ESSENTIAL EQUIPMENT

FOR DISTRICT HEALTH FACILITIES

IN DEVELOPING COUNTRIES

- experimental edition -

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PREFACE

For more than three decades, the international community through the United Nations system and regional and sub-regional health organizations have been making tremendous efforts towards improving the health status of both individuals and communities, in particular in developing countries.

These efforts include:

- The sensitization and involvement of the individuals and the communities in solving their own health problems.
- Setting-up and training of health teams with researchers, planners, managers, administrators, doctors, nurses ....
- The launching of important health programmes such as Primary Health Care (PHC), The Global Programme on AIDS (GPA), The Tropical Diseases Reseach Programme (TDR), The Drug Action Programme (DAP), The Expanded Programme on Immunization (EPI), The Control of Diarrhoeal Diseases (CDD), The Acute Respiratory Diseases Programme (ARD).
- The rationalization of health-care delivery services.
- The enacting of suitable legislation and regulations.

During the same period, a large stock of assorted equipment was acquired through donations, purchases with locally generated resources, purchases with loans ... without a preliminary survey of needs, and without taking into consideration determining factors such as the quality of the health establishments, the quality of staff using them, the availibility of resources to ensure their operation, maintenance, renovation and replacement, and finally the climatic environment.

This negligect results in the high rate of unavailability of equipment (30 to 60%) owing essentially to the absence of preventive maintenance, spare parts, know-how and financial resources and in the non-use of newly installed equipment because of its complex nature.

The rational use of technical equipment, as a matter of necessity implies the elaboration of a policy governing the use of basic equipment (such as that for drugs) adapted to each level of the health-care delivery services: as far as possible, they must be generic, of good quality, easy to operate and to maintain, and favourably priced.

This is the real challenge to be met in facing large-scale mechanization of health-care. In this context the manual makes an important contribution by proposing sets of equipment geared to specific task levels.

It can be done, collectively !

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SUMMARY

The purpose of this manual is to propose ways to health planners, management teams and donor agencies for more adequate and considerate provisions of medical equipment in the developing world at district level: equipment in a position to satisfy identified health needs, equipment which can be operated by the existing staff under known conditions and equipment which - through systematic maintenance and repair - has a satisfactory lifespan in economic terms.

Section I Fundamental Requirements for Managing Equipment

The section deals with general problems of health care equipment management including policy, health care technical service organization, approaches to equipment selection, procurement and maintenance.

Section II Equipment Requirements for Clinical Services

The section discusses equipment needs for various fields of medicine at different levels of the district health system and provides suggestions and explanations for the selection of essential equipment.

Section III Equipment Requirements for Clinical and Hospital Support Services

The section discusses equipment needs for clinical and hospital support services.

Section IV Essential Equipment for Different Health Services within a District Health System

The section presents essential medical and technical equipment for health services within a district health system including approximate data on costs and durability.

Section V Reference Literature and Resource Organizations

The section gives a list of resource organizations and a critical review of available literature.

The experimental edition will be further developed and tuned to the needs of the target groups. The next edition would eg. include generic specifications

In order to achieve this objective, more relevant know-how and experience from all over the world must be collected, analysed and put into an applicable format. The manual can only constitute one step in this direction, complementing other deliberations in the field. We would therefore like to call upon all readers to contribute complementary information, suggestions and corrections for follow-up editions, and thank those who have already done so in commenting on and contributing to this first edition (refer to list of contributors).

The editors

Classification of Health Facilities

For reference purposes, this book classifies district health facilities as follows:

Level I: **Health post or sub-health centre without beds**
(village/community based)

This is the simplest and most elementary structure at the periphery, run by resident staff and carrying out basic health care. Its location may be urban or rural. There are no in-patient facilities or maternity services.

Level II: **Health centre or small district hospital with 1 - 75 beds**
(sub-district based)

Health facilities working in routine health care are restricted to general medical, surgical and obstetrical services. Clinical and radiological services may be unavailable at this level. Usually institutions at this level provide in-patient and out-patient services including maternity. As a general rule only normal, uncomplicated deliveries are assisted. Beds for rehydration therapy should be available. Preventive and promotive activities are predominant.

Level III: **District or provincial hospital with 76 - 250 beds**

Hospitals of this bed capacity should have a wide range of diagnostic and therapeutic services for more specialized diseases / patients requiring special attention from specialized personnel and special medical technical equipment (including an intensive care unit) according to the complexity of the disease and following local epidemiological patterns. Medical sub-specialities such as urology, neurology and ophthalmology often not offered at levels I or II are available. Basically, the first referral level hospital complements the health centre by providing a wider range of services and more expertise for those complicated cases which require attention from more highly qualified and/or specialized personnel and special technology, and which cannot or should not be decentralized further.

The classification used in this book can be related to the one adopted by WHO as follows.

Level I health post or sub-centre	Level I and II are levels of first contact
Level II health centre or small hospital	(health centre types I, II, III including health post, sub-centre, health centre and referral health centre)
Level III district hospital	

Peripheral health units are key components of the health service continuum since they are the point of first contact with the formal health care system and deal with most of the health and medical problems of the population. There is no satisfactory universal definition for them because there is a significant difference from country to country in terms of their size, staffing, resources, provision of services and population coverage. Depending on location, such units might be called a general practice, a dispensary, a health post or a health centre. For ease of reference WHO calls the health facility at first contact level a health centre with the following working definition: a health centre is concerned primarily with ambulatory patients. It provides both curative and preventive services, and whether staffed by a doctor or not, it has a multidisciplinary team capable of providing a range of services

Health centres have developed into three broad categories, or types, based on the sophistication and breadth of services provided. Health centre type I might be called a dispensary, a health post or a sub-centre and provides limited ambulatory curative service and community development. Health centre type II is what is most often called a health centre, and its role is to provide ambulatory curative services, health promotion, prevention and education and support for sub-centres, if any exist.

Health centre type III is called a referral health centre and has the same role as type II plus day surgery, short-term in-patient care and expanded health promotion, prevention and education function. It should be recognized that in practice it may not be possible to place many health centres clearly into either of these three categories.

SECTION I

FUNDAMENTALS IN SELECTING THE RIGHT EQUIPMENT

I.1 CURRENT SITUATION

I.2 NATIONAL EQUIPMENT POLICY AND INFRASTRUCTURE

I.3 IMPORTING HEALTH CARE EQUIPMENT

I.4 SELECTING HEALTH CARE EQUIPMENT

I.5 MAINTENANCE AND REPAIR SYSTEMS

I.6 APPROPRIATE TECHNOLOGY

I.1 CURRENT SITUATION

The common phenomenon in most developing countries is not a lack of health care equipment, but the presence of equipment which is not usable or not used. Around half of the inventory, in some cases as much as 75-80%, is inoperable at any given time. Clearly, these lead to poor quality of care and high wastage of scarce resources as well as a negative effect on the morale of health workers.

In almost all developing countries the most pressing problem is not merely a substantial burden of equipment which is inappropriate to the country's needs and conditions. Many of the equipment are appropriate and could contribute to the country's health goals, but idle due to the inappropriate management of its introduction to the country.

Although national and regional variations exist, common factors can be identified:

* Equipment is not used because
  - it is not appropriate for the local needs and local context,
  - the site is not suitably built or serviced,
  - no expertise is available to install or commission it,
  - staff lack the knowledge to use it,
  - no instruction manuals have been received or are written in a foreign language,
  - some parts have not been specified or delivered,
  - it is defective on delivery,
  - it is not supported by adequate supply of special consumables and short-lived components,
  - long term logistic support is too costly.
* Equipment is not usable because it has become faulty due to
  - inappropriate use,
  - no preventive maintenance, including baseline maintenance by users,
  - inadequate utilities (electricity, water, etc.),
  - adverse environment (heat, humidity, dust, etc.).
* No repair service is available because of
  - no repair and maintenance facilities,
  - no competent staff in-house or with local agent,

- no commitment from a local agent,
- no service manuals,
- no spare parts,
- no funds for spare parts or service.

The underlying reasons for this situation are often:

* lack of awareness,
* lack of policy,
* lack of health care technical services infrastructure,
* lack of qualified manpower,
* lack of information support.

In most developing countries a general lack of awareness, technological management expertise and technical competence leads to unsystematic selection and purchasing. Recurrent cost implications of the purchase or donation of capital equipment are usually not fully appreciated by the recipient and the donor, which results in a lack of budget provision for maintenance and other operating costs at the planning and purchasing stages.

Health care technical services, if they exist at all, perform inadequately because of inadequate workshops, logistics, manpower and organization.

The maintenance manpower development process comprising planning, training and utilization stages usually lacks continuity. The structure of required staff according to the current and future needs is grossly underdeveloped. Performance is also weak and ineffective due to the lack of a conducive working environment, attractive salaries, career prospects, incentives, etc., in one word: lack of motivation. Finally, the problems are compounded by the great diversity of equipment obtained under various multilateral and bilateral assistance programmes though some countries have already developed standards and regulations on equipment.

The health system based on primary health care comprises social, preventive, diagnostic, therapeutic and rehabilitative services at various levels starting from the community and up to the tertiary level of sophisticated university hospitals. All those services utilize a wide range of equipment. Today, the universe of medical devices encompasses some 6,000 distinct types or generic entities and an estimated 750,000 or more brands, models, and sizes ranging from simple disposable devices to very complex systems.

Obviously, most of the equipment offered is needed within the complex health care system, in the right place, at the right time, and in the right balance with respect to the many other health needs of the population.

Despite the rapid development of modern health technology and the wide range of existing equipment, it is nevertheless possible to define general equipment requirements for various levels of a health system and set up standards for commonly used equipment. Such guidelines are based on a clear understanding of health services' functions at a certain level required to meet the needs of a

target population. Such guidelines apply to generalized situations and must be translated by users to suit the country's specific needs. Demographic, epidemiological, climatic and other conditions may be very different and may require further thorough analysis.

I.2 NATIONAL EQUIPMENT POLICY AND INFRA-STRUCTURE

All countries need to have an explicit national health care equipment policy throughout all levels of the national health system in order to ensure quality care and a wise use of health resources. It should be consistent with a country's needs and resources, should cover and integrate planning and budgeting procedures, regulations on standards of safety and efficiency, a clear understanding of and capability for needs assessment, selection and procurement strategies, adequate financial and infrastructure provisions for maintenance and repair, a manpower developement process, and many other factors.

In order to implement the health care equipment policy and to make any sustainable progress, a health care technical service within the health system is needed, extending from the ministry down to the district level. It should have a strong managerial and technical input at the ministry level, effective intersectorial links, a clear structure, adequate funding, and an information support service. A full range of staff from craftsman to technical manager with salaries and career prospects which are adequate and appropriate to the level of their responsibilities would be a long term objective. The technical service should enjoy equal standing with other services at all levels of the system.

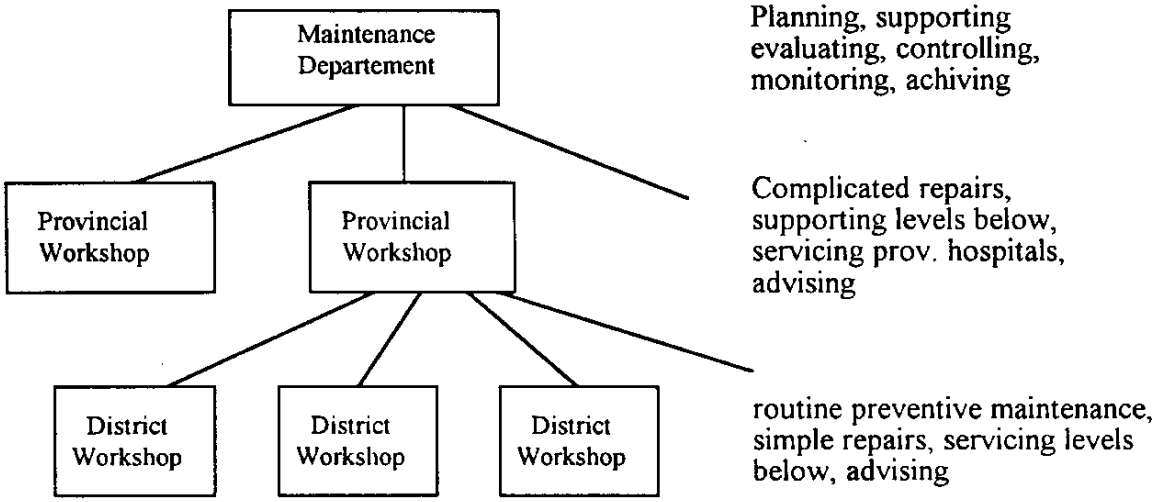
Human resources development, physical infrastructure strengthening and information support should occur simultaneously and not serially. It is only with a coordinated and comprehensive approach that equipment management will be improved and as a result quality of health care delivery enhanced.

Good technology management starts at the top, and, in order to develop and implement national equipment policy, a dedicated technical department is required at the central level close to decision-makers in a health system hierarchy. It should be headed by a well-qualified engineer with leadership potential.

The work to be undertaken at the **national level** is much more than the planning of a nationwide corps of staff and provision of working facilities for them. There must be a continuing action to improve the overall management of technology, ensuring that its appropriateness, quality and quantity are in conformity with the country's needs, resources and conditions at various levels of the system. Control or influence over equipment selection and procurement is an urgent task for a health care technical service: generic specifications, approval of manufacturers and agents,

tendering procedures with correct indication of support required, brand reduction, acceptance testing, etc. are some factors on which guidance must be given. This will help to avoid one of the most tragic and, regrettably, common symptoms of technology mismanagement - the sight of expensive equipment deteriorating into scrap metal because it was delivered to an unprepared site.

An essential precondition for an effective health care technical service is ideally a well established network of **maintenance facilities:**



The **staff required** could be grouped into three broad ranges of personnel designated as A, B and C.

Staff range A have duties which are predominantly technical, and the level of technical complexity remains comparatively low throughout the range. In most countries this range will include many grades of craftsmen, craftsmen supervisors, and polyvalent technicians who are limited in their skills and experience.

Staff range B have duties in which the managerial responsibilities are more important, and whose technical responsibilities are considerably more complex than those of range A. Some of the more experienced or capable polyvalent technicians in developing countries will enter this range.

Staff range C will have duties which are predominantly managerial, and the technical component will be demanding and complex. There will be staff in this range who are responsible for policy decisions at the ministry level, for managing health care technical service at the central or provincial level. It will include senior engineer or scientific grades and possibly a few of the most senior technicians.

The number of staff required can be roughly estimated. If a 100-bed district hospital were to be taken as an example, experience shows that up to six people should be employed (two in range B and four in range A). If there are satellite health centers or clinics to look after, the numbers might be doubled. Numbers do not increase in simple proportion for larger institutions, e.g. 200 beds might be served by 3B + 6A.

Although the majority of resources should be applied to the development of range B and A staff, the imperative need is to train competent and knowledgeable staff in range C for key positions in a health care technical service to formulate policy and manage its implementation. Therefore, in general, care should be given to ensure that all three levels of staff are developed simultaneously.

I.3 IMPORTING HEALTH CARE EQUIPMENT

The successful and sustainable introduction of new technology and import of the respective equipment involve considerably more than just the purchase of a piece of hardware. They require a complex package of inputs whose elements are closely interrelated and include

- **Selection** ensuring appropriateness of equipment to country's needs and conditions. These require access to and capacity to use relevant information for identifying needs and defining selection criteria. Availability of generic specifications and standardization are essential components of the process. Decision-making should be based on a team approach.
- **Procurement** ensuring that contracts include everything required - maintenance, training, manuals, spares, etc. - from the outset. The procurement process requires skills and experience in preparing tenders, negotiations with suppliers. Since a significant proportion of purchases are funded by international donors or equipment is donated, only a strong and knowledgeable medical equipment unit at the ministry is able to place such gifts under the same scrutinity as its own purchases.
- **Financial planning** ensuring budgeting and allocation of resources for the whole life cycle of equipment, including initial purchase and installation as well as running costs. These should be based on a clear understanding of the relationship between expected investment, running costs, life span and potential benefits and should be done before purchasing of equipment.
- **Operation** including provisions for proper installation, commissioning, acceptance testing, calibration, safety, user training, supply of consumables, etc.
- **Maintenance** based on a planned preventive maintenance programme as well as ensuring repair services (for details please refer to section I.6) .
- National capabilities in **technology assessment, research and development** are required in order to evolve a country's technological capacity, such that it becomes able to influence the directions of technology development and participate in development of appropriate technology.
- And, eventually, some countries will wish, as a long-term goal, to increase regional self-sufficiency by developing **local production**, by assembly or manufacture, of spare parts or whole units.

Primarily, local resources must be taken into account when importing medical equipment, and every effort must be made to base its selection, use and maintenance on them. Failure to adequately assess local capacities and their limitations may entirely jeopardize the use of certain technology and equipment.

I.4 SELECTING HEALTH CARE EQUIPMENT

The selection of adequate equipment requires a significant investment of time and resources, and involves many factors including its relevance to priority health needs, available capacity to use and maintain it, the purchase price and life time costs, etc. Therefore, close attention should be paid to the following issues:

- **Public health and epidemiological considerations:** equipment should be relevant to the specific local health problems to be solved. Therefore, it is essential to have a clear understanding of the health needs of the target population and corresponding health service functions required to meet those needs and, eventually, of the capacity and level of different technologies to perform the required functions. Helpful are country specific data with special regard to vital statistics, epidemiological data (such as prevalence and incidence rates of the most important diseases), special risks of certain diseases to patient and community, etc.
- **Economic considerations:** particular emphasis should be placed on equipment cost-effectiveness, taking into account the economic situation, financial control and the overall cost of the equipment (user cost) comprising:
  * investment (purchase) cost
  * transport, taxes, customs fees
  * site preparations (mounting base, power supply, etc.)
  * staff costs including training costs
  * consumables and spare parts
  * disposal of disposables and waste
  * energy consumption
  * keeping "ready to use": cleaning, disinfection, recharging of accumulators, storage
  * maintenance
  * replacement cost in connection with life span
  * disposal costs.
- **Technical considerations:** the specific situation with regard to the purchase and maintenance of equipment, local representatives of suppliers, governmental and parastatal organizations,

nature of workshops at different levels of health care. Equipment which is unreliable or not continuously available for use may turn out to be worse for the user than no equipment at all. The resources available for maintenance and repair determine the standard of technical equipment in hospitals.

The efficiency of such resources also depends on:

* user and service friendliness of the equipment
* availability of spare parts and consumables
* availability of adequate user and service manuals
* suitability of the equipment with regard to climatic conditions and the technical environment (quality of water, electricity, gas supply, type and size of room or building, ventilation, etc.)
* compatibility with existing equipment
* warranty terms
* training resources of the supplier.

