

Round Table

Gerald Bloom

The right equipment ... in working order

Careful planning of the procurement and maintenance of equipment is essential if the potential benefits of medical technology are to be realized.

In certain countries a lack of functioning medical equipment seriously compromises the efforts of health workers. The acquisition of medical equipment is often decided on the basis of requests by individual doctors or in response to offers by foreign donors, and little thought may be given to the prospects for maintenance and replacement. It is easy to underestimate the resources required.

A technical report for the United Kingdom's health service suggests that maintenance costs 6-10% of the capital value per year and that the mean life of equipment is between 6 and 10 years (1), which means that the annual cost of keeping equipment in running order would be 16-25% of the capital value. An estimate for India indicates that maintenance costs 10-15% of the capital value per year (2). Thus, at a conservative estimate, the cost of providing an

equipment service is unlikely to be less than 15% of the capital value of the stock.

On this basis, let us consider a project with a capital cost of US\$ 1 000 000, equipment worth \$ 150 000 and an expected running cost of \$ 250 000 a year.

One would require at least \$ 22 500 to cover maintenance and the replacement of old units, accounting for almost 10% of the project's expected annual running cost. These figures have been borne out in an African country, where, on the basis of an inventory of equipment, it was estimated that maintenance and planned replacement would require 12% of the recurrent health budget. In fact, only a third of this amount was allocated, and the service was seriously impaired. Given the importance of the equipment sector, the use of scarce administrative resources to improve its organization is easily justified.

Health facilities often possess items of equipment used for the same purpose but which have diverse specifications because they have been purchased from various countries. There is frequently a shortage of

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skilled maintenance personnel, and tools and spare parts may be lacking. Inadequate funds may be allocated for inputs, maintenance or replacement.

A recurring cycle can be discerned in the equipment sector in some countries (see figure): new equipment is purchased and installed, its effectiveness declines rapidly, and finally a rehabilitation programme is carried out. In many cases, funding for the equipment cycle comes from international agencies, one of which, the European Development Fund, has found that non-functioning equipment is very frequently a serious problem in health facilities. There is a danger that this agency may find itself increasingly allocating aid for the rehabilitation of earlier projects.

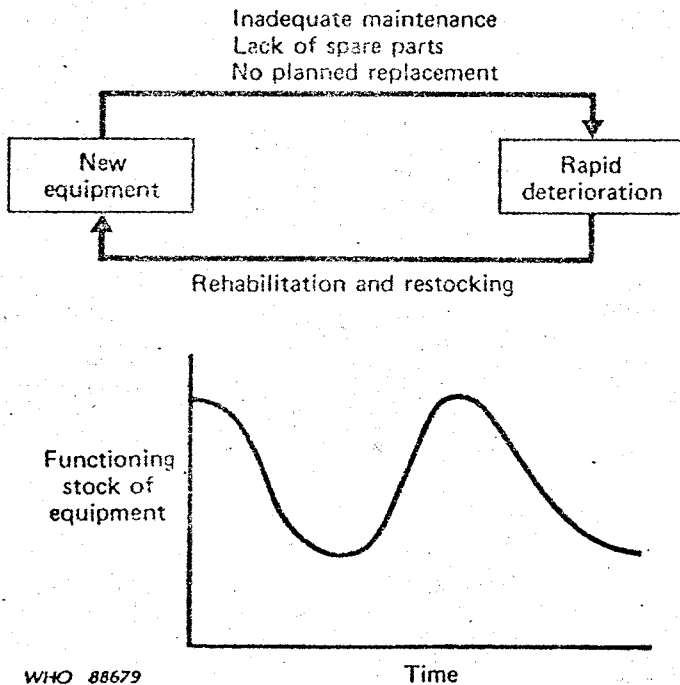
Cyclical funding is characterized by a lack of inputs and maintenance and a rapid deterioration of equipment, so that, for much of the time, the benefit derived from capital investment is small. Typically, little effort is made to standardize equipment, and small contracts are given to a number of suppliers. This makes cost-effective stock selection very difficult. The result is an expensive, ineffective equipment service that depends on periodic injections of money.

In order to avoid this situation it is necessary to plan the development of the equipment sector. The aim should be to acquire equipment capable of providing the services required at an affordable price. Provision should be made for the

uninterrupted functioning of these services over the medium term, and the sources of funding should be defined.

