possible improvement. A limitation of the existing literature is that none of these sources is particularly systematic in doing so. As a step towards a more systematic analysis, Table 1-1 groups into four categories the key issues emerging from the literature addressing specific reasons for poor operational performance of medical equipment in developing countries.

Table 1-1 Suggested Reasons for Poor Equipment Performance

(i) Technology related vices	Inherent complexity of medical de- vices Lack of equipment standardisation Equipment obsolescence
(ii) Hospital-characteristics related	Geographical location and size Type of ownership
(iii) Policy and context related	Absence of public and private sector policies Poor equipment conservation culture Weak infrastructure and organisation Lack of trained maintenance staff Lack of trained equipment operators Weak technical support system Inadequate finances for equipment management Poor logistics support (transport, information) Poor donor practices
(iv) Management-process related	Poor equipment acquisition procedures Poor maintenance and repair procedures Poor equipment replacement procedures Poor management of human resources development Poor equipment performance evaluation procedures Poor management of foreign aid

The purpose of this Series of five Publications is to obtain a better understanding of the rather complex and multi-faceted medical equipment problem in developing countries. The key issues listed in Table 1-1 will, to some extent, serve as a guideline for further discussion.

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(An extended bibliography related to the entire Series is included in Paper 5)

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Annex 1-1 Classification of Hospital Equipment (Glossary)

MEDICAL	General	BP Apparatus Otoscope Blood Bank Vaccine Fridge Oxygen Supply Others
	Imaging	X-ray Fixed/Mobile Fluoroscopy Ultra Sound
	Theatre	Anaesthesia Cryogen Equipment Diathermy Operating Light Operating Table Suction
	Maternity	Doppler Detector Incubator Vacuum Extractor
	Sterilisation	Autoclave Oven (Sterilising) Steriliser (Built-in) Water Bath, electric Water Bath, electronic Disinfectant, electronic Gas Steriliser
	Laboratory	Centrifuge Microscope Incubator Photometer pH Meter
	Pharmacy	Bottle Washer Compressor Filter System Mixer Water Still Weighing Equipment Others
NON-MEDICAL	Electricity Supply	Power Plant, Power Wiring Solar Power
	Water Supply	Pumps, Piping
	Transport	Vehicles, Motor Bikes
	Domestic	Kitchen, Laundry
	Administration	Calculator, Cash Register Computer, Copier Transceiver