- **Managerial considerations:** planners and managers should ensure the availability of a sufficient infrastructure to operate, service, maintain and repair the chosen equipment or while negotiating the contract ensure the supplier's support for maintenance and repair and additional training for local staff. Evaluation and monitoring indicators should be established and data made available for further planning and decision-making (information system). Most important is the availability of health personnel and operators, their qualifications and job descriptions, workload, need for and possibilities of further training.
- **Psychological and sociological considerations:** certain technologies or their design might not be acceptable in certain communities due to specific cultural or religious traits.

Historically, selection and purchase of health care equipment have often been influenced or even decided by individual medical professionals. They rarely arrive at unbiased and rational decisions in this area. They usually tend, for many reasons, to purchase unnecessarily sophisticated equipment.

Selection and purchase of equipment is a multidisciplinary effort and can be effectively carried out only as a result of a collective decision-making by a multiprofessional team comprising medical professionals, engineering staff, public health managers and administrators. Team members should be on equal terms to allow rational decision making. Technical committees should exist at all levels of the health system from the ministry down to the first referral hospital level. A technical committee at a district hospital should be responsible for equipment selection for the hospital itself as well as for smaller health facilities at lower levels.

The process of obtaining medical equipment, from the planning state until its full operation, is time-consuming and expensive.

Steps involved are:

- planning phase
- negotiations with suppliers and possible donors
- ordering procedure, tender
- transportation into the country
- import formalities
- distribution within the country
- installation, acceptance procedure
- organization of maintenance and repair, spare parts
- training of operators and maintenance staff
- payment.

The time of delivery for medical equipment may vary between 6 months and three years; costs of planning, delivery, training and installation often exceed the cost of the equipment. Purchasing "cheap" equipment is still very popular with e.g. tender boards. The costs of transportation and installation of such equipment of usually poor quality are, however, at least as high as for more expensive equipment of possibly better quality. Replacement of poor quality items is necessary in a shorter period of time. Additional expenditures will arise and the users will soon have to wait again for their equipment.

For most developing countries with their long delivery routes, financial constraints and difficult operating conditions, equipment of high quality is, in the end, the better and more economical choice.

Highly sophisticated equipment typically offers a large number of different settings for operation. Electronic data processing makes it possible to choose and display many of these parameters independently. This leads to a great number of different modes of operation. Routine users usually do not utilize that many different possibilities. They do not even have enough time to become sufficiently familiar with all the equipment features. Most users, therefore, should prefer single-control type equipment. Studies have shown that routine users can usually cope with equipment allowing three different settings. More settings require specialists.

For example, some brands of ultrasound equipment in use in German gynaecological clinics offer 99 different adjustments which can be altered independently. In addition, one standard adjustment can be loaded which uses routine values for grey level, depth mode, imaging mode, measuring programme, etc. In practice most doctors have never used any other than the standard adjustment.

I.5 MAINTENANCE AND REPAIR SYSTEMS

A maintenance and repair system has two basic functions. One is to keep up technical operability and the second is to provide information essential for equipment management and especially for deciding about the procurement of equipment.

Keeping equipment working:

Ensuring the operability of medical equipment, hospital plant etc. requires:

- inspection
- regular service (cleaning, disinfection or sterilization if need be, preventive maintenance)
- repair
- assurance of necessary supplies (media, consumables, etc.)
- managing maintenance workshops
- training of users and maintenance staff
- reception of new equipment
- managing external maintenance services (private sector)
- providing and maintaining technical information.

Emphasis must be put on a systematic (planned) and preventive approach. Through preventive measures, such as inspection and servicing, major breakdowns can be avoided, leading eventually to drastic savings. Maintenance is not expensive, repair is!

Maintaining equipment of different levels of sophistication calls for different levels of maintenance:

- **Simple equipment** can usually be maintained, and to a certain extent even be repaired, by the users. This is mainly equipment used in primary health facilities.
- **Equipment of medium sophistication** requires higher levels of skills for maintenance and repair. This kind of staff would ideally be skilled workers or technicians working within the public health service at routine level. Typical equipment are sterilizers, boilers, cooling devices, microscopes, etc.
- **Sophisticated equipment,** such as X-ray units, incubators and sonography, requires in-house personnel as well as the specialized know-how of the supplier. This is of crucial importance when the purchase of highly sophisticated and expensive equipment is considered.

In any case, the availability of **spare parts** deserves special attention. An appropriate set of spare parts should be included in the purchase agreements for the projected lifetime of the equipment. These sets should be defined on the basis of the local conditions and not necessarily according to the recommendations of the supplier. Local suppliers should be asked to ensure the future availability of such parts.

Also user and service **manuals** must be made available on a contractual basis. They must contain detailed information on the technical characteristics and specifications of the equipment. They should include circuit diagrams, PPM schedules (Planned Preventive Maintenance), application troubleshooting and technical faultfinding routines, spare part lists, safety procedures, adjustment procedures, calibration tests. Unfortunately frontpanels and manuals are often not made available in the proper language. Therefore the language must be specified in the purchase contract.

In many countries, the supply of spare parts and consumables meets great obstacles within the national logistical systems. Apart from hard currency constraints, additional problems may stem from complicated and costly customs and order procedures. In most cases it is advisable to order all necessary parts together with the new equipment. As a rule of thumb, 10-20% of the purchase cost of the equipment is required for an appropriate spare part set. For parts with short shelf life, a voucher system could be negotiated.

Evaluation of equipment operations:

As already stated, proper management of equipment and its purchase requires information about performance and economy. Most departments and organizations, however, lack monitoring and evaluation systems for this purpose in developing countries. Regular feed-back of experience from the user to the buyer or provider of equipment does not occur. Exchange of views about different kinds and makes of equipment and their suitability is the exception.

Collecting and forwarding such information and data constitute an important task of in-house maintenance services on the basis of a systematic recording and report system. Such an information system should be an integral part of health (management) information systems and corresponding supervision structures, thus feeding the purchase committee with the required facts for decision making.

Training:

Training of users and in-house service personnel is a most important component for long-term successful operation of medical equipment. The sort of training courses required for users would be different from the ones for service personnel. Users need skills in handling the equipment and in baseline maintenance. The latter skills seldom go beyond cleaning and adjustment routines and very basic troubleshooting.

Courses could be provided by the health authorities themselves (possibly assisted by some foreign donor), suppliers or other local technical training institutions. At least some user training (esp.

training of health authorities' instructors) and maintenance training of technical personnel should be included in the contract with the supplier, in particular when purchasing new items.

I.6 APPROPRIATE TECHNOLOGY

WHO underscores the importance of adequate and appropriate technology in primary health care in the Third World. Most medical equipment has been developed for use in industrialized countries. Therefore much of it is not appropriate for being operated under difficult climatic and environmental conditions. There seem to be solutions at hand: articles about "appropriate" technology and "low cost" technology frequently appear in all sorts of publications, describing alternative designs of equipment. They are supposed to be simple, effective and sustainable under the circumstances in developing countries and may even be locally produced. With regard to medical equipment many of these designs do not meet expectations. Often only a single prototype has been built. Some equipment has only been designed and tested in industrialized countries. Whether it is useful in developing countries remains to be seen.

To prove the **suitability,** a number of criteria must be checked:

- effectiveness
- ease of use
- ease of maintenance, sturdiness
- safety
- low cost (purchase **and** follow-up)
- relevance to existing health problems
- acceptability
- accessibility
- local production.

In practice the following procedures should be followed:

- Try to find out how many pieces of this equipment have been built already.
- Communicate with previous users of this equipment.
- Compare their situation with your own, especially with regard to conditions of use (climate, roads, knowledge of users, availability of service staff, energy and water requirements etc.).
- Calculate costs and energy requirements.
- If construction plans are published, check on availability of materials and on potential local producers. Build one prototype first, calculate the costs and check economy.

Appropriate technology has shown its usefulness and effectiveness in certain areas, such as:

- solar water heating
- solar panels for telecommunications, lighting (microscope, emergency lights in theatre and labour ward, etc.), pumping of water, etc.
- solar stills
- mechanical equipment which has been used for decades (foot-operated suction pumps, hand centrifuges, orthopaedic aids)
- locally produced furniture, appliances, etc.

Some literature on appropriate technology is listed in the fifth section of this handbook.

SECTION II

EQUIPMENT FOR TREATMENT

II.1 INTRODUCTION

II.2 INTERNAL MEDICINE

II.3 SURGERY

II.4 ANAESTHESIA

II.5 OBSTETRICS

II.6 GYNAECOLOGY

II.7 OPHTHALMOLOGY

II.1 INTRODUCTION

The second part of this handbook presents common medical problems in developing countries.

Different diseases have to be treated at different referral levels of health institutions. Important factors influencing the choice of the appropriate health institution are:

- the severity of the disease and complication
- the level of medical specialization and qualification required
- the necessary technical and diagnostic equipment.

The technical equipment should account for the spectrum of diseases, medical specialization and workload of the respective health institution, as well as its manpower and financial capacities.

II.2 INTERNAL MEDICINE

II.2.1 Overview

Diseases relating to internal medicine may be divided into the following groups:

Infectious diseases:

very common:	acute respiratory infections (ARI), diarrhea, pneumonia, menengitis tuberculosis, intestinal parasites, malaria, sexually transmitted diseases incl. AIDS,
common:	hepatitis, skin infections

Diseases of the blood, lymphatic and reticulo-endothelial system:

very common:	anaemia (iron deficiency, megaloblastic, dehydrogenase, tropical splenomegaly syndrome, and after infections)
less common:	malignant lymphomas, Burkitt's lymphoma and leukaemia

Diseases of the cardiovascular system:

very common:	recurrent rheumatic fever
common:	hypertension and cardiac failure, cardiomyopathy, infective endocarditis, pericarditis
rare:	ischemic heart disease

Metabolic diseases:

common:	diabetes mellitus (frequently with complications)

Gastrointestinal diseases:

common:	liver cirrhosis, hepatitis, portal hypertension, gastritis, ulcers
rare:	diseases of the gall bladder, appendicitis, pancreatitis, Chagas' disease
very rare:	Crohn's disease, ulcerative colitis

Malignant diseases (Oncology):

common:	hepatoma, cancer of the esophagus, Kaposi's sarcoma
rare:	lung cancer, colon cancer

Diseases of the urinary system:

common:	pyelonephritis, glomerulonephritis, nephrotic syndrome
less common:	renal and ureteric calculi
rare:	bladder stones (more common in arid areas)

Nutritional diseases:

common:	nutritional deficiencies, vitamin deficiencies, malabsorption

Toxicology and addiction:

very common:	alcoholism
less common:	intoxication (occupational exposure to pesticides, chemical solutions, local medicine, traditional remedies, pharmaceuticals, narcotics, fish poisoning, venomous bites and stings)

Neurological diseases:

common: infections of the central nervous system (meningitis, encephalitis), congenital and developmental disorders, neurological complications due to trauma, intoxication or metabolic disorders.

II.2.2 Treatment

Treatment in internal medicine in developing countries according to the level of health institution:

Internal medicine at Level I:

- Health education, reporting of notifiable diseases, surveillance of epidemics.
- Management of most infectious diseases, most cases of anaemia, and malnutrition.
- Diseases suspected/diagnosed and referred:

  Serious infective diseases (e.g. meningitis), metabolic disorders, cardiac diseases, diseases of liver, kidneys, cardiovascular system, malignant diseases.

Internal medicine at Level II:

- Planning, coordination and supervision of health education, preventive services, control programmes (e.g. onchocerciasis), staff training and supervision.
- Management of the majority of internal diseases.
- Diagnosis and referral of curable malignant diseases, of cases which cannot sufficiently be diagnosed and treated, especially in the field of cardiology, nephrology, neurology, haematology.

Internal medicine at Level III:

- Planning, coordination and supervision of health education, preventive services, control programmes (e.g. tuberculosis), supervision and in-service training of staff, monitoring diseases, promotion of clinical discussion, forum of case presentation and exchange of information.
- Management of the whole spectrum of internal medicine except for curative care of terminal diseases and life-prolonging treatment of incurable diseases.

II.2.3 Equipment

Equipment requirements for internal medicine at different levels of health institutions

Internal medicine constitutes such a great portion of medicine that nobody can be expected to master all possible cases. A library with adequate handbooks at each level is therefore essential. It is also expected that specialists and consultants share their experience with less qualified doctors and paramedics through supervision, clinical ward rounds, publications and promotion of open discussions.

Reliable laboratory services are essential to internal medicine. For complicated cases radiography and ultrasound are of equal importance.

Endoscopic procedures are gaining more and more importance in industrialized countries. Endoscopy, however, is a time-consuming procedure and needs experienced specialists. Endoscopes are very delicate instruments which require good care and often need repair or replacement. In most developing countries the use of endoscopy is therefore restricted to larger institutions.

Equipment for internal medicine at Level I:

- good stethoscope (Littmann type) plus spares (diaphragm, earpieces)
- thermometer
- tape measure
- tongue depressor
- light source
- auriscope (battery operated, can be used with small Ni-Cd cells)
- robust mercury or aneroid sphygmomanometer (mercury sphygmomanometers are more expensive, more accurate and easy to repair, but they are more fragile than aneroid sphygmomanometers.)
- baby + adult scales

Equipment to perform the following laboratory examinations:

- haemoglobin (a simple but reliable method will do - e.g. Sahli method)
- urine examination: protein, glucose, sediment (e.g. test with sulphosalicylic acid, Nylander's reagent)

- microscopy: examination for malaria parasites and other protozoa, for helminths, stool examination for ova

(For details see chapter on laboratory equipment.)

Equipment for internal medicine at Level II:

Same equipment as at basic level plus:

- peak flowmeter to test lung function (bronchodilator aerosols should be kept)
- direct ophthalmoscope
- laryngoscope
- full blood count (WBC, diff. WBC, RBC, PCV)
- Sickling test
- full urine report (bile salt, glucose, protein, specific gravity, pH, sediment)
- examination of cerebrospinal fluid (CSF microscopy, glucose, protein)
- microscopy and cultures: microscopical examination for bacteria
- limited serological examination (e.g. HIV, VDRL, blood grouping and cross-matching)
- electrolytes (flame photometer)
- blood urea, blood sugar, bilirubin
- bleeding time, clotting time

Optional equipment:

- set of rigid metal bronchoscopes (different sizes)
- rectoscope
- electrocardiograph (three channel ECG)
- ultrasound

Due to the unavailability of proper maintenance and repair, and to insufficient training of doctors and paramedics, the following equipment is usually **not reasonable at level II:**

- laparoscope, gastroscope, sigmoidoscope
- X-ray unit: fluoroscopy, angiography
- laboratory: electrophoresis, histology, cytology, bone marrow, blood gas analysis
- dialysis
- intensive care unit with continuous monitoring of ECG, mechanical ventilation, etc., but rooms/beds for special observation

Equipment for internal medicine at Level III:

Same equipment as at basic and routine levels **plus:**

- spirometer
- bronchoscope (different sizes)
- sigmoidoscope and gastroscope with fibre light source
- electrocardiograph (three channel ECG)
- ultrasound
- laparoscopy
- simple ventilator
- X-ray: fluoroscopy
- laboratory: culture and sensitivity, electrophoresis, blood gas analysis, clotting factors, serum enzymes
- histopathology: histology, bone marrow examinations

Optional:

- echocardiograph
- electromyograph
- fibre optic bronchoscope and laparoscope

II.3 SURGERY

II.3.1 Overview

Surgically treatable diseases are not the major killer in developing countries, but many unnecessary deaths still occur due to the lack of surgical facilities. Too many out-patients who could be helped by surgery still die because hospitals can only handle a fraction of the surgical workload.

Accessibility to the health institution is also a major problem for a great part of the rural population. Once health services are available for the population in order to prevent and treat major diseases, surgical services should have the next priority.

In most developing countries, surgery is usually concentrated in district hospitals. District hospitals (levels II & III) thus deserve special attention when it comes to their technical and medical equipment, especially concerning the surgical departments and theatres.

Roughly 10-15% of hospital admissions are surgical cases.

Common surgical cases are:
- hernias,
- appendicitis,
- urethral strictures,
- tubal infections,
- pelvic inflammatory disease (PID),
- abortions,
- volvulus
- fractures, burns, accidents, abscesses
- fibroids,
- osteomyelitis
- tuberculosis,

Rare diseases include
- diverticulitis,
- colon cancer,
- haemorrhoids,
- varicose veins,
- thromboembolic complications.

Half of the cases needing general anaesthesia are obstetric or gynaecological problems, followed by 15% fractures and dislocations due to trauma. About 10% of surgical interventions relate to infectious diseases.

Traumatic bone injuries are dislocations of the upper and lower extremities (shoulder, elbow, wrist, radius, ulna, tibia, fibula). Road and work accidents are common.

Essential companions to surgery are the support departments:

- radiology (X-ray)
- anaesthesia
- sterilization.

Due to their importance, these are described in a seperate chapter (Section III) of this manual.

II.3.2 Surgery Treatment

Surgery can be divided into two main domains:

I. **Emergency procedures** that cannot be delayed and must be handled even at lower levels of health care. The basic level must initiate treatment (e.g. infusion, ligation of bleeding vessels) before referring the patient.

II. **Routine (scheduled, cold) surgery** that can be referred.

Emergencies are either traumatic (haemorrhage, fractures, soft tissue injuries) or visceral emergencies (bowel obstruction, septic complications).

To handle emergencies properly, diagnostic and basic curative equipment must be available at least at routine level. After initial emergency treatment a patient may be referred for specific procedures (i.e. nerve sutures, vascular surgery) to a higher level.

Emergency treatment has to be carried out by a General Medical Officer or even by a Clinical Officer (= a medical professional non-academically trained such as manager for health facilities below hospital level) in the absence of a surgeon; treatment schedules and equipment should be simple and effective.

Decisions on equipment specifications have to be made at national level, taking into consideration that other disciplines (gynaecology, orthopaedics) may need the same equipment. This mainly refers to diagnostic means and equipment of theatres.

The use of disposable materials (drapes, scalpels) should be minimized. The use of more labour-intensive re-usable materials is feasible at all levels of health care, also in view of disposal problems.

The standard of anaesthetic facilities must match the standard of surgical procedures.

Surgery at Level I:

Minor out-patient surgery:

- splinting of fractures and sprains
- abscess incisions
- suture of cuts
- dressing of wounds and small burns

Recognition of acute and chronic surgical disease, first emergency treatment and/or referral.

Surgery at Level II:

Trauma:

- fracture setting and plastering
- skeletal traction
- treatment of complicated wounds

General surgery:

- scheduled routine operations (i.e. hernias, thyroidectomy, appendectomy, cholecystectomies, bladder stones)
- soft tissue operations (septic and aseptic)
- skin grafting

Surgical emergencies:

- bowel obstruction, intestinal perforations, splenectomy, revision of internal haemorrhage (chest, abdomen, cranium)
- amputations

Surgery at Level III:

All above tasks plus:

General surgery:

- major scheduled operations (stomach resection, intestinal resection for malignancy and urological procedures).

II.3.3 Equipment

II.3.3.1 General Equipment

Specifications of theatre installations like operating tables, lights and sterilization which can be used by various disciplines are described in the appendix "Theatre equipment" and will not be listed in the following.