In a health service where there is inadequate information it may be useful to inventory the stock of equipment and assess its condition. It should also be possible to make a rough estimate of the annual expenditure required for maintenance and capital replacement. Such a study can provide a basis for improvement plans. The establishment of a well-managed equipment service demands sustained support from decision-makers. A recognition of the size of the problem should highlight the need to allocate sufficient administrative and

The equipment cycle



WHO 88679

technical personnel to oversee rationalization.

List of required equipment

The selection of equipment often lacks a scientific basis. International suppliers and middlemen have had a significant influence on the choices made in some countries. In order to make the best use of funds, requirements should be clearly defined before potential sellers are contacted.

Appropriate equipment should be defined for each level of care, and a detailed list should be prepared, bearing in mind user preferences, relevance to priority health problems, ease of use and maintenance, safety, and cost, the latter to include provision for a continuing service. The list should indicate priorities, so as to facilitate decision-making where there are resource constraints. Health workers, planners and technical experts should all be involved in decision-making. If the capacity to prepare such a list does not exist in a country's ministry of health, the assistance of an independent consultant should be obtained for this purpose and also for the setting up of a reviewing mechanism. In this connection it may be possible for regional institutions to provide technical support.

Purchasing plan

A purchasing plan should be drawn up to project annual requirements over a period long enough to achieve rationalization of the equipment sector, perhaps ten years. Proposals should cover restocking, expansion, spare parts, and wear and tear. Probable needs can thus be clearly defined and an important step taken towards improving procurement practices.

The fact that most large pieces of equipment are budgeted for in a country's development vote has implications for how any proposed expenditure might be regarded by the finance ministry. The division of public expenditure into

The existence of a purchasing plan may enable procurement officers to negotiate comparatively long-term contracts covering purchases and support for maintenance.

recurrent and development categories rests on an implied level of commitment to repetition in the future. Recurrent expenditure, typically meeting wage bills or consumable inputs, must be repeated each year if the level of services is to be maintained. The finance ministry thus tends to be quite strongly committed to continuing this allocation each year. Development expenditure, on the other hand, relates to large items that are expected to yield benefits for many years. While a new purchase may well imply increased recurrent inputs for it to be operational, it is assumed that the investment will not have to be repeated for a very long time. Development expenditure is usually seen as providing for expansion and as being avoidable in times of fiscal constraint.

In order to rationalize procurement, some funds must be committed for future expenditure. They should provide for the resources that will be required annually to pay for spare parts and to replace old units. Initially, the provision made may have to be based on experience acquired in other countries but eventually local needs should be defined. Some planned purchases for restocking and expansion may also merit high priority. The absence of a piece of

equipment may seriously impair the functioning of facilities and personnel. Some purchases may be essential for the development of primary health care. An attempt should be made to define a core

Significant Improvements have been made through in-service training, with the accent on preparing personnel to keep common pieces of equipment in good order.

schedule of equipment, the purchase of which will be less affected by resource constraints than will be that of other items. The prioritized purchasing plan should form part of the forward budget for the equipment service. Provision must also be made for a maintenance team and consumable inputs. The forward budget will have to be discussed with the finance ministry if commitment to future expenditure on both the recurrent and development votes is to be established. The advantages of a planned purchasing policy, as compared to the equipment cycle, will have to be demonstrated so that provisions can be made to support rationalization.

Rationalization of procurement

It is the task of the procurement unit to obtain the best possible deal for the health service. For a number of countries most purchases will be made on the international market. The usual procedure is to invite firms to submit tenders, and in this connection it is important to indicate requirements as clearly as possible, including the specifications of equipment in the standardized list and the need to support the maintenance unit. The choice of a supplier does not depend simply on price, as the appropriateness of equipment

to local needs and the quality of support services have to be taken into account. This principle should be established with the board that awards tenders. The existence of a purchasing plan may enable procurement officers to negotiate comparatively long-term contracts covering purchases, including those of spares, and support for maintenance. Every effort should be made to ensure that the contract signed with the supplier is as advantageous as possible. It may be useful to employ an expert adviser to assist in the negotiations.