Equipment requirements for surgery at different levels of health institutions:

Surgery at Level I:

Diagnostics:

- stethoscope,
- reflex hammer,
- measuring tape,
- domestic light source (electric or alternative energy)

Therapy:

- examination and treatment bench
- tourniquet
- small surgical instrument set (for suturing and control of haemorrhage, see also section "Theatre equipment")
- disinfectant
- local anaesthesia
- bandages, plasters, splints

Sterilization:

- steam pressure autoclave (pot, 10 l volume, is sufficient, variable energy source: electric, gas, paraffin)

Surgery at Level II:

All equipment as at basic level I plus:

Diagnostics:

- basic radiography and/or
- ultrasound

Therapy:

- at least 2 operating theatres (one for minor procedures, fracture setting and septic procedures, one for clean major surgery)
- theatre table (manually operated)
- theatre light (cold light with stand-by battery)
- foot-operated suction pump
- basic surgical instrument set (see section "Theatre equipment")
- basic orthopaedic set (chisels, drills, traction pins)
- skin graft knife
- instruments for craniotomy
- optional: electrocautery equipment

Sterilization:

- (electric) steam autoclave (size according to workload, 10-20 l)

Surgery at Level III:

All equipment as at routine level II plus:

Diagnostics:

- fluoroscopy
- image intensifier
- ultrasound (linear array 3.5 MHz)
- optional: endoscopy equipment

Therapy:

- 2 operating theatres, one of them highly aseptic
- 2 operating tables (tiltable and height adjustable) with attachments to suit specific needs ('Chogoria' leg supports for hip abduction and an arm board)
- electrocautery
- instrument sets including instruments for microsurgery, intestinal staplers
- emergency power generator
- air conditioning (active or passive)

Sterilization:

- steam sterilizer, size according to workload (20-60 l) (see also Section III)

II.3.3.2 Surgical Instruments:

Types of surgical instruments vary from one country to another and depend on the different routines used at the different surgical training centres as well as on the personal preferences of the surgeon. However, to reflect the range of "maximal" (developed countries) and "minimal" (developing countries) equipment for the practice of general surgery, levels II & III are given as examples.

Equipment for "First Aid - Minor Surgery Dressing" (Health Centre Level without theatre)

1 instrument tray
1 tracheal catheter for adults, rubber
1 urethral catheter set
1 urethral catheter (female), metal
1 jar forceps
1 tourniquet
1 bandage scissors, angular, 18 cm
1 gauze scissors, straight, 21cm
1 sponge forceps, serrated jaw, 22 cm
1 forceps, 21 cm
1 tissue forceps, toothed, 15 cm

1 knife handle and blade set
1 grooved director, round point
1 dressing forceps, non-toothed 15 cm
1 haemostatic forceps (Kocher), 14 cm
1 haemostatic forceps (Kelly), 14 cm
1 operating scissors, straight 14 cm
1 needle holder (Mayo Hegar), 15 cm
1 suture set
1 probe
1 splinter forceps

Others:

syringes
splint kit
suture clips
gloves
intravenous rehydration set

Optional:

maternal care:

1 breast pump
3 vaginal specula, small, medium, large
1 haemostatic forceps (Rochester Pean), 16 cm

paediatric:

1 nasal aspirator, infant-sized
1 tracheal catheter, infant-sized
2 tubes for nasal feeding, 5.8 Fr
1 rectal syringe

"Minimum" surgical instrument set and equipment needed for laparotomy at district hospital level (Level II or III), (Aesculap or Martin, Germany):

2 curved dissecting scissors
1 scalpel handle and 1 blade
2 dissecting scissors, short
2 dissecting scissors, long
2 stitch scissors
12 artery forceps, curved, small
12 artery forceps, straight, small
12 artery forceps, curved, long
12 artery forceps, straight, long
1 needle holder, short
1 needle holder, long
1 retractor (Langenbeck), medium
1 retractor (Langenbeck), narrow
1 retractor (Deaver), medium
1 retractor (Deaver), narrow
1 self-retaining retractor
2 dissecting forceps, toothed
2 dissecting forceps, non toothed, long
4 tissue forceps (Allis)
4 tissue forceps (Duval)
4 tissue forceps (Babcock)
8 sponge forceps
2 malleable retractors (spatulae)
2 occlusion clamps, straight
2 occlusion clamps, curved
2 syringes (10 and 20 ml) and needles
sutures catgut, chromic catgut (with different sizes and needles)
1 suction nozzle and suction apparatus
1 diathermy electrode, lead and apparatus
1 probe flexible, round

1 crafty director/administrator
1 nasogastric tube
6 towel clips

Others:

bowls, kidney dishes, gallipots, swabs, antiseptic solution, adhesive tape, drainage tubes, colostomy bags.

Example of a "small" set of instruments applicable to hospitals at national level

5 towel clips
1 pair of stitch scissors
2 pairs of small curved (Mayo) scissors
2 scalpel handles
10 small curved (mosquito) artery forceps
10 large tissue forceps (one pin)
3 small, non-toothed dissecting forceps
3 small, toothed dissecting forceps
1 small, toothed dissecting forceps
1 small, fine pointed, non toothed dissecting forceps
1 small, fine, toothed dissecting forceps
1 medium length, fine, pointed, non toothed dissecting forceps
1 medium length, fine, pointed, toothed, dissecting forceps
5 sponge holding forceps
10 artery forceps (Roberts)
5 gall bladder forceps (Moynihan's)
1 double-ended retractor (Morris)
2 large retractors (Langenbeck)
2 small retractors (Langenbeck)
2 double-ended retractors (Czerny's)
1 aneurysm needle
1 malleable silver probe
1 sinus forceps

1 double-ended scoop curette
1 double-ended dissector (Mc Donald)
1 double-ended dissector (Watson-Cheyne)
1 blunt-ended diathermy electrode handle
1 needle-ended diathermy handle
1 diathermy cable
1 diathermy quiver
1 sucker
3 needle holders
1 suction tube

The "large set" of instruments commonly used in industrialized countries contains all the instruments from the "small" set plus:

1 large, single-bladed retractor (Morris)
2 intestinal forceps with fine blades
1 extra long needle holder (Mayo-Hegar)
1 long toothed dissecting forceps
1 long non-toothed dissecting forceps
1 extra long-toothed dissecting forceps
1 extra long non toothed dissecting forceps
1 extra long handled scissors, curved tip

II.3.3.3 Endoscopic Instruments

Technical equipment for endoscopic procedures for level III (optional, only in places where the technical and personnel infrastructure is suitable).

1. Proctoscopy:

The simplest form of endoscope, a tube of about 8 cm. Lighting can be provided by a small low voltage bulb or by a fibre-light cable.

- proctoscope, light source
- lubricant

2. Sigmoidoscopy:

The sigmoidoscope is essentially an elongated version of the proctoscope (about 30 cm). Light is provided by a small low voltage bulb or through a fibre-light cable. Air is insufflated into the sigmoidoscope and into the bowel to improve the view.

- sigmoidoscope
- bellows
- light source
- biopsy forceps
- lubricant

Flexible sigmoidoscopes with a fibre-light source are also used for inspection of higher parts of the terminal bowel section.

3. Cystoscopy:

Endoscopy of the urethra and bladder can be used either for diagnostic or therapeutic procedures. Equipment can therefore vary depending on the aim of the procedure.

The cystoscope consists of an optical system through which the bladder can be examined internally. For optimal view, the bladder is filled with clear sterile water. The cystoscope carries a light source as is the case with all the other endoscopic instruments.

Modifications of the basic diagnostic cystoscope are usually seen when surgical procedures (such as biopsies, coagulation of bleeding vessels) are required.

Simple, diagnostic cystoscope:

- circular sheath
- obturator
- oval sheath
- telescope
- double or single catheterizing scope
- faucet
- light source, including cable
- three-way tap
- sterile water

Surgical cystoscope:

- sheath
- obturator
- catheterizing mechanism
- telescope
- 30 telescope
- 70 telescope
- water tap
- bridge
- diathermy electrode
- biopsy forceps
- light source incl. cable

4. Esophago-duodeno-gastroscopy:

Gastroscopes are designed for diagnosis (incl. biopsies) and therapeutic procedures (haemostasis of bleeding vessels). The set consists of a flexible fibre optic gastroscope.

- pharyngoscope with light carrier
- gastroscope (adult and child size)
- mouth gag
- dental props
- tongue depressor
- sucker and suction tubing
- light source and lead
- Ryle's tube
- dilator for cardiospasm (Negus)
- forceps (set)
- dilators (Chevalier-Jackson)

5. Bronchoscopy:

Bronchoscopes are designed for diagnosis (incl. biopsy) and therapeutic procedures such as haemostasis. The formerly commonly used rigid set is being gradually replaced by flexible fibre optic equipment.

- laryngoscope
- bronchoscope

- mouth gag
- dental prop
- tongue depressor
- set of forceps
- light source and lead
- suction apparatus and tubing
- biopsy forceps

6. Laparoscopy:

This endoscopic procedure is commonly used in the field of gynaecology, especially in female sterilization (tubal ligation), but also in routine diagnostic and curative surgery.

- laparoscope
- trocar
- Verres needle
- cannula
- light source and cable
- insufflator (CO_2 gas)

II.4 ANAESTHESIA

II.4.1 Overview

II.4.1.1 Role of Anaesthesia in Developing Countries

In developing countries, anaesthesia is frequently applied by medical assistants, clinical officers or other paramedical staff with little or no training in anaesthesia.

Good anaesthesia depends more on skills, training and standards of the anaesthetist than on the availability of expensive and sophisticated equipment.

The spectrum of the most commonly performed surgical procedures under anaesthesia at the routine level includes primarily obstetric/gynaecological emergencies and minor operations like hernia repairs, cataract extractions, etc.

Within the curative services, surgical procedures requiring general anaesthesia play a minor role (in many countries less than 20% of all admissions). In view of logistical problems as well as financial

and personnel constraints, it is therefore usually not justified to purchase complicated and sophisticated equipment which is expensive and difficult to maintain, and to run.

Most anaesthetic equipment depends on a regular supply of medical gases. Spare parts for anaesthetic machines are often not stocked and have to be imported from abroad. Due to lack of these and trained technicians, anaesthetic equipment is irregularly or never serviced. Failures with fatal outcomes are common.

Anaesthetic apparatuses used in developing countries must therefore be as simple as possible.

Considering the costs and unreliable supply of compressed gases (oxygen, nitrous oxide) and the side-effects of the administration of nitrous oxide (hypoxic mixture), inhalational anaesthesia based on a continuous flow of nitrous oxide and oxygen (Boyle's machine) is not adequate.

II.4.1.2 Draw-over Anaesthesia

Draw-over anaesthesia is the system of choice up to referral and even national level. Draw-over techniques are economical and capable of producing a very good anaesthesia; they are simple to understand and use and can be serviced locally.

The most practical equipment under these circumstances consists of a combination of the EMO vaporizer or the Afya (Dräger) vaporizer, the OMV (Oxford miniature vaporizer), equipped and calibrated for both halothane and trichloroethylene (Trilene), Cyprane Pac vaporizer or the Malawi model/triservice anaesthetic machine together with a means of inflation such as a manual resuscitator (self-inflating bag) or Oxford bellows, an Ambu or similar valve (Ruben, Laerdal), and a face-mask or endotracheal connector.

II.4.1.3 Oxygen

Oxygen is needed in addition to agents which cause cardio-respiratory depression such as halothane, and for very young, very old and critically ill patients.

Oxygen concentrators are a safe and affordable alternative to the use of gas cylinders (e.g. the Malawi model anaesthetic machine). Oxygen concentrators can be run by solar energy/rechargeable batteries or from the mains electricity. Oxygen concentrators work very economically and do not depend on susceptible supplies with gas cylinders. Thus oxygen can save the health budget more than 50% as compared to the supplies with gas cylinders.

II.4.1.4 Mechanical Ventilation

Mechanical ventilation is a life-sustaining technology that is costly and that requires highly trained staff and regular servicing. Not only purchase and initial installation of the ventilators are very expensive. The additional costs for monitoring equipment, e.g pulse oximeter, an automated oscillometer, CVP manometer, central venous catheter, a ventilator disconnection alarm, respirometer, capnograph, blood gas and acid-base status machine mean a continuous unnecessary drain on the hospital budget.

Referral hospitals in many developing countries give evidence that even at higher levels of the health system good anaesthesia for all clinical purposes can be provided without mechanical ventilators and nitrous oxide. At larger referral centres, mechanical ventilation may be feasible. In such cases ventilators (e.g. TC-50) in combination with the above equipment may be affordable and safe.

Ideally, all hospitals in one country should be equipped with the same type of anaesthetic apparatus/facilities. Standardized equipment reduces capital expenditure and lowers the costs of servicing, maintenance and spare parts. It also enables students at teaching hospitals to become familiar with the apparatus they will be using later.

II.4.1.5 Anaesthetic and Recovery Room

A recovery room or ward and an anaesthetic room with a responsible nurse would be ideal even at the routine level. Recovery rooms should be equipped with:

- beds
- 2 oxygen concentrators
- cupboards to store equipment and drugs
- 2 trolleys and worktops to allow preparation of syringes, needles, cannulae and drugs
- 2 blood pressure machines (tonometre).

II.4.2 Treatment

Anaesthesia at Level I:

Anaesthesia for the management of wounds, episiotomies, biopsy excisions, incision and drainage of abscesses. Suitable anaesthetic methods are: local infiltration, field block, surface anaesthesia (spray).

Essential monitoring required: pulse (palpation), blood pressure (sphygmomanometer).

Essential monitoring required: pulse (palpation), blood pressure (sphygmomanometer).

Most conditions requiring anaesthesia (Caesarean sections, evacuations, hernia inguinal, hydroceles, fractures, trauma, cataract, tumours) are referred to the next level.

Anaesthesia at Level II:

Anaesthesia for the management of Caesarean sections, dilatation and curettage, hernia repair, laparotomy (mainly for treatment of ruptured ectopic pregnancies, tubo-ovarian surgery) hydrocelectomy, amputations, reduction of closed fractures, cataract extraction, skin graft, circumcisions, foreign body removal. Suitable anaesthetic methods are: local infiltration, field block, surface anaesthesia (spray), general anaesthesia (with inhalational anaesthetic agents, intravenous anaesthetic agents or intramuscular agents), regional anaesthesia (epidural and subarachnoid anaesthesia), nerve blocks.

Continuous monitoring should include the following parameters:

pulse (palpation), ventilation/breathing (observation/perception of the patient's colour, respiratory rate, adequacy of chest movement and the movement of the reservoir bag, auscultation), blood pressure (sphygmomanometer), Hb (laboratory).

Anaesthesia at Level III:

In addition to the management of all operations performed at routine level, anaesthesia is required for orthopaedic surgery, ENT surgery, more advanced general and gynaecological surgery, and ophthalmic surgery. In many countries, anaesthetic departments at referral level also serve as training institutions for anaesthetic assistants and are also responsible for supervision of anaesthetic equipment and personnel at lower levels.

At the referral level, mechanical ventilation is necessary for very long surgical procedures in theatre, long-term ventilation in recovery rooms or even in intensive care wards.

Suitable anaesthetic methods at referral level: local infiltration, field block, surface anaesthesia (spray), general anaesthesia (with inhalational anaesthetic agents, intravenous anaesthetic agents or intramuscular agents), regional anaesthesia (epidural and subarachnoid anaesthesia), nerve blocks, mechanical ventilation.

II.4.3 Equipment

Anaesthesia equipment at Level I:

- selection of needles and syringes (2 ml, 5 ml, 10 ml),
- stethoscope
- sphygmomanometer
- sterilization apparatus (pressure cooker type)
- clock
- torch
- mini-swabs or cotton wool
- skin disinfection

Anaesthesia equipment at Level II:

(including special equipment for paediatric anaesthesia)

- self-inflating bags of the Ambu type
- intubation cushion
- anaesthetic facemasks (sizes infant to large adult, 2 of each size)
- oropharyngeal airways: Guedel airway (size 000-5), Philipps airway
- 4 nasopharyngeal airways
- endotracheal tubes (Oxford or Portex [Magill] size 2.5-10 mm (internal diameter) in 0.5 mm steps with cuffs only on sizes >6 mm) and connectors
- gum-elastic bougie (introducer)
- endotracheal tube connector (15 mm plastic)
- breathing hose and connectors (lengths of 1 metre antistatic tubing, 30 cm tubing for connection of vaporizers, T-piece for oxygen enrichment)
- breathing valves (Ambu E1, Ruben, Laerdal and Ambu E2 for resuscitation for adult and paediatric)
- nasogastric tube
- straight-blade laryngoscopes (e.g. Magill) (infant to adult sizes, one of each size)
- curved-blade laryngoscopes (four sizes) including infant blades
- universal battery charger and tester (also solar energy)
- adhesive tape
- tongue forceps
- mouth gag

- laryngeal spray
- lubricants
- scissors
- breathing tubes
- artery forceps (Kocher's and Spencer Wells')
- Mayo's tongue and towel forceps
- Magill's forceps
- T-piece breathing system for infants, oxygen delivery tube for T-piece
- reservoir and rebreathing tubes
- tourniquet hose
- Oxford inflating bellows
- self-inflating bag
- resuscitator
- oxygen concentrator (oxygen cylinder only as back-up and for emergencies)
- anaesthetic machine with complete breathing attachment and preferably a compensated vaporizer (draw-over apparatus: EMO, triservice apparatus, continuous flow/draw-over apparatus: Malawi model anaesthetic machine)
- anaesthetic vaporizers (draw-over type, e.g. EMO) for either halothane (e.g. OMV or Cyprane Pac Vaporizer) or trichloroethylene
- equipment for intravenous use: needles and cannulae, including paediatric sizes and an umbilical vein catheter, infusion sets, infusion sets for blood transfusion, butterfly needles
- flowmeters for both oxygen and air
- suction equipment (2 foot-operated suction pumps as well as electrically operated suction pumps)
- a brush for cleaning endotracheal tubes
- thermometer
- anaesthetic record sheets
- equipment cupboards
- drug cupboards, worktops
- trolleys, resuscitation trolley

Local anaesthesia:

- spinal needles (size 25G and 22G)
- Touhy needles (size 17G), sterilization containers for autoclaving, tourniquet, gallipot

Special equipment needs for dental anaesthesia:

- anaesthesia required for tooth extractions, fillings, drilling, dental surgery
- methods used: mainly local anaesthetic blocks, sedation techniques, rarely general anaesthesia
- essential equipment: selection of needles, syringes (size 5 and 10 ml), stethoscope, sphygmomanometer, manual resuscitator. If general anaesthesia is required, the procedure should be performed in the theatre.

Anaesthesia equipment at Level III:

Equipment needs for anaesthesia at referral level are very similar to the equipment needs at routine level. Looking at the audit of operations performed at referral level, ventilators for anaesthesia in the theatre are usually not required. However, ventilators often have to be employed for respiratory failure in paralysed or apnoeic patients, who need long-term ventilation in the intensive care ward.

Equipment needed:

- ventilator, e.g. TC 5O, Penlon Nuffield anaesthetic ventilator
- pulse oxymeter
- central venous pressure set (not electrical)
- central venous catheter (optional)

II.5 OBSTETRICS

(also refer to II.3 Surgery)

II.5.1 Overview

Reducing maternal morbidity and mortality is essentially linked to routinely performed antenatal health care for mother and child. The introduction of a basic, routine screening programme

starting in early pregnancy with regularl follow-up visits is the key to success in improving maternal and fetal health.

The introduction of a documentation system such as a patient card for every pregnant woman has considerably improved the survey of pregnancy and focussed the attention on possible risk factors or previous complications.

The basic but essential work of recognizing potential risk factors for mother and child must be complemented by a well-functioning referral system. The referral system starts at the level of traditional birth attendants and extends up to the national referral hospital in a set-up where each level fullfils clearly defined functions in a well-planned system of maternal and neonatal care.

One important task of maternal care is to filter patients and make sure that all mothers at risk have access to higher levels of the health system in time. Antenatal care and observation during uncomplicated labour do not require highly sophisticated equipment.

In developing countries with their high birth rates and limited resources, ultrasound and cardiotocography are usually not used for routine screening but, if they are available, they should be applied to the examination of special high risk cases which have been identified by other means before.

In most developing countries, about 50% of all operations at levels II and III of health care (district and provincial hospitals) are obstetrical and gynaecological ones. The requirements of these obstetrical operations therefore determine the design and equipment of the operating theatre.

Essential laboratory needs for maternal care are urine examination, Hb and blood grouping and cross-matching. All hospitals with large maternity units should keep a blood bank. In countries with a high prevalence of venereal diseases, serological tests for syphilis should be performed routinely, and HIV tests are today compulsory for all blood banks in the world.

II.5.2 Treatment

Maternal care and obstetrics at Level I:

This comprises health education, cooperation with communities and community health workers (TBAs), screening of antenatal and postnatal cases, referral of risk cases in time, management of normal labour, care of the newborn, as well as prevention, catheter treatment and referral of vesico-vaginal fistulas (VVFs), and, where experienced staff is present, vacuum extraction in the third stage.

Maternal care and obstetrics at Level II:

This comprises planning, coordination and supervision of health education and preventive and curative services, and, in addition to the basic level, antenatal and postnatal care of mothers at risk, management of complicated labour, obstetrical operations (Caesarean sections, hysterectomies, forceps deliveries, etc.)

Complicated cases must be referred according to national policy (e.g. 2 and more previous operations, decompensated diabetes, etc.). Prevention, catheter treatment and referral of VVFs.

Maternal care and obstetrics at Level III:

Planning, coordination and supervision of health education and preventive and curative services are the main tasks at this level as well as the development of guidelines for management of antenatal and postnatal care and management of labour.

Multidisciplinary management of very sick mothers, management of elective obstetrical operations, referred emergency operations (difficult cases of ruptured uteri), rehabilitation of mothers after professional malpractice or negligence, management of vesico-vaginal fistulas and care of the premature and small for date neonate are further important tasks.

Optional activities comprise: amnioscopy, amniocentesis and simple tests on amniotic fluid such as the shake test as a simplified method of assessing the lecithin:sphingomyelin ratio; staining of fetal cells with Nile blue sulphate.

II.5.3 Obstetrics Equipment

II.5.3.1 General Equipment

Proceedings in obstetrics vary considerably between industrialized and developing countries and between anglophone and francophone countries. Arguments about the advantages and disadvantages of certain delivery forceps, about the use of destructive operations and about the use of symphysiotomies will continue forever.

The authors believe that cranioclasts are dangerous and should not be used any more. Traction forceps like Tarnier's axis traction forceps have been rendered obsolete.

Forceps deliveries should only be done by an experienced person and with the kind of forceps she is most familiar with. The vacuum extractor has many advantages over the forceps but needs experienced personnel. Episiotomy and Symphysiotomy have an important place in obstetrical practice in all developing countries where craniopelvic disproportion (CPD) is com-

mon. The best methods for recognition of CPD in developing countries are: past obstetric history, measurement of mother's height, measurement of the diagonal conjugate, the use of the labour graph and - if available - ultrasound.

Cleanliness and sterility are a prerequisite at all places where operative deliveries or intrauterine procedures are performed.

Failure of electric power can be fatal at locations where all equipment depends on electricity. Additional light sources (e.g. battery-operated), hand-operated vacuum extractors and foot-operated suction pumps are essential equipment.

For busy maternity units, separate sterilizers are recommended. There is no place for baby incubators where supplies of oxygen are only sporadic.

Drop counters or infusion pumps are regarded as essential equipment in obstetrics in developed countries. However, break-downs and unqualified operation by paramedical staff are common. Since they are mainly used for precise administration of tocolytic or utero-tonic preparations, the malfunction of drop counters and infusion pumps can be very hazardous. In most developing countries estimation of drip rate with a watch, observation of patient and infusion by a qualified nurse/midwife consistute the better choice.

Essential equipment for obstetrics at Level I:

- sufficient supplies with antenatal charts and partograms
- good light source (eg. small spot lamp, adjustable)
- adult scales
- baby scales
- blood pressure machine(s)
- fetoscope (wood)
- simple delivery beds according to expected number of deliveries per day (preference given to delivery beds which are able to be tipped into head-down position)
- 1 foot suction pump
- gag and airway
- self-retaining catheters
- metal catheters
- neonatal mouth sucker
- sufficient number of instrument sets plus linen according to expected number of deliveries per day. The composition of the instrument sets may vary from country to country and should be in accordance with national preferences and surgical tradition
- sterilizer (cooker type will do for most centres)

- laboratory facilities for testing Hb and urine for protein and glycosuria (simple methods will do, e.g. Sahli method for Hb, Nylander's reagent for protein)
- gloves

Optional (depending on national policy):

- vacuum extractor (with hand pump) with adequate spare parts (particularly chains, seals, rubber tubing) to be kept in labour ward.

Essential equipment for obstetrical care at Level II:

As for basic level plus:

- sufficient number of instrument sets in labour ward, ideally twice as many sets as expected number of cases per day.

The instrument sets must include:

- vaginal specula of various widths and retractors
- obstetrical forceps
- scissors, perforator, cranioclast, dilators (Hegar)
- straight clamps
- knives and knife blades of different sizes
- needles and suture material
- curettes of different sizes
- self-retaining catheters
- metal catheters
- obstetric forceps (only if obstetrician or experienced medical officer stationed in maternity)
- fetal stethoscope, monaural
- Hb meter
- an autoclave or a simple pressure cooker
- delivery beds with retractable foot parts
- device for back plate and pelvis elevation (manually)
- device for instantaneous adjustment of Trendelenburg position (manually), adjustment to gynaecologic position provided by knee crutches (e.g. Goepel knee crutches)
- good light source in labour ward to perform obstetrical operations, preferably:
  - operation light, ceiling or wall-mounted, swing type
  - one operation light, stand type with battery, mobile

- simple anaesthetic machine in labour ward: in many developing countries, the EMO vaporizer and the OMV (Oxford miniature vaporizer), both equipped and calibrated for halothane or trichloroethylene and combined with a means of manual resuscitation (Ambu bag), are the best choice.
- infant warming beds
- vacuum extractor (with hand pump) with adequate spare parts (particularly chains, seals, rubber tubing) to be kept in labour ward
- ultrasound with linear array transducer (3.5 MHz)

Essential support services:

- operating theatre, basic laboratory with blood bank, laundry, sterilization (radiology is desirable but not absolutely necessary)

Optional:

- 1 hand ultrasound fetal heart detector
- baby incubator (only where maintenance and supply of oxygen can be guaranteed)

Essential equipment for obstetrical care at Level III:

As for routine level plus:

- bilirubinometer in the maternity unit
- 1 stopwatch for infusion drop counting
- ultrasound with linear array transducer (3.5 - 5.0 MHz) and the following transducer options: annular array or curved linear array, transvaginal array. It is generally advisable to have both a linear and an annular array - the linear array is necessary to measure fetal dimensions and proportions. The annular array is useful in the detection of gynaecological problems and for diagnostics in internal medicine. However, if resources are so limited that only one transducer can be purchased, a linear array is advisable.
- essential support services as above plus expanded laboratory services for more serological examinations, fibrinogen and clotting factors, electrolytes, blood pH in umbilical artery (see under laboratory services)
- ECG
- 1 ultrasound fetal heart detector

Optional:

- conical specula for amnioscopy
- hormone laboratory for oestriol and hPL
- infant incubator(s)

II.5.3.2 Instruments necessary for Obstetric Procedures

Common procedures in obstetrics are:

- episiotomy
- dilatation and curettage
- Caesarean section

1. Episiotomy:

2 episiotomy scissors
8 artery forceps, small
2 dissecting forceps, toothed
2 dissecting forceps, non-toothed
1 needle holder
4 sponge forceps
1 syringe incl. needle
sutures and ligatures catgut or chromic catgut
1 urinary catheter

2. Dilatation and curettage (D & C)

1 vaginal speculum
2 Vulsellum forceps
1 uterine sound
1 uterine dilators set
1 uterine curette, sharp
1 uterine curette, blunt
4 sponge forceps

3. Caesarean section:

Laparotomy set plus the following instruments:

8 uterine haemostatic forceps (Green Armitage)

1 obstetric forceps, small

1 vaginal speculum

1 urinary catheter

II.6 GYNAECOLOGY

II.6.1 Overview

In developing countries, gynaecology is mainly a surgical speciality. Operations include ectopic gestations, evacuations and dilatation and curettage, tubal ligations, operations of vesico-vaginal or recto-vaginal fistulas, operations on pelvic abscesses, hysterectomies and operations for cancer, especially for cancer of the cervix. Most of these operations can be done with the normal equipment/instruments of general surgery.

In conservative gynaecology there is usually a big demand for the following services:

- diagnosis and treatment of sexually transmitted diseases (STDs), including pelvic inflammatory disease (PID)
- family planning
- examinations for infertility
- diagnosis and treatment of infectious diseases affecting the female genital tract.

Examinations for infertility and treatment are common gynaecological procedures in many industrialized countries. These procedures are very time-consuming and often very expensive.

In many developing countries female infertility is caused by pelvic infections which have not been diagnosed and treated in time.

II.6.2 Treatment

Gynaecological care at Level I:

(as part of MCH-programmes)

Gynaecological care at basic level comprises family planning counselling, early diagnosis and treatment of sexually transmitted diseases (STDs) and pelvic inflammatory disease (PID), health education on STD and AIDS prevention, as well as early diagnosis and referral of any possible gynaecological cancer, such as breast cancer, suspicious lower abdominal masses and referral of vesico-vaginal (VVF) or recto-vaginal fistulas (RVF).

Gynaecology at Level II:

At routine level, gynaecology comprises supervision of family planning services, clinical supervision on management of STDs and PID at the basic level, planning and supervision of health education, screening of infertility patients, setting up a tentative diagnosis, and deciding on prospects of further treatment.

Further diagnostic procedures and treatment or referral of:

- family planning clients who need special attention
- gynaecological oncology (cervical cancer, breast cancer and other suspicious lower abdominal masses)
- vesico-vaginal (VVF) or recto-vaginal fistulas (RVF)

Surgical treatment at this level should include:

- dilatation and curettage (D & C)
- surgery of ectopic pregnancies
- drainage of intra-abdominal abscesses
- uncomplicated operations of lower abdominal masses not involving other structures of the pelvis (e.g. fibroids, ovarian cysts).

Gynaecology at Level III:

At referral level, the main tasks consist of overall planning and management of family planning services, planning and management of control programmes (e.g. STDs and AIDS) or preventive services (VVF prevention, cervical screening), publishing guidelines on management of STDs and PID at all levels of health care, treatment of infertility patients, as well as further diagnosis and

treatment of gynaecological oncology cases, such as cancer of the cervix, breast cancer and others which could not be treated at lower levels of health care, treatment of complicated vesico-vaginal or recto-vaginal fistulas.

II.6.3 Equipment

II.6.3.1 General Equipment

Equipment for conservative gynaecology must provide satisfactory conditions for bimanual pelvic examination and speculum examination (examination chair and good light source).

Cervical smears should be taken at all levels of health care. Colposcopy and further treatment of cervical diseases require an experienced gynaecologist and should therefore be reserved for the higher levels of health care.

Nearly all operations in this speciality (ectopic gestations, operations for vesico-vaginal and recto-vaginal fistulas, operations on pelvic abscesses, hysterectomies and operations at the adnexae) can be done with general surgical equipment and instruments.

The equipment and instruments for mini-laparotomies are easy to handle, and the costs are lower compared to the equipment needed for endoscopic procedures such as laparoscopy. The surgical technique of laparotomy is usually familiar to all staff working in developing countries. However laparoscopy usually can be performed as day surgery, and no admission of patients may be necessary (tubal ligation).

Gynaecological equipment at Level I:

- couch or chair for bimanual pelvic examination and speculum examination
- good light source
- specula, forceps

Gynaecological equipment at Level II:

Consultation room(s) for gynaecological examination should be equipped with the following:

- gynaecological examination chair with proper leg holders (foot plates, stirrups for knee crutches) and pelvis elevation

- good light source
- microscope
- instrument sterilizer (pressure cooker)

Theatre:

- operating table with knee crutches for abdominal-vaginal procedures
- general surgical set
- set for mini-laparotomy

Optional:

- ultrasound at least linear scan (3.5 MHz)

Gynaecological equipment at Level III:

- consultation room(s) with gynaecological examination chair as above, light source
- microscope
- instrument sterilizer (pressure cooker)
- colposcope
- ultrasound linear (3.5 MHz) and sector scan (3.5 - 5 MHz)

Optional:

- ultrasound vaginal sector scan
- equipment for laparoscopy (see surgical equipment)

II.6.3.2 Gynaecological Theatre Equipment

For gynaecological surgical procedures a general surgical set is usually sufficient. (See section "general surgery"equipment).

Additional instruments for gynaecological examinations and specialized gynaecological-surgical procedures at district hospital level (II or III):

1 vaginal speculum (Sims), small

1 vaginal speculum (Sims), large

1 vaginal speculum (weighted)
2 forceps (Vulsellum), 28 cm
2 episiotomy scissors
1 uterine sound, 30 cm
6 (set) of uterine dilators (Hegar)
(set) uterine curettes
6 hysterectomy forceps (straight), 22.5 cm
8 haemostatic forceps (Green Armitage), 20 cm
1 retractor (Doyen)
2 vaginal wall retractors
1 punch biopsy forceps
1 set of suction cannulae
2 amniohooks
1 vacuum extractor
1 cranial perforator
1 craniotomy forceps
1 obstetric forceps, low, curved
1 obstetric forceps, high, straight (Kjelland)
1 colposcope
1 microscope

Special procedures:

Dilatation of the cervix and uterine curettage (D & C):

1 vaginal speculum, weighted
1 Vulsellum forceps
1 Sims vaginal speculum
1 uterine sound
1 set of dilators (Hegar)
1 uterine curette, sharp
1 uterine curette, blunt
1 urinary catheter

Abdominal hysterectomy, surgery of the adnexae, ectopic pregnancies:

Laparotomy instruments and:

diathermy

self-retaining abdominal retractor

additional hysterectomy clamps (4)

Vulsella forceps (2)

myomectomy screw

urinary catheter

II.7 OPHTHALMOLOGY

II.7.1 Overview

Prevention and treatment of eye diseases play an important role at health institutions in most parts of the third world.

Many countries have trained cadres of paramedical staff for tasks which, in industrialized countries, are performed by general practitioners or even ophthalmologists.

The following staff is necessary for comprehensive eye care within the referral system:

- opticians with basic knowledge (grinding and fitting lenses into frames)
- ophthalmic opticians with broader knowledge and better skills
- ophthalmic clinical officers or medical assistants and general medical officers with basic knowledge of eye care
- ophthalmologists

Because of the delicate instruments and equipment used in ophthalmology, the training of ophthalmic staff must include handling and maintenance of equipment.

Eye care in developing countries requires a functioning referral system. In many countries a system of travelling ophthalmic clinical officers and/or ophthalmologists has been successfully established.

Certain national support services appear to be important for eye programmes. These services include:

- production of eye drops
- production of spectacles

II.7.2 Treatment

Eye care at Level I:

Health education and execution of preventive services (e.g. Vit A programmes), assistance in control programmes (e.g. onchocerciasis).

Diseases managed at this level: conjunctivitis, easily removable foreign bodies, chalazion (conservative treatment), trachoma.

Diseases diagnosed and referred: cataract, glaucoma, tumours, posterior segment disease, diseases affecting the cornea, trauma, diminished visual acuity.

Ophthalmology at Level II:

Planning, coordination and supervision of health education, preventive services (e.g. Vit A programmes), control programmes (e.g. onchocerciasis).

Diseases managed: extraocular eye diseases, enucleations, lid surgery (entropion, tarsorrhaphy).

Diseases diagnosed and referred: all intraocular diseases, cataract, glaucoma.

Exceptions: In some developing countries, clinical officers and general medical officers have been trained to perform cataract surgery. These operations would then be performed at routine level.

Ophthalmology at Level III:

Overall planning and management of health education, planning of preventive services (e.g. Vit A programmes), control programmes (e.g. onchocerciasis). Medical training for medical/ health personnel working at level I.

Diseases managed: intra- and extraocular eye diseases including trauma.

II.7.3 Equipment

II.7.3.1 General Equipment

Sophisticated equipment and instruments for ophthalmology should only be procured if maintenance, repair and adequate training of users can be guaranteed.

The library should contain adequate manuals on eye care and eye surgery at each level.

Equipment at Level I:

- light source
- lid retractor
- cotton-tipped sticks
- visual acuity board (reading charts)
- near-vision testing card

Equipment at Level II:

Same equipment as at basic level **plus:**

- minor eye surgical set (if cataract surgery is performed at this level: basic cataract surgeon's kit)
- direct ophthalmoscope
- light source
- magnification lens (2.3x) or operating loupe with head band
- eye tonometer
- basic refraction set of spherical lenses
- organized use of major operating theatre
- separate small sterilizer (autoclave) for eye instruments
- Ishihara colour vision charts

Optional:

- slit lamp

Equipment at Level III:

Same equipment as at basic and routine levels **plus:**

- indirect ophthalmoscope
- slit lamp
- full intraocular surgical kit
- operating loupe
- perimeter
- lens meter
- full refraction set
- retinoscope
- refractometer

Optional:

- operating microscope with coaxial light, special operating stool, photocoagulation system (light)

II.7.3.2 Equipment for Essential Support Services for Ophthalmology

Spectacle production:

- electric edger
- frame heater (hot air blower)
- lens meter
- set of tools (pliers, rulers, screwdrivers)
- start set of lenses and frames

Production of eye drops:

- precision balance
- pipette press or dropper tops and sealing machine
- set of basic chemicals (preservatives, buffers, drugs, stains)
- autoclave
- water still

SECTION III

SUPPORT SERVICES

III.1 LABORATORY

III.2 RADIOLOGY

III.3 STERILIZATION

III.4 PHYSIOTHERAPY

III.5 LIBRARY

III.6 HOSPITAL WORKSHOP

III.1 LABORATORY

III.1.1 Overview

In many developing countries the availability of good laboratory services still present the bottleneck in clinical diagnosis. Trained personnel is scarce, supplies with reagents limited, equipment often out of order.