The policies of donor agencies may obstruct the rationalization of procurement. If funds are tied to purchase from the donor country, a purchasing unit may be able to advise on the cost-effectiveness of accepting such an arrangement. The rules for awarding contracts may cause problems: for example, in projects funded by the European Economic Community it was thought that purchasing via competitive tender precluded standardization, since this could require preference to be given to firms that had already supplied equipment. The Lomé Convention, however, specifies that the criterion of "economically most advantageous" should be used when tenders are being assessed. A strong procurement unit can specify guidelines to ensure that the needs of an equipment service are considered in the selection process. Finally, donors have been reluctant to commit funds for extended periods, although this tendency is diminishing as the consequences of an excessive focus on short-term capital projects become apparent—in the costly equipment cycle, for example. The creation of an expenditure plan covering a substantial number of years provides a context in which negotiations on longer-term support for the creation of a sustainable equipment sector can be pressed.

Maintenance

Clearly, an inability to keep apparatus in running order will contribute significantly towards a decline in the usable stock of equipment, and will be very costly in terms of both lowered effectiveness of health services and increased pressure to make new purchases. It is also self-evident that a maintenance capacity cannot be established without adequate funds. When a decision to purchase equipment is made, the resources required to keep it in running order should be firmly committed. It is not enough, however, to make money available: the development of a maintenance capacity must be planned to meet priority needs. The strategy adopted should be based on an understanding of the national equipment sector.

Although it may appear that the simplest solution to this problem is to employ private companies, the desired results may not be obtained in this way. It is not advisable to have a public sector with no technical skills, since there is a need for maintenance on a regular basis. Furthermore, an important element in the avoidance of breakdowns is the education of users in correct ways of handling apparatus. Thus there is a need to create a cadre of technical experts in the public sector to ensure that decisions on equipment purchase and the use of external expertise for repairs are based on adequate information. When deciding whether to entrust maintenance to the private sector it is important to consider cost and quality control. Where the private sector is capable of providing services, alternatives should be assessed with a view to ensuring that any relationship is advantageous to the public sector. In countries where new resources are being allocated to create a capacity not previously available, it would seem desirable to develop a team that has a close

relationship to the public sector equipment service.

In many countries there is an immediate need to restore large amounts of equipment to running order. There is also a need to keep relatively simple items in good condition. Health policies aimed at expanding infrastructures in support of primary health care have made the basic maintenance of equipment a priority. Steps should also be taken to develop a corps of experts who can take a leadership role in training, the selection of equipment, and the repair of the more sophisticated units.

The diversity of objectives is unlikely to be met by a single development strategy. It may be necessary to recruit expatriates to do repair work, and where this happens they should also be brought into a process for establishing a local capacity to carry out maintenance. In a number of countries much equipment cannot be utilized due to faults that could easily be remedied. Significant improvements have been made through in-service training, with the accent on preparing personnel to keep common pieces of equipment in good order. Some initiatives have been hampered by training problems, difficulties in recruiting trainees,

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or transfers of qualified personnel to the private sector. The importance of equipment maintenance should be reflected in attractive salaries and career prospects.

In the longer run there will be a need for more highly trained cadres, capable of

Management, maintenance and repair of health care equipment

WHO Global Action Plan

Annual world expenditure on medical equipment is approximately US \$15 billion. However, in most developing countries a large proportion of this equipment is inoperable. In response to this situation, efforts have been made to improve various aspects of management, maintenance and repair of health care equipment. At WHO headquarters and regional offices, specific activities have been undertaken, focusing on the need to increase awareness in Member States of the issues involved. These have included the need for specific policies and improved managerial and technical capacities; support for the development and strengthening of national and intercountry training capabilities through the establishment of training institutions and the organization of courses; providing technical advice and consultancy services on the organization of maintenance and repair facilities and the selection, procurement and use of equipment. Collaborative activities with countries or intercountry programmes have also been developed by other international agencies, including IAEA, UNICEF, UNIDO, ILO, UNESCO, UNDP, the World Bank and the Commonwealth Secretariat, and by nongovernmental organizations, among them the International Federation of Hospital Engineering, the International Federation for Medical and Biological Engineering, and the International Hospital Federation, and by bilateral development agencies.