Clinicians therefore weigh up carefully which examinations are essential and restrict themselves to a limited number of reliable tests. Decisions on necessary laboratory examinations depend not only on diagnostic needs but also on the workload and availability and skills of laboratory technicians, and the laboratory equipment in working order at their disposal. To request the whole spectrum of laboratory examinations as a routine or to ask for three- and fourfold confirmation of a known diagnosis - a wasteful and often unnecessary practice in western medicine - is irresponsible in developing countries and may overtax all of the laboratory services.

Each test requested should be justified, and it might be necessary to choose one parameter out of many as an indicator for certain ailments (e.g. only to examine blood urea as an indicator for urinary retention and to leave out creatinine, uric acid, etc.)

When deciding which tests are appropriate for a particular level of health care the following questions should be considered:

- Which level of skill is required for the test?
- How much of the precious time of the laboratory technician does the test consume?
- How sophisticated is the equipment the test asks for?
- How many supplies does the equipment need?
- Who will maintain the equipment?
- How reliable and accurate are the test results?
- Are constant and regular electricity supplies guaranteed? If not, how can laboratory services be maintained during power failure (stand-by batteries, generator, simpler methods)?

The following points are generally valid:

- Static methods are more reliable than dynamic methods (substrate tests vs. enzyme tests).
- White-cell counts, red-cell counts and especially platelet counts are very time-consuming and often unreliable.
- Flame photometers require constant supplies of gas; adjustment and maintenance require experienced personnel.
- Sticks methods and ready-for-use test-kits are often more expensive than ordinary laboratory tests, regular supplies must be guaranteed, and expiry dates must be observed.
- Digital display at colorimeters facilitates direct reading of results which is much more reliable and superior to any methods requiring manual calculation of values.

- Wherever regular and frequent microscopic examinations have to be done binocular microscopes with electric illumination are essential. Monocular microscoping with sunlight soon leads to fatigue and cannot yield reliable results; oil immersion microscopy requires binocular microscopes with electric illumination.
- For practical work reliability of results is more important than accuracy.

Each laboratory must have manuals and posters in a language understood by the users.

A set-up of trained laboratory technicians acting as responsible staff and less qualified microscopists/laboratory assistants for the routine work has proved successful in many developing countries.

III.1.2 Services

Laboratory services at Level I:

Simple laboratory tests to serve curative and preventive care at this level and to assist in decision making as to which patients/clients should be referred to higher levels of health care.

The following examinations are required:

- Hb
- ESR[1] (erythrocyte sedimentation rate)
- urine: protein, glucose, sediment
- stool, ova, entamoeba cysts, giardia
- smear on gonorrhea (methylene blue stain/Gram stain)

In addition to these examinations the following tests might be necessary according to regional characteristics:

- Sickling test
- microscopy for malaria parasites, trypanosomes, filaria, acid-fast bacilli
- qualitative urine tests on DDS and Rifampicin
- basic chlamydia tests

When more specific tests are needed for proper diagnosis patients and not specimens are referred to the higher level

[1] *Some experienced doctors doubt the diagnostic value of ESR in the tropics.*

Laboratory services at Level II:

Supervision and in-service training of laboratory staff in the health district concerned. Training has to include care of equipment, especially the care of microscopes. Control of laboratory equipment, procurement of supplies.

Provision of routine laboratory tests to serve curative and preventive care at this level and to assist in making the decision as to which patients/clients are to be referred to higher levels of health care.

In addition to the examinations performed at the basic level the following tests are required:

- full blood count (WBC, diff. WBC, RBC, PCV)
- full urine report (bile salt, glucose, protein, specific gravity, pH, sediment)
- examination of CSF (microscopy, glucose, protein)

Blood chemistry:

- bilirubin
- SGOT
- SGPT
- alkaline phosphatase
- urea
- glucose
- total plasma protein
- serum electrolytes (Na^+ ,K^+, ...)
- bleeding time
- clotting time

Serological examinations:

- blood grouping and cross-matching
- HIV (ELISA test)
- VDRL
- microscopic examination of smears, sputum, rectal biopsy, etc.
- preparation of specimens for dispatch to reference laboratories where feasible (problems: transport, time, temperature)

The following are usually not required:

- blood enzyme tests
- plasma lipids

- serum osmolality
- clotting factors
- culture and sensitivity
- histology

Optional tests:

- Hepatitis B - serology

Laboratory services at Level III:

Supervision and in-service training of laboratory staff working at lower levels. The training must include care of equipment, especially the care of microscopes.

Control of laboratory equipment, management of maintenance and repair of equipment, procurement of supplies including consumables, production and distribution of reagents.

Provision of a comprehensive spectrum of reliable basic, routine and specialized laboratory tests to serve curative and preventive care at this level.

Laboratories at this level often serve as reference laboratories. Organizational structures to receive specimens and to send the results to referring health institutions have to be operational.

Haematology:

- ESR
- Hb (colorimetric)
- PCV
- red cell count
- leucocyte count
- reticulocyte count
- thrombocyte count
- differential count
- sickle cell test
- bleeding time
- clotting time
- specimen preparation and dispactching of bone marrow aspirates

Colorimetric Tests:

- haemoglobin
- glucose
- urea
- creatinine
- total protein
- bilirubin
- alkaline phosphatase
- SGOT/SGPT

Enzyme tests:

- CPK
- amylase
- lipase
- SGOT/SGPT
- LDH
- γ-GT
- alkaline phosphatase and other enzyme tests according to specific diagnostic needs

Plasma lipids:

- cholesterol
- triglycerides

Serology:

- Gruber-Widal H+O
- VDRL
- blood grouping
- rhesus determination
- cross-match
- rheuma serology
- hepatitis serology (A, B, C)
- Weil-Felix (Ox 19 / Rickettsia)
- specimen taking and dispatching for other serologic tests

Urine:

- deposits
- nitrate (test strip)
- pH (test strip)
- protein
- glucose
- ketones
- urobilinogen
- bilirubin
- pregnancy test

Stool:

- occult blood
- worm eggs
- protozoas

Cerebrospinal fluid:

- Pandy test
- total protein
- cell count
- deposit staining acc. Gram/Ziehl-Neelsen
- culture

Swabs:

- Gram stain
- Ziehl-Neelsen stain
- methylene blue stain

Blood parasitology:

- malaria parasites
- borreliosis
- trypanosomes

Examination for:

- schistosomiasis
- amoebiasis
- filariasis
- toxoplasmosis
- trypanosomiasis
- brucellosis
- microfilariae

Sputum:

- Ziehl-Neelsen stain

Skin snip:

- Ziehl-Neelsen stain
- microfilariae

Optional tests:

- HIV confirmatory test (ELISA)
- serological tests for endemic viral diseases (e.g. Dengue)
- radio-immuno assay or enzymatic tests for TSH, T3, T4, sex hormones (enzymatic tests appear more appropriate because no radioactive substances are needed)
- resistance tests for malaria parasites

III.1.3 Equipment

Laboratory tests must yield reliable and reproducible results.

Precise results require more sophisticated equipment. Exaggerated precision does not necessarily lead to better diagnosis and treatment (e.g. the accuracy of Hb levels of ± 1 g% is more than sufficient in most cases).

Well-functioning laboratory services demand at least:

- well-trained and supervised staff (training and supervision must include care of equipment)
- constant supply of laboratory reagents
- constant supply of electricity with voltage fluctuations not exceeding +/- 10%

- constant supply of water
- regular maintenance and repair of equipment.

In countries where a regular supply of laboratory reagents cannot be maintained any discussion on laboratory equipment will remain purely academic.

Break-down of electricity supplies is not only a problem at the lower levels of health care but also in many capitals of developing countries where referral hospitals and central laboratories are located. The voltage sometimes fluctuates between 150 and 250 V. Ways must be found to keep laboratories working despite these problems. One way could be to connect the laboratories to an emergency power supply (which often fails as well) or to use the buffer capacity of batteries. Microscopes and colorimeters can be connected to a 12 V DC source; batteries can be charged by the mains or by solar panels. All laboratories in developing countries must have equipment on stand-by which does not depend on electricity, e.g. a manually operated centrifuge, foot suction pumps, a mechanical precision balance, a kerosene or - better still - gas refrigerator. Vulnerable equipment must be connected to voltage stabilizers.

In countries where the water supply is a problem, laboratories must have their own elevated water tank.

Potential errors and fatigue of laboratory staff must be minimized. Colorimeters which give a direct reading are therefore preferable to those colorimeters which require calculations. For laboratory staff working on microscopes for long hours, binocular microscopes with electric illumination are essential.

The list of essential equipment mentioned below does not give required numbers; the numbers of, e.g. microscopes, needed depend only on the number of specimens examined per time unit and number of staff available and not on the level of health care.

Some laboratory equipment (like scintillation counters and autoanalysers) has only a limited life expectancy even under the best maintenance conditions. Procurement of such equipment should only be considered if replacement at the end of its lifetime can be guaranteed.

Laboratory equipment at Level I:

- binocular microscope with electric illumination (where there is no electricity, solar or battery-powered), 10x wide field oculars, objectives 10x, 40x, 100x (alternatively: objectives 5x, 12.5x, 50x, 125x)
- plastic cover for microscope
- ESR stand
- centrifuge, hand-driven, table model, swing-out head (6x15 ml)
- stopwatch
- haemoglobinometer set (Sahli type)

Laboratory equipment at Level II:

As above plus:

- centrifuge, electrical
- centrifuge, hand-driven, table model, swing-out head
- decentralized additional haemoglobinometer sets (maternity, MCH clinics, paediatric wards)
- colorimeter
- sterilizer, hot air (for destruction of infection samples a separate autoclave may be required)
- haematocrit
- bilirubinometer
- pH meter
- mechanical balance
- small water still
- water filter
- staining equipment
- counting chamber
- hand tally counter
- bunsen burner / spirit lamp
- interval timer
- watch

Sundries:

- dispensing and pipetting devices (4 to 20 ml)
- racks and trays
- syringes
- needles
- blood lancets
- forceps
- markers
- thermometers
- glass and plastic ware
- containers for dispatching specimens
- blood bank with refrigerator
- all blood grouping sera

Laboratory equipment at Level III:

As above plus:

- flame photometer
- electronic balance
- incubator for culture and sensitivity
- spectrophotometer
- water still / deionizer capable of producing 10-12 l distilled or deionized water per day

Histology and cytology section equipped with rotary microtome, microscopes, staining equipment.

Optional:

- microscopes with
  - phase condenser
  - dark field observation
  - UV fluorescence.

  Those microscopes should best be used in specialists' offices, e.g. gynaecology clinics, STD clinics and dermatological clinics.

III.2 RADIOLOGY

III.2.1 Overview

Level I:

No radiological examinations. Patients requiring X-ray examination are referred to higher levels.

Level II:

Radiological examination of skeleton, chest, abdomen should be possible.

Level III:

The whole range of classical radiological examinations should be offered:

- **fluoroscopy** of the stomach, intestines, thorax
- **intravenous pyelograms** where country specific health needs - e.g. high prevalence of nephrolithiasis - and possible medical intervention at this level - e.g. operations on the urinary tract - make this necessary
- **radiological examination of the gall bladder** where countryspecific health needs - e.g. high prevalence of cholelithiasis - make this feasible

At present the investment and running costs of computer tomography (CT), Digital Subtraction Angiography (DSA) and Nuclear Magnetic Resonance Imaging (NMR) cannot be met by the health budgets of most developing countries without seriously cutting back on more basic health services.

Furthermore, in most developing countries the logistical support for successful operation of this highly sophisticated equipment is not to be found either in government services or in the private sector.

National or other acceptable regulations on radiological protection (safety of equipment, X-ray measuring devices, etc.) and on routine inspection of radiological equipment (for radiation leakage, scatter radiation, shock-proof properties) must be observed.

The following types of X-ray units exist:

- fixed units / mobile units
- single phase / three phase / multipulse / multiphase units
- mains supply / battery-generated / capacitor discharge

Attention: Before selecting / purchasing an X-ray unit, the technical features of the power supply of the radiology department must be assessed. Relevant data are: mains voltage and fluctuations, power, capacity of power supply (kW), or maximal current (A). Impedance must be below 0.32 Ohms.

Examples for specification of X-ray systems:

1. Simple radiographic system (e.g. from India)

X-ray generator (Pleodor 60): stationary anode tube, single phase, mains supplied, fixed unit

Output: 5 kW

max. 100 kV at 25 mA

max. 60 mA at 40 - 70 kV

exposure time: 0.1 sec to 6 sec

Mains connection: AC, single phase, 240 V (200-270 V), 15 A fused, at 50 Hz, or three-phase current, 380 V

Fluoroscopy possible, but not advisable.

2. Basic radiographic system

Multipulse generator, rotating anode tube, fixed system

Generator output:

not less than 11 kW

54 kV - 125 kV

max. 150 mA

exposure time: 0.003 sec shortest exposure time

Mains connection: AC, single phase, 220 V (automatic mains compensation), 10 A fused, battery-charged (capacity 11 Ah, 6 h charging time), alternative connection to solar panels (solar technology because of high energy requirements is still very expensive to buy and to run and therefore generally not recommended)

No fluoroscopy.

3. Medium power three phase unit

Three phase, 6 pulse generator. Fixed system (ceiling-mounted).

Output:

50 - 70 kW

125 kV - 200 kV

150 mA - 800 mA

exposure time: 0.003 sec shortest exposure time

Mains connection: AC, three phase, 380 V (automatic mains compensation), >10 A fused (operation with batteries, solar panels or capacitors not possible)

Darkroom requirements:

Manual processing of films in common darkrooms is advisable.

Automatic processing machines are liable to frequent break-downs and should only be used where regular service and maintenance can be guaranteed. Automatic processors also need air conditioning and special provision for water supply and drainage.

III.2.2 Equipment

X-ray facilities **at level I** are usually **not** required.

Radiographic equipment at Level II:

Simple radiographic system (see above) and/or

Basic radiographic system (see above)

Manual film processor

Radiographic equipment at Level III:

As for the routine level and/or

- a good "medium power three phase unit" with:

  fluorographic/radiographic table

  image-intensifier set

  manual film processor.

Optional:

- multisection casette with screens (capacity 3-7 films)
- dental X-ray unit
- processing machine (if necessary and sustainibly feasible)

III.2.3 Diagnostic Imaging - a Comparison

The following table gives a comparison between X-ray and ultrasound equipment with reference to the requirements of typical health institutions in developing countries:

Area	X-ray	Ultrasound
capital investment	high	high
running costs	high	low
expenditure for maintenance/repair	high	low
installation expenditure	high	low
space	large	small
energy requirements	large	small
record keeping	easy	easy
darkroom	necessary	no
chemicals	necessary	
size of record store	large	small
interpretation of stored image	easy	difficult in absence of examination records
risks for patients	considerable	absent

Usefulness in diagnostic areas:

Area	X-ray	Ultrasound
chest	very useful	very limited
skeleton	very useful	very limited
joints	very useful	limited
abdomen	useful	useful
liver	very limited	very useful
kidney	useful	useful
pregnancy	very limited	very useful
intestinal obstruction	very useful	less useful
internal haemorrhage	limited	useful
bowel perforation	useful	useful
foreign bodies	useful	limited

Sonography cannot yet replace radiography but is gaining increasing importance both in internal medicine and in obstetrics and gynaecology.

Three months of supervision in a busy ultrasound department will allow an experienced doctor, medical assistant or paramedic to recognize most of the important obstetric and gynaecological problems as well as any large tumour, cyst or abscess in the liver, spleen or kidney; gall bladder. The inexperienced can more easily recognize human anatomy and pathology in the linear array than in the curved array. Transvaginal screening is very valuable for early pregnancies and changes at uterus and adnexae, but is more difficult to interpret than abdominal ultrasound images.

Because of the many fields ultrasound can be used in, a small hospital in a developing country should first be equipped with a sonographic unit and not with an X-ray unit.

III.3 STERILIZATION

III.3.1 Overview

Sterilization stands for the destruction of all infective organisms: vegetative microorganisms, spores and viruses.

Disinfection refers to the destruction of vegetative organisms, but not necessarily spores.

Methods of sterilization

1. Hot air ovens

Ovens are electrically heated and usually an internal fan provides even distribution of the heat. Sterilizing time takes about 2 hours at 170°C. This method is best suitable for glassware, ophthalmic instruments, and metal containers which are not soft-soldered. It is not suitable for eg. tissues, plastics and rubber.

2. Steam autoclaves

Moist heat acts by producing a coagulation of the enzymes and protein within the bacterial cell. Using hot steam at high pressure, sterilization takes 15 minutes at 130°C or 25 minutes at 120°C.

3. Chemical sterilization

There are a number of chemicals with antibacterial properties. The instruments must be in contact with the solution or gas for an adequate period of time.

4. Sterilization by radiation

The total destruction of bacteria including spores can be achieved by exposing the articles to the action of γ-rays. The radiation interferes with the mitotic activity of the microorganisms.This process is not suitable for use in hospitals but is employed commercially.

5. Disinfection and antiseptics:

Disinfectants have serious limitations and they are ineffective if pus or blood is present. However they are necessary in daily routine work, especially in articles where heat may not be applicable (drains, rubber, suture materials). Some chemical disinfectants are chlorhexidine, glutaraldehyde, cresol and sodium hydrochloride (Eau de Javelle).

Attention! Proper sterilization of instruments and other equipment is crucial in preventing HIV transmission.

III.3.2 Equipment

Autoclaves

The pressure and temperature in an autoclave (pressure cooker) must be held constant for a certain length of time to achieve its effect. Standard time is 25 min. at 120°C.

At the district hospital level sterilization should largely be based on autoclaving. For efficient use an autoclave requires a trained operator and good maintenance. One common problem in developing countries is the unreliable electrical supply. A (second) simple autoclave heated by kerosene or gas may therefore be suitable in many cases. The selection of the right autoclave requires many considerations such as expected workload, servicing needs, maintenance costs, size, energy (electricity or gas-operated).

Desirable features for an autoclave are a horizontal or vertical cylindrical drum and a short cycle. The chamber capacity should not be larger than required. Sterilizers with excessive capacities are more expensive to operate and need longer cycles. The requirement is calculated as follows:

necessary capacity [ltrs] = average daily workload [ltrs] / daily number of cycles x 1.5

Single-Walled Autoclaves

These are metal containers with some water on the bottom part to boil. They act just like pressure cookers used for cooking.