Unfortunately, the assistance provided to countries has not been as effective as anticipated because of a failure to appreciate the complexity of the problems. WHO, recognizing the growing importance of the subject and responding to the concerns of Member States about the lack of coordinated action, the duplication of effort, the neglect of some areas, and the wastage of resources, has launched the Global Action Plan on Management, Maintenance and Repair of Health Care Equipment, with the following main objectives:

- formulation and adoption of policies, strategies and approaches specifically related to health care equipment, as part of overall national health policies;
- establishment of information systems capable of receiving, assimilating and disseminating technical information to the health sector;
- strengthening of technical service infrastructures attached to national health systems;
- training of national staff, including technical managers, engineers, technicians, operators and users;
- strengthening of national training capabilities, including the establishment of national and intercountry training centres;
- strengthening of mechanisms for the exchange of information and for the sharing of experiences, expertise and training facilities at intercountry, subregional, regional and interregional levels.

The Global Action Plan addresses the following major problems confronting developing countries:

- lack of organizational policy;
- lack of information support;
- ineffective technical service infrastructures;
- lack of manpower development and training.

It aims to fulfil its objectives through collaboration with all the parties concerned, liaison with other organizations and agencies, and mobilization of resources for action. It is intended to complement other efforts in the field of health care technology undertaken and planned by various WHO programmes and by intergovernmental and nongovernmental organizations.

Enquiries about the Global Action Plan should be addressed to the Division of Strengthening of Health Services, World Health Organization, 1211 Geneva 27, Switzerland.

playing a leadership role in the maintenance field. Their responsibilities will include: developing an effective service, performing complex repairs, providing technical advice on procurement, and training and supervising technicians. There is a need to combine substantial experience of working in the maintenance service with specialized training. The latter can be arranged through a combination of formal courses offered by educational institutions, training provided by suppliers, work done under specialists in the maintenance service, and innovative programmes such as twinning with a health service in another country. The mix should be tailored, as far as possible, to the requirements of the maintenance service. In these circumstances there is a need for a coherent strategy for the development of the service and strong leadership to provide guidance through the early stages. The importance of retaining these cadres in the public sector should be reflected in the contractual obligations of the trainees and in the career prospects offered.

It is important that the development of a

maintenance team be integrated into the process of rationalizing the equipment service, particularly with regard to agreements made with international suppliers. Efforts should be made to ensure that all relevant information on purchased equipment is made available and that the supply of spare parts is assured. Contracts should, where necessary, cover the provision of training for local workers, access to consultation, and the availability of specialized personnel.

Coordination and collaboration

In a ministry of health, decisions affecting the development of an equipment service may be taken in an uncoordinated way by individual health facilities, a central procurement unit, a separate maintenance team, and government officers in contact with donor agencies. In every ministry of health there should be a unit with the capacity to give a strong lead in the creation of an equipment service. Liaison with other ministries, including those of

finance, planning, and trade, is also necessary so that the government is aware of the need to coordinate decisions on the importation of medical equipment.

Many benefits could accrue from collaboration at regional level. The

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advantages of standardizing equipment would be greater if suppliers were competing in a market of regional dimensions. The larger the market, the greater is the feasibility of seeking to create a capacity for manufacturing some equipment or components locally. It is very difficult to create the expertise to evaluate equipment, advise on the revision of standard lists, and strengthen negotiations with international suppliers at national level in all but the largest countries. The development of special training programmes, sophisticated maintenance capacities, and an ability to assess new technology and create relevant research programmes are all more viable at a regional level.

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The equipment cycle described above is the product of policies of national authorities, supplier companies, and donor agencies, all of whom will have to change their behaviour if rationalization is to be achieved in this field.

Ministries of health should recognize the cost of their previous neglect of this issue. Sufficient resources should be allocated to create development plans for equipment services and ensure their implementation. Efforts should be made to alert the ministries concerned to the benefits obtainable from a rational approach to the procurement of equipment. Regional initiatives should be taken in order to develop capacities that cannot be created at national level.

Large suppliers have to decide whether they wish to focus on short-term gains resulting from cyclical re-equipping of the health sector, or on the establishment of long-term markets. Donor agencies have to recognize the expensive consequences of some of their policies in this area. Neither companies nor donors are likely to change their policies in the absence of a coherent approach to negotiations by purchasers at the national and regional levels, something that could be encouraged by international organizations.

Unless ways are mapped out for ensuring sustainable equipment services at reasonable cost, health sectors will increasingly be denied the benefits that medical technology can provide. □

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Discussion

Hans Halbwachs

—Planned maintenance the key

In the Agency for Technical Cooperation of the Federal Republic of Germany, we have found that a maintenance and repair system can only be successful with proper adaptation to local conditions. In addition to the standardization of quality criteria and equipment lists for the different levels of care, countries should define and enforce adequate acquisition procedures. These should cover spare parts, comprehensive documentation, and satisfactory warranties, among other things.

With regard to Dr Bloom's statement about the annual cost of maintaining equipment, we found in an African country that the average life of the most important equipment was only about 35% of achievable values. A planned maintenance system, designed according to the situation in the country, could raise the average life by 10-20%. The annual expenditure for such a system ranges from 3% to 10% of the capital cost. In most countries it is advisable to adopt a cautious policy and start with a low percentage (2-3%); in this way it is possible to achieve at least a balance between maintenance expenditure and saved replacement cost. This estimate is applicable to the majority of health care facilities in rural areas which are the primary target of donor interventions. The combination of maintenance and equipment replacement costs, as suggested by

Dr Bloom, may not always be useful in developing countries. Only too often, Third World countries depend on donations of equipment and replacement costs are not taken into account. In many cases these are placed under separate budgetary headings and are not regarded as part of the service cost.

In developing countries, maintenance costs are mostly an unknown quantity. Cost centre accounting, or at least a well-developed maintenance record system, is necessary to facilitate planning and allow verification of the hypothesis that maintenance is financially advantageous rather than an additional burden on the health budget. It should be understood that other measures than preventive maintenance in the classical sense would be necessary to achieve optimal results with respect to financial benefits and an adequate quality of medical care.

Only if a health ministry has acquired maintenance know-how will it be able to cooperate with the private sector in a way satisfactory to both parties.

Subjects related to maintenance should be introduced into the basic vocational training of medical, paramedical and administrative personnel. Postgraduate courses for users, or seminars for administrators, have an important supportive role but on their own do not have the desired long-term effect. This is

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because maintenance requires an integrated approach whereby almost all health personnel are actively involved. Thus administrators should know how to facilitate a maintenance service, while nurses should know how they can fit into a maintenance schedule in case of a breakdown.

This all leads to the need for a coherent maintenance strategy based on a planned maintenance scheme. In order to design, introduce and enforce such a system and to follow up activities in the field, a sufficiently strong unit responsible for equipment management should be established at ministerial level, as advocated by Dr Bloom. He also refers to the usefulness of an equipment inventory: I would go even further and suggest that this is an indispensable first step for a ministerial unit when setting up a national maintenance system. The design and implementation of the training of maintenance personnel should also be undertaken at an early stage. A nationally recognized training scheme is necessary, to avoid, among other things, problems with entry requirements and with the salary structure in the public service. The establishment of additional public service posts is often difficult, partly because constraints may be imposed by the International Monetary Fund. Salaries for technical staff in public service are usually much lower than those in the private sector and non-negotiable. One solution to this problem would be to create a foundation linked to the ministry which was independent enough to provide sufficient flexibility.

The private sector plays a special role in equipment management in developing countries. Manufacturers are inevitably involved when highly sophisticated equipment and complicated repairs are

needed. On the other hand, private firms can hardly be used for preventive maintenance programmes, since the continuous presence of qualified technical staff is imperative. Private companies often do not provide acceptable maintenance services, partly because the market for medical equipment in developing countries is comparatively small. Furthermore, underdeveloped technical structures present difficulties, a problem that can be significantly mitigated through manpower development and standardization. Only if a health ministry has acquired maintenance know-how will it be able to cooperate with the private sector in a way satisfactory to both parties.

There is a great need for further exchanges of information and opinions and for the coordination of donor activities. The World Health Organization could take a leading part by developing a practicable strategy for equipment management and maintenance in health services of Third World countries. A good start has been made with the Organization's proposal for a global action plan in this field. □

Ved P. Kumar

—A tried and tested solution

As Dr Bloom mentions, in most developing countries there is a large variety of equipment of different models and makes, complicating the problems of maintenance and spare parts management.