Disadvantages: often no thermometer, articles still moist after sterilization.

Double-Walled Autoclaves

The steam kept in the jacket round the chamber enters the chambers through a pipe when needed and pushes the air out. Therefore operating cycles are short and energy consumption is relatively low. Also, the sterilized articles are less moist after sterilization.

The decision whether to choose a horizontal or vertical autoclave depends largely on whether piped steam is available or not and on the necessary autoclave capacity.

II.4 PHYSIOTHERAPY

III.4.1 Overview

Major general, traumatic and orthopaedic surgery cannot be successfully undertaken without physiotherapeutic aftercare. Physiotherapy services in poor countries are determined by lack of specialists and lack of equipment. Frequently, nurses or medical assistants will have to work in the capacity of a physiotherapist. There is a tendency to compensate for lack of knowledge and training by using sophisticated equipment (i.e. electrostimulation, microwave, electric extension tables). Therefore training is essential. Adequate services rely on knowledge, skill and dedication. Most of the equipment of a physiotherapy unit can be produced locally. Long-term rehabilitation treatment requires interdisciplinary cooperation and should be planned at national level. Support services to a physiotherapy unit are:

- orthopaedic workshop staffed with orthopaedic technicians
- production of sophisticated braces
- assembly of pre-manufactured prostheses and aids
- wheelchair production.

III.4.2 Treatment

Physiotherapy at Level I:

No physiotherapy services required. Relevant cases will be referred for medical/surgical treatment to higher level (see orthopaedics/surgery).

Physiotherapy at Level II:

- postoperative respiration stimulation and thrombosis prophylaxis
- rehabilitation training of hemiplegia and paraplegia
- remobilization of fractures
- stretching of contractures (polio, burns)
- remobilization of joint contractures (polyarthritis)
- manipulations of the spine

Optional:

- treatment of cerebral paresis (only if expertise is available)

Physiotherapy at Level III:

Same services as at routine level plus:

- treatment of cerebral paresis
- fitting and supply of

  braces

  crutches

  pads

  orthopaedic footwear.

III.4.3 Equipment:

Locally produced equipment should be used, as industrially manufactured equipment is expensive and therefore cannot be provided in sufficient numbers. Blueprints for manufacturing appropriate rehabilitation equipment are available from various international organizations.

Physiotherapy equipment at Level I:

No equipment necessary.

Optional: stock of crutches in various sizes.

Physiotherapy equipment at Level II:

- crutches
- parallel bars
- treatment bench
- gymnastic mattresses
- pulley apparatus
- hot/cold packs (including heater and fridge)

Optional:

- bath tubs for hydrotherapy

Buildings:

- one gymnastic hall, one office and one storeroom.

Physiotherapy equipment at Level III:

Same equipment as at routine level plus:

- electrotherapy equipment (short-wave, infrared, electrostimulation)
- pool for hydrotherapy
- thermoplast equipment (production of splints)

Support services:

- workshop for production of low cost crutches, braces, pads, sandals.

III.5 LIBRARY

Books and journals are essential tools of the medical profession.

Libraries should therefore exist at all levels of health care and the contents of the libraries must relate to the health needs of the target population, to the standard of health care and to the specific information needs of the personnel.

The different information needs should lead to standardized reference lists of books and journals for the different levels of health care. The provision of the same handbooks and journals to identical levels of health care can contribute to achieving a comparable standard of medicine at all health institutions in a country.

Libraries at higher levels should have at least the following sections:

- general medical library including handbooks and journals
- general library for paramedical staff (nurses, laboratory staff, etc.)
- general library for management and administration
- technical library with manuals on radiography, sonography, laboratory equipment, and documentation and operating instructions of all technical equipment.

Support structures are just as import as a good selection of books and journals:

- a good library system (this includes a functioning lending system of a lending library, an appropriate arrangement of a reference library, etc.)
- control system of the inventory
- adequate facilities with sufficient shelves, desks, seats
- trained staff (e.g. at least one trained librarian supervising the medical libraries in the country)

For ease of information flow and ordering literature, cooperation with a national library service should be sought.

III.6 HOSPITAL WORKSHOPS

III.6.1 Overview

With regard to organization, management and maintenance of equipment, a national policy is required. This policy has to describe the structure, function and responsibilities of workshops at different levels.

Due to economic constraints, **workshops at level** are not recommended. A tool box may be considered.

Maintenance workshop at level II

In addition to maintenance and repair of the equipment found at this level the staff of the workshop has to perform the following functions:

- training of users
- advising hospital administrator / medical staff as a member of a "technical committee" on replacement of equipment, procurement of new equipment and spare parts, inventory
- maintenance of health institutions at lower level
- keeping record of all equipment, maintenance activities (time and expenditure of maintenance and repair, securement of all technical information and manuals, information on availability of spare parts, etc.)
- stock keeping of important spare parts
- management of external services.

Maintenance of:

- water supply, waste water, sanitary installation
- buildings, fixtures, furniture
- electrical supply, emergency generators
- cooling devices
- sterilization
- medical equipment of low sophistication.

Maintenance workshop at level III

Workshops at central level maintain and repair equipment found at this level. Workshops at this level provide specialized services for sophisticated equipment and specialist service support for equipment at lower levels. Limitations of maintenance and repair of equipment must be defined by the national policy. In addition, workshops at this highest level are responsible for:

- continuous training and supervision of engineers, technicians, and craftsmen at lower levels
- national publications on issues concerning technical equipment
- counselling national policy makers and purchasers of equipment as a member of a "national technical committee" on replacement of equipment, procurement of new equipment and spare parts, inventory, etc.
- collecting and compiling information on all types of equipment in use (problems and expenditure of maintenance and repair, securement of all technical information and manuals, information on availability of spare parts, etc.)
- stock-keeping of important spare parts
- supervision of workshops and health institutions at subordinate level.

III.6.2 Workshop Equipment

The workshops should be equipped for:

- heavy metalwork
- light metalwork
- plumbing
- electricity
- electronics
- carpentry
- masonry

Tool box for level I

- 1 locksmith hammer, 200 g
- 1 set screwdriver, 3, 5, 8, 10 mm
- 1 set star screwdriver, 3 pieces
- 1 slide rule, 150 mm
- 1 adjustable spanner up to 24 mm
- 1 water-pump pliers
- 1 grip pliers
- 1 combination pliers
- 1 round nose pliers
- 1 halfround file, smooth, 250 mm
- 1 set double open end spanners, 6-26 mm

- 1 padlock
- 1 set Allen keys, 2 - 14 mm
- 1 set drill bits, 1 - 13 mm (1/10 fractions) HSS
- 1 set concrete drill bits, 4, 6, 8, 10, 12 (long) mm
- 1 centre punch
- 1 (elec.) drilling machine incl. set of bits
- 1 tool box
- 1 combination sharpening stone
- 1 set splint pin driver, 3 pcs.
- 1 metal tape measure, 3 m
- 1 Swiss army knife (biggest version)
- 1 pair of heavy duty scissors
- 1 long nose pliers
- 1 inspection lamp
- 1 set needle files
- 1 fret saw & 20 blades
- 1 set cold chisels
- 1 set watchmaker's screwdrivers
- 1 set twist gimlets
- 1 pair of leather gloves
- 2 pipe wrenches up to 2.5"
- 1 side cutter
- 1 elec. soldering iron, 50 W / 240 V
- 1 phase tester
- 1 multimeter
- 1 panel saw, 500 mm
- 2 wood chisels, 10, 20 mm
- 1 glass cutter
- 1 spirit level

Tools for Level II

- 1 parallel vice, 130 mm
- 1 locksmith hammer, 200 g
- 1 locksmith hammer, 500 g

- 1 set screwdriver, 3, 5, 8, 10 mm
- 1 set star screwdriver, 3 pcs.
- 1 square, 250 x 165 mm
- 1 compass, 150 mm
- 1 steel scriber
- 1 hacksaw, 300 mm and 15 blades
- 1 adjustable spanner up to 24 mm
- 1 water-pump pliers
- 1 grip pliers
- 1 combination pliers
- 1 round nose pliers
- 1 tinner snip
- 1 flat file, rough, 350 mm
- 1 flat file, smooth, 250 mm
- 1 halfround file, smooth, 250 mm
- 1 round file, smooth
- 1 triangular file, smooth, 150 mm
- 1 set double open end spanners, 6 - 26 mm
- 1 set do., equivalent inch
- 1 set ring spanners, 6 - 27 mm
- 1 set do., equivalent inch
- 4 padlocks (various)
- 1 set socket spanners 6 - 22 with ratchet, etc.
- 1 set Allen keys, 2 - 14 mm
- 1 set do., equivalent inch
- 1 set taps & dies, 3 - 12 mm
- 1 set do., equivalent inch
- 1 set drillings, 1 - 13 mm (1/10 fractions) HSS
- 1 set concrete drill bits, 4, 6, 8, 10, 12 (long) mm
- 1 set screw extractors, 5 pcs.
- 1 centre punch
- 1 safety goggles
- 1 wire brush
- 1 grease gun, 300 mm

- 1 elec. drilling machine incl. jigsaw, grinding & polishing attachments
- 1 drilling stand
- 1 hand angle grinder
- 1 kerosene blowlamp
- 1 soldering iron for above
- 1 gas welding set (complete)
- 1 tool box
- 1 combination sharpening stone
- 1 scraper (3-edged)
- 1 set splint pin driver, 3 pcs.
- 1 metal tape measure, 3 m
- 1 Swiss army knife (biggest version)
- 1 pair of heavy duty scissors
- 1 oil can, 350 cc
- 1 set hollow punches, 3 - 30 mm
- 1 blind rivet pliers
- 1 pair vice flaps
- 1 gas cylinder trolley
- 1 anvil
- 1 long nose pliers
- 1 inspection lamp
- 1 set needle files
- 1 calipers
- 1 panga
- 1 workbench
- 1 cupboard
- 1 wall shelf
- 1 ladder
- 1 fret saw and 20 blades
- 1 set taps and dies, 1 - 3 mm
- 1 set cold chisels
- 1 small machine vice
- 1 V-block
- 1 air blower attachment

- 1 set watchmaker's screwdrivers
- 1 tweezers
- 1 sheet metal stand shears
- 1 probing magnet
- 1 set countersinks, 3 pcs.
- 1 set twist gimlets
- 1 conical reamer, 3 - 25 mm
- 1 set hole cutter for sheet metal, 10 - 30 mm
- 1 set balance weights, 1 mg - 250 g
- 2 snap ring pliers (internal / external)
- 1 nut splitter
- 1 set special wrenches for microscopes
- 1 micrometer
- 1 metal detector
- 1 stopwatch
- 1 pair leather gloves
- 1 fridge refilling set
- 1 set drawing equipment (DIN A4)
- 2 pipe wrenches up to 2.5"
- 1 pipe vice and stand
- 1 sewerage cleaning rod
- 1 pipe cutter & flaring tool
- 1 sink drainage sucker
- 1 set ratchet die, 1/2" - 2"
- 1 set spare knives for above
- 1 side cutter
- 1 elec. soldering iron, 50 W / 240 V
- 1 phase tester
- 1 battery charger
- 1 multimeter
- 1 extension cable for power supply, 25 m
- 1 soldering iron, 16 W / 240 V
- 1 plane, 350 mm, and spare blade
- 1 rebate plane & spare knife

- 1 wood & planing vice
- 1 bow saw, 700 mm
- 1 panel saw, 500 mm
- 1 tenon saw
- 1 saw set pliers
- 2 wood chisels, 10, 20 mm
- 1 hand drill, 10 mm
- 1 wood rasp
- 2 G-clamps, 120 mm
- 2 do., 250 mm
- 2 do., 1250 mm
- 1 brace
- 3 brace bits, 10, 14, 22 mm
- 1 claw hammer
- 1 pincer
- 1 sliding bevel
- 2 paint scrapers, 20, 50 mm
- 3 brushes, 1/2", 1", 2"
- 1 mitre box
- 1 mortice gauge
- 1 canvas awl
- 1 glass cutter
- 1 flat chisel
- 1 pointed chisel
- 1 spirit level
- 1 mason's trowel
- 1 mason's float
- 1 sledge hammer
- 1 wind-up tape, 30 m
- 1 tyre pump (manual)
- 3 tyre levers
- 1 pressure gauge
- 1 feeder gauge, 0.005 - 1 mm
- 3 funnels
- 1 crimp pliers

Workshop equipment at level III

As for level II plus:

- 1 lathe (small)
- 1 mill (small)
- 1 bending machine (for sheet metal)
- 1 do. (for pipes)
- 1 universal circular saw
- 1 standing drilling machine
- 1 compressor
- 1 set paint sprayer
- 1 set precision measuring tools
- 1 set elec. welding
- 1 oscilloscope
- 1 insulation tester
- 1 3-phase tester
- 1 function generator

SECTION IV

LISTS OF EQUIPMENT

IV.1 INVESTMENTS

IV.2 MAINTENANCE REQUIREMENTS

IV.3 INSTRUMENT SETS

The following lists are based upon data from 1992.

"Investment Costs in US$"

These prices are calculated *without* transport, insurance, customs, and other extras. Depending on the receiving country concerned these extras may amount to up to 20% of investment costs.

"Additional Investment Costs"

Some apparatus need special installation preparation and installation work. These additional costs, which may be between 2% and 25% of investment costs, depend on local circumstances.

"Running Costs per Year in US$"

They consist of consumables, reagents and chemicals, medical gases, and regular maintenance (cleaning, inspection, preventive maintenance). *Not included* in these prices are

X-ray tubes,

ultrasonic transducers,

fibre optics,

energy and water supply, as these depend on local prices,

salaries for operators, etc.

"Main Cost Factors"

The usual main contributor to the yearly running costs is marked by "x". Some cost factors cannot be exactly differentiated; the main factor may vary. This is marked by "(x)" in the table.

Maintenance, esp. repair, costs (see above) which don't occur periodically per year are not included here. Possible costs of this type are marked by /x/.

"Lifetime in Years"

Information is given concerning to the average life span, which depends on

- type of apparatus
- installation
- quality of power supply
- instrument quality
- care in operation, maintenance etc.
- frequency of use.

IV.1 List of Equipment: Investments

ITEM	LEVEL	INVESTMENT COST IN US$	ADDITIONAL INVESTMENT COST	RUNNING COST PER YEAR IN US$	REMARKS	MAIN COST FACTORS consum.	MAIN COST FACTORS maint.	LIFETIME IN YEARS
amnioscope with light source	III	1,400 - 2,200	no	90 - 130			x	6- 9
anaesthetic machine, simple	II	1,600 - 3,300	no	400 - 700	incl. consumables	x	x	6-12
anaesthetic machine	II	10,500 - 42,000	d.o.t.	3,100 - 6,000	incl. consumables	x	x	8-15
autoclave, steam pressure (10-l pot)	I	50 - 70	no	5 - 10			x	5
autoclave, electric steam	II	1,100 - 6,000	no	20 - 900			x	6-12
balance, mechanical (laboratory)	II	100 - 300	no	0 - 50			x	8-12
balance, electronic (laboratory)	III	1,600 - 4,100	no	0 - 240			x	6-10
balance, precision (eye-drop production)	III	1,100 - 1,700	no	0 - 200			x	8-12
bath tubs for hydrotherapy	II	4,000 - 7,000	yes	0 - 60			x	10-20
bench, examination and treatment	I	250 - 450	no	0 - 20			x	10-14
bench, physiotherapy	II	200 - 400	no	0 - 20			x	10-14
blood bank with refrigerator	II	1,400 - 5,300	d.o.t.	200 - 650			x	8-12
blood gas analyser	III	33,500 - 38,000	no	13,400 - 15,400	incl. reagents	x		5- 8
blood pressure apparatus	I	30 - 90	no	5 - 15			x	5
bronchoscope, flexible, with light source	II	12,000 - 17,500	no	130 - 400			x	6- 9
centrifuge (hand-driven)	I	70 - 120	no	10 - 20			x	6-10
centrifuge, electrical	II	260 - 1,750	no	60 - 220			x	6-12
centrifuge, haematocrit	II	550 - 1,500	no	60 - 220			x	6-12
colorimeter	II	630 - 900	no	80 - 180			x	6- 9
colposcope	II	1,700 - 3,100	no	90 - 270			x	8-12
couch or chair for pelvic examination	I	300 - 500	no	0 - 50			x	10-20
counting chamber	II	210 - 450	no	20 - 50			x	5- 9
cystoscope, simple	III	1,400 - 2,200	no	90 - 130			x	6- 9
cystoscope (min. invasive surgery)	III	34,700 - 41,600	no	130 - 400			x	6- 9
delivery bed with retractable foot parts	II	500 - 2,800	no	0 - 100			x	10-15
ECG (three channel type)	II	4,200 - 7,500	no	500 - 800	incl. paper/gel		x	8-14
echocardiography	III	22,500 - 34,300	no	7,500 - 14,500		x	x	6-10
electrocautery (Semm type)	III	1,300 - 3,800	d.o.t.	70 - 400			x	8-12
electrophoresis	III	1,600 - 3,300	no	800 - 2,400			x	6-10
electromyograph	III	15,500 - 40,600	no	800 - 5,000			x	6-12
electrostimulation (physiotherapy)	III	3,000 - 5,500	no	180 - 800			x	8-12
eye tonometer	II	1,800 - 3,100	no	50 - 150			x	6-10
eye tonometer, Schiotz	II	100 - 150	no	0 - 50			x	6-15
fango (paraffin) preparation unit	III	3,200 - 4,700	yes	300 - 900	without fango/paraffin	x		10-15
fetal heart detector	II	6,800 - 10,400	no	340 - 1,800			x	6-12
film processor, manual (X-ray)	II	500 - 750	no	20 - 80	without chemicals		x	6-12
film processing machine	III	5,700 - 17,500	yes	750 - 2,400	without chemicals	x		6- 9
film viewer (X-ray)	II	50 - 250	d.o.t.	10 - 25			x	6-12
flame photometer	III	2,200 - 16,300	no	1,100 - 2,100	without reagents	x		8-12