Major hospitals often have surplus equipment, whereas in peripheral facilities

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there are shortages of the most commonly used equipment and what is available frequently does not work because it is not regularly maintained or repaired. Three categories of non-functional equipment are generally found at various levels of health care:

- broken-down equipment awaiting condemnation or procedural write-off;
- equipment needing major or minor repairs and awaiting either the arrival of spare parts or the attention of an expert technician;
- donor-supplied and other sophisticated equipment that either has not been commissioned or has been damaged in transit and is awaiting the arrival of spares and/or the manufacturer's service representatives.

The management of equipment is generally neglected. A busy ministry of health official may be assisted by a junior supply officer with experience in tendering procedures but with little knowledge of the functional and technical aspects of biomedical equipment. Tenders may be issued with inappropriate specifications and equipment of varying specifications may be accepted.

The approach to equipment care is more prominently curative than preventive. Users, who are mostly doctors and laboratory technicians, have neither the training nor the inclination for preventive maintenance and generally abandon equipment once it stops functioning, even if only minor faults are responsible.

There is no standardization of equipment nor is there a policy regarding the level of sophistication that countries can absorb. Single-specialty doctors, trained abroad, are sometimes influential in securing the

procurement of highly sophisticated and costly equipment that is rarely used. When these doctors leave the public service the equipment is likely to become idle if there are no other trained persons capable of using it. Equipment lists for various levels of health care are not well defined.

Equipment should be inventoried at each level of health care by age, type and functional status.

The insistence by donors on tied procurement militates against standardization. Sophisticated equipment is often donated which has very little use in developing countries and is very expensive to maintain. There is a lack of maintenance skills and a quick turnover of technical staff in the public sector due to poor pay and career prospects. No systematic assessment or use of private sector capabilities is made, mainly because of a lack of expertise in health ministries.

Usually, there is no distinct operational budget, since transport, petrol, oil, lubricants and equipment maintenance tend to be lumped together. Often the major portion of these funds is used for running ministry vehicles.

Maintenance contracts are seldom entered into with manufacturers at the time of purchase. Where such contracts exist they are often with manufacturers having no local or regional representation, and the response time is therefore six months or longer in most cases. Circuit diagrams for sophisticated equipment are seldom available.

One way of dealing with the equipment problem, which has been successfully tried

in Malawi, Sri Lanka and other developing countries, is outlined below.

- Equipment should be inventoried at each level of health care by age, type and functional status (serviceable, broken down but repairable, or unserviceable and requiring condemnation). This helps to identify any redundant or surplus items. The result of such an inventory, combined with the standardization of equipment, should form the basis for future procurement. Standardization should cover the level of sophistication and the cost-effectiveness of equipment. The Crown Agents in the United Kingdom and UNICEF have done some very good work in standardizing equipment packages for the primary and secondary levels of health care and could be requested for assistance.
 - Equipment, especially the most commonly used items, should be standardized for the various levels of health care, and a clear policy decision should be taken on the level of sophistication required. Standardized equipment lists should be made available to donors.
 - Procurement procedures should be standardized and one of the following options should be exercised.
 - Open general tender could be adopted for commonly used equipment, based on well-defined functional and technical specifications. Evaluation and quality control criteria should be developed to evaluate bids.
 - For highly sophisticated equipment, prudent shopping or direct negotiation with reputable manufacturers who have local or regional servicing facilities should be considered. Procurement
- from such sources should involve total package deals, with long-term service contracts and guaranteed spares for at least five years.
- A system of monitoring the performance of suppliers in terms of service and the availability of spare parts should be developed. A regional information-sharing system should be set up so as to improve the countries' bargaining position and encourage suppliers to establish a regional service focus.
 - An equipment management unit should be set up in each ministry of health under a qualified biomedical engineer. The unit should be responsible for overseeing and organizing routine preventive maintenance and major repairs by using a blend of in-house and private sector facilities. It should also draw up both technical and functional specifications for equipment that is to be procured.
 - Undertaking total in-house maintenance is not generally cost-effective. Furthermore, high staff turnover, inefficiencies in public sector operations, and the theft of spare parts usually increase costs and reduce the efficacy of maintenance. A multi-pronged approach to maintenance is therefore desirable, using a blend of all available resources as indicated below.
 - For preventive maintenance and routine repairs, each ministry of health should, depending on the size of the country, establish maintenance teams at central or regional level, consisting of an electrical and a mechanical technician. These teams should have tool kits, simple diagnostic kits, and common spares, and should visit peripheral facilities every month or two months in

accordance with a fixed itinerary. Peripheral units should receive advance notice of the visits and should be requested to have equipment requiring routine maintenance and minor repair in a state of readiness. The biomedical unit should prepare maintenance manuals and checklists for use by the teams.

- In each principal hospital there should be a maintenance team consisting of an instrument engineer, an electrical technician, and a mechanical technician. The instrument engineer should be responsible for establishing routine maintenance schedules, carrying out preventive maintenance and minor repairs, and inspecting and preparing maintenance orders for equipment that requires major repairs. An emergency response system should also be set up.
- For major repairs, private sector facilities should be used. The biomedical engineering unit and the instrument engineers in hospitals should periodically assess private sector capability and prepare a list of private sector services. Based on this analysis, contracts should be entered into with the private sector for specific jobs at firm prices and fixed time-schedules. The biomedical unit should exercise quality control on repairs undertaken by the private sector.
- For sophisticated equipment a service contract including the provision of spares for five years should be entered into with the suppliers at the time of purchase, clearly specifying the periodicity of service, the charges, and the damages payable in the event of breach of contract.
- An equipment breakdown reporting system should be introduced and strictly enforced, so that information is available to maintenance teams before they make field visits, enabling them to requisition spare parts that may not be in their routine maintenance kits.
- A classified list of spare parts used in maintenance should form the basis for their procurement. A limited stock of spare parts that are difficult to obtain should be maintained under tight security; they could be made available to private sector workshops for specific jobs so as to avoid delays that might be caused by foreign exchange constraints.
- Adequate reserve stocks of maintenance tool kits and diagnostic kits should be kept at central stores so that routine maintenance can proceed without interruption. In addition a reserve stock of the most commonly used equipment, equivalent to 5% of the annual procurement budget, should be kept at central stores for replacement supply to facilities in the event of major breakdown, so that services to patients are not impaired. Initially, it is probable that the reserve equipment list will be prepared on the basis of expected demand rather than of experience. At the end of each budget year, therefore, the unused stock should be accounted for as inventory on hand for the next year's procurement planning, and fresh provision should be made for reserve stock procurement in accordance with previous experience. This process should be repeated annually to prevent the undue accumulation of some types of equipment, until the reserve equipment list has been satisfactorily refined.
- A training plan should be developed to improve the technical skills of maintenance staff by:

- using the services of expatriate specialists for on-the-job training and maintenance scheduling;
 - seconding maintenance staff to private-sector workshops for extended periods;
 - seconding staff to manufacturers' service centres for training in the maintenance of equipment supplied by the manufacturers, as part of procurement-cum-service contracts;
 - sending selected staff to institutions in developed countries to keep them abreast of the latest maintenance techniques;
 - periodic training of clinical staff in the care of equipment by users and in routine maintenance.
- Maintenance manuals and users' guides should be produced and circulated to all user staff.
 - Detailed manuals should be prepared for maintenance staff and should be carried by them while on field visits. A recording system for scheduled maintenance, including the indication of spares used, should be developed. All parts that are replaced should be properly accounted for; they may be either reconditioned for subsequent use or disposed of. □

A. Mallouppas

—A global enterprise

Developing countries have to contend not only with a lack of technical tradition and

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skills but also with financial problems and a dearth of expertise in middle management. Many field reports point to the extremely limited availability of foreign currency and the consequently poor ability to purchase spares, a major factor preventing even the simplest repair work. Moreover, even where a national health care technical service exists, bad roads and unreliable vehicles make it very difficult to get technicians to equipment or vice versa. General problems of foreign currency, roads, water, electricity, and so on belong in the domains of ministries outside the health sector. Work on policy formulation, equipment management, the setting up of a health care technical service, manpower development, and information data banks can only be effectively performed if these problems are resolved. When suggesting approaches and implementing actions, it is important to remember that problems do not exist in isolation but are part of an interacting whole.

Dr Bloom highlights the main issues involved in equipment management and deals with them mainly from a financial viewpoint, without going into the details of technical solutions. The World Health Organization's Global Action Plan (1) dealing with this field was formulated on the basis of various studies, including the report of a WHO interregional meeting (2). Specific funding proposals made in the Global Action Plan are being studied by donor agencies and it is hoped that implementation will commence in 1989.