ITEM	LEVEL	INVESTMENT COST IN US$	ADDITIONAL INVESTMENT COST	RUNNING COST PER YEAR IN US$	REMARKS	MAIN COST FACTORS consum./maint.		LIFETIME IN YEARS
flowmeter (oxygen/air)	II	160 - 530	no	0 - 90			x	8-12
gastroscope, flexible, with light source	III	14,400 - 26,200	no	130 - 400			x	6- 9
gymnastic mattresses	II	50 - 200	no	0 - 20			x	15
hand tally counter	II	7 - 30	no	0 - 10			x	5
haemoglobinometer (Sahli type)	I	30 - 50	no	2 - 5			x	4
incubator, baby (simple type)	II	5,000 - 13,700	no	200 - 800			x	6-12
incubator, infant (intensive care)	III	15,200 - 34,300	d.o.t.	1,100 - 2,000	without medical gases	x	x	8-12
incubator (laboratory)	III	600 - 1,800	no	40 - 150			x	10-15
infrared beam (physiotherapy)	III	30 - 400	no	15 - 40			x	3-12
laparoscope & insufflator	III	4,900 - 6,400	no	500 - 900	without CO_2 gas	x		6-10
laryngoscope	II	70 - 240	no	20 - 50			x	8-12
lens meter	III	750 - 1,600	no	0 - 240			x	12-18
light source with magnification (2.3x)	II	230 - 600	no	90 - 180			x	5-10
light source, wall-mounted or mobile	II	100 - 450	d.o.t.	0 - 40			x	6-15
microscope, binocular (10x, 40x, 100x)	I	460 - 550	no	0 - 30			x	10-20
microscope with phase condenser	III	670 - 820	no	0 - 40			x	10-20
microscope, UV fluorescence	III	800 - 1,100	no	0 - 60			x	10-20
microtome	III	600 - 2,200	no	20 - 280			x	10-15
operating loupe with light source	III	230 - 600	no	90 - 180			x	5-10
operating microscope with coaxial light	III	11,000 - 15,600	d.o.t.	300 - 750			x	12-20
operating stool	III	380 - 500	no	20 - 40			x	8-10
ophthalmoscope, direct	II	50 - 180	no	20 - 70			x	4- 8
otoscope (set)	I	30 - 140	no	20 - 60			x	4- 8
oxygen concentrator	II	2,800 - 4,200	no	400 - 650	incl. filters	x	x	5- 8
oxygen concentrator monitor	II	1,100 - 1,500	no	100 - 300			x	5-10
parallel bars	II	400 - 2,500	no	0 - 150			x	20-30
patient lifter (hydrotherapy)	II	300 - 700	no	30 - 90			x	8-12
peak flowmeter (lung function)	II	1,200 - 2,300	no	60 - 300			x	8-15
perimeter	III	3,600 - 11,000	no	150 - 700			x	8-12
pharyngoscope with light source	III	1,400 - 2,200	no	90 - 130			x	6- 9
pH meter	II	220 - 570	no	50 - 150			x	3- 6
photocoagulation system, ophthalmologic	III	25,000 - 38,000	yes	1,300 - 9,000			x	8-12
pulley apparatus	II	240 - 620	no	0 - 80			x	8-15
pulse oxymeter	III	3,200 - 5,000	no	200 - 650			x	6-12
radiographic system, dental X-ray unit	III	3,100 - 4,700	yes	7,600 - 12,100	incl. films/chemicals	x	/x/	10-15
radiographic system, basic	II	8,000 - 31,200	yes	46,800 - 75,000	incl. films/chemicals	x	/x/	10-15
radiographic system, simple	II	14,500 - 53,100	yes	63,000 - 84,000	incl. films/chemicals	x	/x/	10-15
radiography (surgery) image intensifier	III	120,000 -250,000	yes	33,000 - 45,000	incl. films/chemicals	x	/x/	8-12
radiographic system, three phase unit	III	85,000 -170,000	yes	90,000 -120,000	incl. films/chemicals	x	/x/	10-15
rectoscope (rigid) with light source	II	900 - 2,900	no	90 - 180			x	8-15
refractometer	III	1,800 - 3,800	no	200 - 600			x	10-15

ITEM	LEVEL	INVESTMENT COST IN US$	ADDITIONAL INVESTMENT COST	RUNNING COST PER YEAR IN US$	REMARKS	MAIN COST FACTORS consum./maint.		LIFETIME IN YEARS
resuscitator, neonatal, hand-operated	II	130 - 250	no	15 - 50			x	3- 6
retinoscope	III	120 - 500	no	40 - 120			x	5- 8
scale, adult	I	130 - 380	no	0 - 60			x	8-15
scale, infant (25 kg)	I	60 - 260	no	0 - 40			x	10-20
short-wave	III	4,100 - 7,200	no	200 - 1,100			x	8-15
sigmoidoscope, flexible, with light source	III	14,400 - 21,800	no	90 - 180			x	6- 9
slit lamp	II	4,800 - 9,800	d.o.t.	360 - 1,000			x	10-15
spectrophotometer	III	5,400 - 12,600	no	400 - 2,400	without reagents	(x)		6-12
spirometer	III	2,300 - 4,500	no	230 - 970	incl. consumables		x	6-12
sterilization apparatus (cooker type)	I	190 - 250	no	10 - 60			x	4- 6
sterilizer for eye instruments	II	60 - 90	no	5 - 10			x	4- 6
stopwatch (laboratory)	I	10 - 30	no	0 - 10			x	3- 6
stretcher with wheels	II	410 - 750	no	10 - 160			x	8-15
suction pump, electrically operated	II	180 - 2,300	no	40 - 370			x	8-12
suction pump, foot-operated	II	190 - 230	no	40 - 60			x	6-10
table, examination (gynaecology)	II	370 - 750	no	10 - 50			x	12-15
theatre table, mechanical	II	1,600 - 15,700	d.o.t.	50 - 1,250			x	10-20
theatre light (with stand-by battery)	II	1,100 - 5,000	d.o.t.	20 - 1,800			x	8-15
trolley, medical purpose	II	80 - 1,200	no	0 - 120			x	8-20
ultrasound, gynaecological	III	26,000 - 30,000	no	7,800 - 13,500	incl. hardcopy	x	/x/	6- 9
ultrasound, internal medicine/obstetrics	II	22,000 - 28,000	no	7,500 - 13,300	incl. hardcopy	x	/x/	6- 9
ultrasound, internal medicine	III	34,400 - 41,200	no	8,100 - 13,900	incl. hardcopy	x	/x/	6-10
ultrasound, obstetrics	III	24,000 - 28,000	no	7,600 - 13,300	incl. hardcopy	x	/x/	6- 9
ultrasound, surgery	III	34,400 - 98,000	no	2,700 - 6,400	incl. hardcopy	x	/x/	6-10
vacuum extractor, manual	I	480 - 600	no	20 - 150			x	4- 8
ventilator, long-term	III	17,500 - 40,600	d.o.t.	4,500 - 9,800	incl. consumables	x	x	6-12
ventilator, simple (anaesthetic)	III	2,900 - 7,000	no	750 - 2,200	incl. consumables	x	x	6-10
water bath (laboratory)	II	190 - 750	no	25 - 300			x	6-10
water still, small (approx. 2 l/h)	II	800 - 1,100	no	60 - 150			x	4- 6
water still, small (approx. 4 l/h)	II	1,300 - 1,700	yes	60 - 350			x	5- 8
wheelchair, simple, adult size	II	280 - 400	no	20 - 100			x	8-12

IV.2 Maintenance Requirements

ITEM	LEVEL	MAINTENANCE REQUIRED (without repair) BY USER	INHOUSE SERVICE	EXTERNAL SERVICE
amnioscope with light source	III	x	xx	
anaesthetic machine, simple	II	xxx	x	xxx
anaesthetic machine	II	xx	x	xxx
autoclave, steam pressure (10-l pot)	I	x	xx	
autoclave, electric steam	II	x	xx	
balance, mechanical (laboratory)	II	xx	x	
balance, electronic (laboratory)	III	x	xx	
balance, precision (eye-drop production)	III	x	xx	
bath tubs for hydrotherapy	II	x		
bench, examination and treatment	I	xx		
bench, physiotherapy	II	xx		
blood bank with refrigerator	II	xx	xx	
blood gas analyser	III	xx	x	xxx
blood pressure apparatus	I	xxx		
bronchoscope, flexible, with light source	II	x	xx	
centrifuge (hand-driven)	I	xx		
centrifuge, electrical	II	xx	x	
centrifuge, haematocrit	II	xx	x	
colorimeter	II	x	x	
colposcope	II	xx		
couch or chair for pelvic examination	I	xx		
cystoscope, simple	III	xxx		
cystoscope (min. invasive surgery)	III	x	xxx	
delivery bed with retractable foot parts	II	xx		

ITEM	LEVEL	MAINTENANCE REQUIRED (without repair) BY USER	INHOUSE SERVICE	EXTERNAL SERVICE
ECG (three channel type)	II	x	xx	xx
echocardiography	III	x	xxx	
electrocautery (Semm type)	III	x	x	
electrophoresis	III	x	x	
electromyograph	III	xxx		
electrostimulation (physiotherapy)	III	x	xx	
eye tonometer	II	x	x	
eye tonometer, Schiotz	II	x	x	
fango (paraffin) preparation unit	III	xx	x	
fetal heart detector	II	x	xx	
film processor, manual (X-ray)	II	x	xx	
film processing machine	III	xxx	xx	xxx
film viewer (X-ray)	II	xxx		
flame photometer	III	x	xx	
flowmeter (oxygen/air)	II	xxx	x	
gastroscope, flexible, with light source	III	x	xx	
gymnastic mattreses, set	II	x		
hand tally counter	II	x		
hemoglobinometer (Sahli type)	I	xxx		
incubator, baby (simple type)	II	xx	x	
incubator, infant (intensive care)	III	x	xxx	
incubator (laboratory)	III	x	x	
infrared radiator (physiotherapy)	III	xx		
laparoscope & insufflator	III	x	xx	
laryngoscope	II	x	x	

ITEM	LEVEL	MAINTENANCE REQUIRED (without repair) BY USER	INHOUSE SERVICE	EXTERNAL SERVICE
lens meter	III	x	x	
light source with magnification (2.3x)	II	xx		
light source, wall-mounted or mobile	II	xx		
microscope, binocular (10x, 40x, 100x)	I	x	x	
microscope with phase condenser	III	x	x	
microscope, UV fluorescence	III	x	x	
microtome	III	xx	x	
operating loupe with light source	III	x	xx	
operating microscope with coaxial light	III	x	xxx	xx
operating stool	III	xx		
ophthalmoscope, direct	II	xx	x	
otoscope (set)	I	xx	x	
oxygen concentrator	II	xxx	xx	x
oxygen concentrator monitor	II	x	xx	
parallel bars	II	x		
patient lifter (hydrotherapy)	II	xx		
peak flowmeter (lung function)	II	xxx	x	
perimeter	III	x	xx	
pharyngoscope with light source	III	x	x	
pH meter	II	xx	x	
photocoagulation system, ophthalmologic	III	xxx		
pulley apparatus	II	x		
pulse oxymeter	III	x	xxx	
radiographic system, dental x-ray unit	III	x	xx	
radiographic system, basic	II	xx	x	
ITEM	LEVEL	MAINTENANCE REQUIRED (without repair) BY USER	INHOUSE	EXTERNAL

			SERVICE	SERVICE
radiographic system, simple	II	xx	xx	
radiography (surgery) image intensifier	III	x	xx	
radiographic system, three phase unit	III	xx	xx	
rectoscope (rigid) with light source	II	xxx	x	
refractometer	III	x	xx	
resuscitator, neonatal, hand-operated	II	xxx		
retinoscope	III	xx		
scale, adult	I	x		
scale, infant, (25 kg)	I	x		
short-wave	III	x	xx	
sigmoidoscope, flexible, with light source	III	x	xx	
slit lamp	II	x	xxx	
spectrophotometer	III	x	xx	
spirometer	III	xx	x	
sterilization apparatus (cooker type)	I	xx	x	
sterilizer for eye instruments	II	xx	x	
stopwatch (laboratory)	I	x		
stretcher with wheels	II	x		
suction pump, electrically operated	II	x	xxx	xx
suction pump, foot operated	II	x	xx	
table, examination (gynaecology)	II	xx		
theatre table, mechanical	II	xx	x	
theatre light (with stand-by battery)	II	xx	x	
trolley, medical purpose	II	xx		
ultrasound, all types	II, III	x	xxx	
vacuum extractor, manual	I	x		
ventilator, long-term	III	xxx	x	xx
ventilator, simple (anaesthetic)	III	xxx	x	xx

ITEM	LEVEL	MAINTENANCE REQUIRED (without repair) BY USER	INHOUSE SERVICE	EXTERNAL SERVICE
water bath (laboratory)	II	xx	x	
water still, small (approx. 2-4 l/h)	II	xx	x	
wheelchair, simple, adult size	II	xx		

x - xx - xxx = number of x's indicates intensity of work

IV.3 INSTRUMENT SETS

Standard Surgical Instrument Sets

Set	No. of Parts	Price in US$
General Set	74	730
Minor Set	49	390
Abrams Pleural Biopsy Set	24	630
Tracheostomy Set	34	230
Skin Biopsy Set	9	240
Suture Set	6	160
I.V. Cut Down Set	14	370
Gynaecology Basis Set	75	600
Vaginal Suture Set	22	210
Tubal Ligation Set	51	1,330
Caesarien Set	61	610
D & C Set	22	580

Specialized Surgical Instrument Sets

Set	No. of Parts	Price in US$
Large General Set	97	1,100
Intestinal Set	45	1,180
Thoracotomy Set	49	2,340
Perineal Set	38	990
Gall Bladder Set	13	390
Thyroidectomy Set	56	470
Skin Graft Set	18	360
Vasectomy Set	17	450
Abdominal Hysterectomy Set	77	940
Prostaglandin	6	160
Vaginal Repair & Hysterectomy	67	610
Prolapse Tray	34	890
Laparoscopy	12	160
Hysterosalpingogram & Hydrotubation	7	180
Dental Surgery Instrument Set	65	1,700
Postmortem Instrument Set	27	700

Other Standard Instrument Sets

Set	No. of Parts	Price in US$
Instrument Set for Ward	26	35
Instrument Set for Treatment Room / Outpatient Department	83	340

Set	No. of Parts	Price in US$
Instrument Set for Consulting Room / Outpatient Department	66	220
Instrument Set for Obstetrics & Gynaecology, Exam. and Treatm. Room	226	310
Instrument Set for Basic Dental Treatment (per room)	19	160
Instrument Set for Basic Eye Treatment (per room)	58	490
Instrument Set (Anaesthetic) for Intubation of the Trachea (incl. 1 laryngoscope)	389	1,290

SECTION V

LITERATURE AND RESOURCE ORGANIZATIONS

V.1 ANNOTATED BIBLIOGRAPHY OF DOCUMENTS DEALING WITH ESSENTIAL MEDICAL EQUIPMENT FOR HEALTH INSTITUTIONS IN DEVELOPING COUNTRIES

V.2 RESOURCE ORGANIZATIONS

V.1 ANNOTATED BIBLIOGRAPHY OF DOCUMENTS DEALING WITH ESSENTIAL MEDICAL EQUIPMENT FOR HEALTH INSTITUTIONS IN DEVELOPING COUNTRIES

Each of the following cited items has the same structure:
Authors / Editors / Publisher
Organization:
Title:
Contents:
Good as reference for:
Less suitable for:
Criticism:

V.1.1 General Medical Equipment

American Hospital Association (Publisher)
- **O:** American Hospital Association, 840 North Lake Shore Drive, Chicago, Illinois 60611
- **T:** **Medical equipment management in hospitals**
- **C:** 1. Hospitals - furniture, equipment, etc.
  Maintenance and repair - handbooks, manuals, etc.
  2. Medical instruments and apparatus - maintenance and repair, handbooks, manuals, etc.
- **Good:** Medical equipment management in general
  Medical equipment management with special regard to the situation in the USA

Berche, T.
- **T:** **L'hospital de district: son fonctionnement au sein des services de santé de district**
  Séminaire-atelier du 23/11-27/11/1992 à Yaoundé, Cameroun
  WHO, Geneva, IMT, Anvers, GTZ, Eschborn
- **C:** Report and papers of a seminar

Bloom, Gerald (Author)
- **O:** Institute of Development Studies, University of Sussex, Brighton BN1 9RE, England
- **T:** **The right equipment ... in working order**
- **C:** Maintenance policy issues
- **Good:** Economic aspects
  Rehabilitation and restocking of equipment
  Rationalization of procurement
  Purchasing plans for equipment
- **Less:** Detailed information about medical equipment

Bloom, Gerald; Temple-Bird, Caroline (Authors)

O: Institute of Development Studies, University of Sussex, Brighton BNI 9RE, England

T: **Medical Equipment in Sub-Saharan Africa**

C: Introduction - the crisis in the health sector and the medical equipment problem
Unpacking medical equipment technology - planning, allocating resources, maintenance and replacement, training

Good: General policy formulation
Good overview of the situation of medical equipment in Africa
Findings and statements valid for almost all developing countries.

Less: Detailed planning of essential equipment for defined levels of health care.

Crisp, C. W. (Author)

O: Department of Health and Social Security, Health Service Supply Branch, 14 Russell Square, London WC 1B 5EP

T: **Management of Equipment**

C: Introduction
Selection of equipment
Acceptance procedure
Training
Servicing
Replacement policy
Procurement - technical considerations
Standard questionnaire for the supply of electro-medical equipment

Good: Procurement and management of medical equipment
Calculation of overall costs
Although written for Britain's National Health Service very good reference in all aspects of health equipment management.

Less: Questions concerning simple equipment and appropriate technology
Some details specifically valid for Great Britain only

Dammann, V., Pfeiff, H. (Editors)

O: Dept. of Technology in Health Care, Fachhochschule Gießen-Friedberg

Publ.: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Eschborn, Germany (1986), ISBN 3-88085-293-6

T: **Hospital Engineering in Developing Countries**

C: Proceedings of a symposium in Gießen (1983):
Hospital engineering:
- Introduction
- Training (in general)
- Technical Installations and Technical Training
- Tasks and Decision-making Aids

Checklist for compiling a Location Data File
Classification of Medical Apparatus according to Their Potential Danger to

Patients
Workshop Equippment

Good: Survey on all aspects of hospital engineering and its special problems in developing countries
Proposals for establishment and staffing of a national and local hospital equipment management and maintenance system
Draft of a hospital technician's vocational training curriculum.
Hints for hospital inventory lists

Less: Medical equipment lists

Daschner, F. (Author)

O: Institute for Clinical Hygiene, University of Freiburg
T: **Hygiene, Müllreduktion und Umweltschutz in Kliniken**
C: Removal of waste in hospitals
Classification of waste
Amount of waste and possibilities of reduction
Economic use of antibiotics
Examples of unnecessary packing and disposable systems
Proposals
Good: Classification of waste
Possibilities of waste reduction
Appropriate hygiene in hospitals
Less: Information on specific equipment
Cr: Only available in German

Diesfeld, Hans-Jochen; Wolter, Sigrid (Authors)

O: Institute for Tropical Hygiene, Heidelberg
T: **Medizin in Entwicklungsländern**
C: The book covers all issues important for medical volunteers going to the tropics.
Good: Health systems, Primary Health Care, mother/child health, health planning, paediatrics, obstetrics and family planning, anaesthesia and surgery, internal medicine, laboratory, ophthalmology, environmental hygiene.
Most chapters contain information about essential equipment.
Addresses of all German institutions dealing with development aid.
Less: Detailed information about medical equipment
Cr: Only available in German

Halbwachs, Hans; Korte, R. (Editors)

O: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH,
and **Publ.:** Eschborn, Germany, and WHO (1990), WHO/SHS/NHP/90.2
T: **Maintenance Strategies for Public Health Facilities in Developing Countries**
C: Contributions to a workshop held in March 1989 in Nairobi
Good: Survey on maintenance: objectives, problems, staff, training
Related reference data
Competence ratings for maintenance of typical kind of apparatus

Issakov, A., Malloupas, A., McKie, J. (editors)

O: Division of Strenghthening of Health Services, WHO, Geneva

T: **Manpower Development for a Health Care Technical Service**
Report of the World Health Organization Interregional Meeting on Manpower Development and Training for Health Care Equipment Management, Maintenance and Repair
WHO/SHS/NHP/90.4 (1990)

C: Summaries of reports from countries, participating institutions and organizations
Manpower and training needs of a developing health care technical service
Health care equipment profession: levels of involved practitioners
Translating the medical device survey into manpower requirements
Clinical engineering and biomedical equipment technology certification
Proposed certification in health technology management

Good: Planning data: job descriptions, educational needs
Lists: type-related requirements of service hours of medical equipment
References, bibliography

King, Maurice (Editor)

O: International group of experts around Dr. M. King, Nyeri, Kenya

T: Primary ....
The group of authors around Dr. King publishes manuals for medical care in developing countries. All manuals have a similar title (**Primary** Surgery, **Primary** Child Care, etc.) and a similar arrangement.

Good: All manuals describe the medical equipment necessary for interventions in the different specialities.

Knebel, Peter (Author)

O: OECD - Organization for Economic Cooperation and Development; CILSS - Permanent Interstate Committee for Drought Control in the Sahel. Club du Sahel.

T: **Primary and Secondary Health Care in Developing Countries. Furniture and Equipment in Relation to Activities, Personnel and Architecture.**

C: I Furniture and Equipment in Relation to Activities and Service Units:
Village Health Worker Team
Rural Health Post
Dispensary
MCH centre
Maternity Ward
Laboratory
Dentistry
Consultation Room
Operating Theatre
X-Ray Unit
Nutrition Rehabilitation
Support Services
Mobile Teams / Home Visiting
Codification, Price, Description of Materials

Summary of Furniture and Equipment Costs
II Personnel in Relation to:
Type of Health Facilities, Activities and Service Units, Number of Patients per Day/Year.
Summary of Personnel for a Health Centre / for a Hospital
III Architectural Layout and Floorplan
in Relation to Type of Health Facilities
Space Requirement
Patient Flow
Attachments:
UNICEF Ordering Procedures
Inventory Control
Catchment Area
Basic Demographic Assumptions
Calculation of Manpower Needs

Good: This publication represents a comprehensive list of furniture and equipment in relation to activities and service units.
The prices serve as a good guideline.
The attachments are useful.
Though published in 1984 still a good reference.

Less: Information on electro-medical equipment insufficient.

Cr: Some equipment recommended is rather antiquated (cranioclast, obstetrical forceps with traction).

Malloupas, Andreas; Porter, David; Issakov, Andrei (Authors)

O: WHO

T: **Guidelines for Country Situation Analysis on Management, Maintenance and Repair of Health Care Equipment.**

C: Strategy and approach
Promotion of awareness, policy formulation and information support
Strengthening of national health care technical services
Manpower development

Good: Very good as a guideline for a comprehensive problem analysis and country situation analysis on medical equipment
Essential for formulation and adoption of policies, strategies and approaches related to health care equipment

Less: Direct decision on essential medical equipment

Cr: Not issued to general public

Malloupas, Andreas (Author)

O: WHO Collaborating Centre on Training and Research on Management, Maintenance and Repair of Health Care Equipment. EMRO/Regional Training Centre. Higher Technical Institute, Nicosia, Cyprus.

T: **Essential Medical Equipment for Hospitals at District and Provincial Levels**

C: General part including preface, rationale and justification, organization and management of equipment.

Specific part dealing with equipment requirements for hospitals of different sizes (50, 100, 200 beds). This part covers essential health needs, essential medical equipment needs, and the equipment, layout and staff requirements of hospital service workshops.
The final section discusses manpower development and training.
The Annex contains background information on pH meters, a short outline syllabus for a polyvalent technician course and details to be covered in a handbook.

Good: Equipment and staffing of hospital workshops
Management aspects and team approach are emphasized.
Information on mobile and stationary X-ray units, laboratory.

Less: Detailed information on electro-medical equipment.
Information about equipment for specific disciplines.

Cr: Staff requirements for hospital workshops rather on the high side.
The subdivision into hospitals of different sizes (50, 100 and 200 beds) does not necessarily reflect their position in the institutional hierarchy, e.g. a 200-bed hospital can be both a district hospital of a medium level and a regional referral centre.

N.N. **(Author)**

O: Official equipment list for various hospitals in Indonesia

T: Hospital Rempang, Hospital Purworejo, Hospital Klaten, Hospital Blora, Hospital Magelang, Hospital Pakem, Hospital Semarang, Surakarta Orthopaedic Hospital .... (equipment lists), 1974

C: Lists of equipment and furniture for various hospitals in Indonesia.
The different lists vary between very compressed and very detailed.
A general equipment policy or objectives in favour of or against certain equipment is not visible.

Good: Ideas of essential equipment for a specific country

Less: Equipment needs in all other countries

"Round Table" (Different authors)

O: World Health Forum, Vol.10, 1989

T: **The right equipment ... in working order (see below)**

C: Planned maintenance - the key
A tried and tested solution
A global enterprise
Link in a chain
An important element in the health for all strategy
People need machine, machine needs people
Manufacturers and users in joint endeavour
An integrated approach

Good: The topics mentioned above.

Less: Detailed information on essential medical equipment

Temple-Bird, C.; Halbwachs, H. (Editors)

O: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH,
and **Publ.:** Eschborn, Germany (1991)

T: **Spare Parts and Working Materials for the Maintenance and Repair of Health Care Equipment**

C: Contributions to a workshop held in August 1991 in Lübeck
X-ray machines, infant incubators, anaesthesia machines, suction machines, autoclaves, laundry, engines, water pumps and generators.

Good: for planning of maintenance

Less: Planning of equipment from medical view

Cr: Deals with selected equipment only.

Torfs, M.E. (Author)

O: WHO

T: **Provisional Reference List of Equipment and Supplies for Peripheral Health Services**

C: Report:
- Introduction
- Methodology
- Survey analysis
- Conclusions and basic suggestions
- Design of reference equipment list

Revised lists:
- List "S" for centres carrying out comprehensive PHC
- List "M": Reference equipment for mobile health manpower
- Equipment listed under UNIPAC:

Dental equipment
BCG vaccination set
Drugs, chemicals food supplements, vaccines, dressings
Laboratory equipment
Equipment and supplies for sanitation activities

Good: Comprehensive list of all essential equipment and drugs at health centre level.

Less: Questions on essential equipment at higher levels of health care.

Cr: Very long lists of items (and sometimes comments). Difficult to read, unsuitable for quick reference; good for detailed planning.

WHO Study Group on the Functions of Hospitals at the First Referral Level

O: WHO, Geneva, WHO Technical Report Series 819

T: **The Hospital in Rural and Urban Districts**

C: Among others:
Medical and surgical conditions (list)
Surgical and medical procedures (list)

V.1.2 Special Equipment

V.1.2.1 Appropriate Technology

Savage, Anne et al. (Author)

O: Articles from the British Medical Journal (1985)

T: **Appropriate Technology**

C: A summary of different articles covering:
Operating theatre and equipment
Immunization, rehydrations and transfusion
Diagnostic imaging in small hospitals
A plain man's guide to maintenance
Obstetric care
Care of the newborn
Child health
Anaesthetics
Epidemiology and research at low cost
Priorities for hospital cleaning, disinfection, sterilization, and control of infection
Laboratory equipment
Equipment for the gastroenterologist
The cardiologist in the Third World
The respiratory physician in a Third World district hospital
Orthopaedic aids at low costs
Ophthalmology in developing countries
Essential medicines in the Third World
Principles of health education
Appropriate teaching aids
Mental health care in the district hospital
Writing it down

Good: Appropriate technology and equipment at low cost.
Commited and pragmatic writers with long experience in developing countries.
Suppliers and approximate costs of equipment usually mentioned.

Less: Information on more sophisticated equipment at referral hospitals.

Cr: Preference is given to United Kingdom suppliers

Different authors

O: FAKT, Stuttgart; Natur und Technik, Hoisbüttel

T: **Energiefragen im Krankenhausbereich der Dritten Welt (Protokoll einer Fachtagung vom 22.-23. September 1989**

C: Energy saving
Experience with RE in hospitals
Planning and operating generators
Energy storage
Potentials and limitations of solar technology, biomass, wind, water
Passive methods (building design and construction)

Good: Practical and sensible overview of possibilities of saving energy and of alternative sources of energy, good drawings and sketches
Less: Non-German readers
Cr: Only available in German.
Availability of equipment and costs of installation and running not exhaustively covered.

Rosbergen, Alke (different authors)
O: I.T.I.R. (Intermediate Technology Information Ring).
Address of authors: Nudestraat 4, 6701 CE Wageningen, Netherlands.
T: **Appropriate Technology in Ophthalmology**
C: Manufacturing of instruments
Repair of macro- and microsurgical instruments
The use of injection needles
Corneo-scleral suturing needles
Tonometers
Illumination and optics
Cryoextractor
Dressings
Visual field, perimetry
Teaching and learning
Good: Good booklet for all topics mentioned above
Very good instructions
Cr: Some instruments recommended may have a short life span, but production and replacement are cheap and quick.

V.1.2.2 Ophthalmology

Harjinder, S. Chana (Author)
O: Norwegian Association for the Blind and Partially Sighted
T: **Eye Care Programmes in Developing Countries**
C: Principles, planning, implementation and evaluation of eye care programmes
Presentation of different programmes
Country profiles
Agreements between donor and recipient
Staff calculations
Essential ophthalmic drugs
Essential ophthalmic equipment and instruments
Equipment for optical workshops
Equipment for eye drops unit
Good: Good reference for all topics mentioned above
Good chapters on equipment, especially for low cost spectacles production and production of eye drops
Good handbook for libraries of the second and third level of health care.

V.1.2.3 Traumatology, surgery, Orthopaedics

Bewes, Peter (Author)
- O: Honorary surgeon, Kilimanjaro Christian Medical Centre, Tanzania
- T: **Surgery, a Manual for Rural Health Workers**

Cook, J., Sankaran, B., Wasunna, A. E. O. (editors)
- O: Consultant Surgeon, Dept. of Surgery, Eastern General Hospital, Edinburgh, Scotland
- T: **General Surgery at the District Hospital**
  WHO, Genf (1988)
- **Good:** Lists of equipment and instruments (annex)

Cook, J., Sankara, B., Wasunna, A. E. O.
- O: Consultant Surgeon, Dept. of Surgery, Eastern General Hospital, Edinburgh, Scotland
- T: **Surgery at the District Hospital: Obstetrics, Gynaecology, Orthopaedics and Traumatology**
  WHO, Genf (1991)
- C: Among others:
  Surgical trays and equipment for specific procedures (lists, annex)

Dobson, M. B.
- O: Nuffield Department of Anaesthetics, John Radcliffe Hospital, Oxford, England
- T: **Anaesthesia at the District Hospital**
  WHO Genf (1988)
- C: Among others:
  Supplies and equipment

Huckstep, R.L. (Author)
- O: lately: Prof. of Orthopaedic Surgery, Makerere University, Kampala
- T: **Poliomyelitis**
- C: General aspects, prophylaxis, diagnosis, treatment
  Management of deformities, specific treatment
  Appliances
  Rehabilitation
- **Good:** Clinical work
  Manufacture of simple appliances, crutches, wheelchairs
- **Less:** Modern orthopaedic technology and prosthetics
- Cr: First edition 1975, still **the** standard manual for good management of severe deformities by simple methods

King, Maurice (Author)
- O: Kenya/German Project for District Hospital Surgery (GTZ)
- T: **Primary traumatology, part 2 (experimental addition)**
- C: Covers the remainder of trauma after part 1

Good: Management of trauma at secondary level
Management of eye injuries
Most chapters contain recommendations about necessary equipment
Cr: General availability doubtful

Kirk, R.M. (Editor)
O: Churchill Livingstone, Medical Division of Longman Group Limited (low price edition)
T: **General surgical operations**
C: Introduction
Anaesthesia
Paediatric Surgery
Abdominal Surgery
Oesophageal Surgery
Urological Operations
Gynaecology and Obstetrics
Vascular Surgery
Cardiothoracic Surgery
Orthopaedic Surgery
Plastic Surgery
Neurosurgery
Endocrine Surgery
Oral and Dental Surgery
Ear, Nose and Throat Surgery
Ophthalmology

V.1.2.4 Laboratory Equipment

Manfred Dietrich, Peter Kern (Authors)
O: Bernhard-Nocht-Institut für Schiffs- und Tropenkrankheiten, Hamburg
T: **Tropenlabor**
C: Laboratory examinations, essential equipment for each examination cited.
Staining
Picture section
Diseases and examinations
Preparation of specimens for dispatching
Good: All topics mentioned above
Less: Detailed description of laboratory equipment
Cr: Only available in German

V.1.2.5 Buildings

Lippsmeier, Georg, Dr.-Ing. (Publisher); Demeter, Hans, Dipl.-Ing.; Kazuo Oka, Dipl.-Ing.
O: Institut für Tropenbau, Starnberg - Institute for Building in the Tropics, Starnberg, Germany
Sponsor: Deutsche Forschungsgemeinschaft - German Research Society
T: **Hospitalbau in den Tropen - Hospital Design in the Tropics.**
C: Report on a Research Project

Mein, Philip; Jorgnesen, Thomas (Authors)
O: University of Nairobi, Housing Research and Development Unit; African Medical and Research Foundation
T: **Design for medical buildings**
C: Medical context
Project planning
Site planning
Building design
Building construction
Building services
Contract planning
Appendix
Good: Construction guidelines for medical buildings with special reference to appropriate designs for developing and tropical countries.
Relationship diagrams, flow of patients, linkages between different units and services
Less: Detailed installation of sophisticated medical equipment
Cr: Good plans, instructive sketches, practical advice

V.2 RESOURCE ORGANIZATIONS

African Medical and Research Foundation
Wilson Airport
P.O.B. 30125
Nairobi
Kenya

Appropriate Health Resources and Technologies Action Group (AHRTAG)
85 Marylebone High Street
London W1M 3DE
United Kingdom

Management of Health Physical Resources, Dr. A. Issakov
WHO Division of Strengthening of Health Services
CH-1211 Geneva 27
Switzerland

Arbeitskreise:
Anwenderschulung. Dipl.-Ing. K. Henning
Clinical Engineering. Prof. Dr. D. Kraft
Instandhaltung in der Medizintechnik. Dipl.-Ing. V. Dammann
Fachverband Biomedizinische Technik e.V.
Gießener Str. 118
D-35452 Heuchelheim
Germany

Arbeitskreis Medizintechnik. Dipl.-Ing. G. Lehmann
Fachvereinigung Krankenhaustechnik e.V.
Mauerbergstr. 85
D-76534 Baden-Baden
Germany

Asociatión Española de Ingeniera y Architectura Hospitalaria
Av.Diagonal, 647
E-08028 Barcelona
Spain

BEGECA
Postfach 287
D-5100 Aachen
Germany

Belgische Vereinigung Van Ziekenhuis Tecgnici (BVZT), Mr. Lucien Wulaaert
Duivenplein - 6
B-8000 Brugge
Belgium

Bundesfachschule für Orthopädietechnik
Leiter: Dipl.-Ing. W. Kaphingst
Schließstr. 8
D-4600 Dortmund 1

Christoffel Blindenmission
Nibelungenstraße 124
D-6140 Bensheim
Germany

Dachverband Medizinische Technik. Dipl.-Ing. R. Theobald
c/o VDE
Stresemannallee
D-6000 Frankfurt / M.
Germany

DEKRA
Prüfstelle für Medizintechnik
Schulze-Delitzsch-Straße
D-7000 Stuttgart-Vaihingen
Germany

Deutsche Gesellschaft für Orthopädie und Traumatologie, DGOT
"Orthopädie, Orthopädie-Technik und Rehabilitation in Entwicklungsländern"
Prof. Dr. G. Neff
Freie Universität Berlin, Oskar-Helene-Heim
Cayallee 229
D-1000 Berlin 33

ECHO
The Joint Mission Hospital, Equipment Board Limited
Ullswater Cresent
Coulsdon, Surrey
CR3 2HR
England

ECRI
5200 Butler Pike
Plymouth Meeting
PA 19462
USA

Fachverband Biomedizinische Technik (fbmt) e.V.
Gießener Str. 118
D-35452 Heuchelheim
Germany

Fachvereinigung Krankenhaustechnik e.V.
Geschäftsstelle
Mauerbergstr. 85
D-76534 Baden-Baden
Germany

FAKT
(Fördergesellschaft für angepaßte Techniken in der Dritten Welt)
Gänsheidestraße 43
D-7000 Stuttgart 1
Germany

FENATO
Sig. Dott. Ing. Alberto Lena
via dell'Unita d'Italia 13
I-47100 Forli
Italy

Foreningen of Sygehus
Attn. Mr. K. A. J. Jenson
Hjorringen Sygehus
DK-9800 Hjorring
Denmark

GATE/GTZ
Postfach 5180
D-6236 Eschborn
Germany

Hesparian Foundation
Box 1692
Palo Alto, CA 94302
USA

Institute of Hospital Engineering
20 Landport Terrace, Portsmouth
Hants PO1 2RG
United Kingdom

Interess foreningen, SPRI, Mr. Leig Tegman
Box 27310
102-54 Stockholm
Sweden

Intermediate Technology Development Group (ITDG) and
Intermediate Technology Publications
103-105 Southhampton Row, London WC1B 4HH
United Kingdom

International Agency for the Prevention of Blindness
National Institutes of Health
Bethesda Maryland 20205
USA

Nederlandse Vereinigin Van Techmici In de Gezandheidszorg (NVTG),
Mr. Gaston E. Lam
Pr. Irene Weg 7
NL-7422 DD-Schalkhaar
Netherlands

Society for Hospital Engineering of the American Hospital Association
840 North Lake Shore Drive
Chicago IL 60611
USA

Teaching Aids at Low Cost (TALC)
P.O. Box 49
St. Albans
Herts. AL1 4AX
United Kingdom

Technologietransfer Marburg TTM
Johann-Konrad-Schaefer-Straße 6
D-3550 Marburg
Germany

TOOL - Transfer of Technology for Development
Entrepotdok 68 a
NL-1018 AD Amsterdam
Netherlands

TÜV-Rheinland, Prüfstelle für Medizinische Technik
Am Grauen Stein
D-5000 Köln-Poll
Germany

UNICEF Procurement and Assembly Centre
Supply Division
Unicef Plads
Freeport
DK-2100 Copenhagen
Denmark

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