It has emerged that particular importance attaches to:

- the establishment of a health care technical service in each developing country, with facilities, staff, equipment, budget, and back-up support;

- the adoption at ministry level of proper policy formulation and planning for equipment, based on the identification of needs and leading to purchases, specifications, training of users and service personnel, inventory and installation;
- the strengthening of local expertise in the collecting, collating, assimilating and distribution of information;
- the establishment of national information data banks and of training within local capabilities.

To meet these requirements it is necessary to have technical managers, engineers and technicians, for whom there should be suitable training, designed with the needs of developing countries in mind. At present the various training establishments cater mainly for technicians; the higher, more specialized grades are poorly served. Studies are being carried out on how best to approach the training of people in the higher grades while improving that of technicians, particularly at country level.

Technical managers at M.Sc. level and engineers at B.Sc. level are intended to provide middle management for the servicing of the more advanced equipment now available in almost every country. It is on their shoulders that responsibility for the necessary teamwork and liaison between users and service, finance and planning departments will fall. They will have access to policy-makers and will have to fight for budget allocations, facilities, training and, importantly, the right of engineers in particular to be present at the initial planning stages of equipment management.

At present, given the very difficult financial situation, the standardization of equipment

may be impossible, since, in many countries, purchases are restricted and new equipment is usually donated.

Unfortunately, donors are frequently unaware of, or do not care about, the consequences of their actions, and in many cases totally inappropriate equipment is provided, almost always without technical

The aim should be to make developing countries self-sufficient in basic training, servicing, planning and policy formulation.

support; even manuals are lacking in some instances. Donors and governments have to be persuaded that equipment should be appropriate and accompanied by spare parts and technical documentation, and that training for users and service personnel should also be provided. It is not possible to achieve good administrative practices, inventory control, the planning of facilities, and the training of users in the handling, care and simple maintenance of equipment, particularly at the primary care level, unless there are adequate engineering and technical management staff.

The preparation of competitive specifications for at least a standard list of equipment also needs experienced personnel, whose training and placement require time, and who, under present circumstances, will probably be lost to the private sector. Under the Global Action Plan, WHO is hoping to produce generic specifications for standard equipment, use and maintenance manuals, and training materials. The initial list of equipment will probably cover commonly used items such

as microscopes, sterilizers, autoclaves, hot air ovens, and suction pumps.

The above information, together with training materials, could best be produced at regional or global level, as Dr Bloom indicates, since this is where the necessary resources and expertise exist. Furthermore, on this basis the results could be made available to all countries. Information concerning service workshop tools and facilities, staff structures, training opportunities and so on could also be produced at this level and made available to countries through intercountry awareness workshops, in order to strengthen national health care technical services.

Any expatriate inputs at national level should be designed to establish a sound base of training, servicing, planning and management. It is not satisfactory to give attention only to one aspect or, worse, to go into countries, service equipment, and then leave without having made a truly lasting contribution.

The final aim should be to make developing countries self-sufficient in basic training, servicing, planning and policy formulation, so that they can handle their own projects. However, it should not be forgotten that establishing so much expertise and tradition takes time, and that a committed, comprehensive and realistic approach is vital. □

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Joseph McKie

—Links in a chain—

Dr Bloom's excellent paper should be read in the ministries of developed countries that buy themselves out of problems of their own creation and thereby exacerbate those of developing countries. However, to health service administrators in the Third World the systematic approach propounded by Dr Bloom may seem unrealistic.

Attempts at improving the equipment situation are frequently undermined. Thus an embryonic training scheme may be defeated by a lack of experienced trainers; the acquisition of experience may be made difficult by a lack of posts and of a career structure; technical ability acquired during training may quickly decline if work is abandoned because there is no funding for spare parts; when funding schemes are devised, the ordering of parts may be frustrated by currency restrictions and customs regulations; underlying these and many other difficulties is widespread poverty.

In 1986 the World Health Organization held the first interregional meeting on the maintenance and repair of health care equipment in Nicosia, with participants from 25 countries, international organizations, professional organizations, aid agencies, and major manufacturers. Recommendations were made which led to a Global Action Plan, concentrating on the promotion of awareness, policy formulation and information exchange, the strengthening of national health care technical services, and manpower

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development. The latter question, touched on briefly by Dr Bloom, is of major importance to all developing countries that cannot employ expatriates in substantial numbers. In fact, manpower development has usually been the first problem to be identified and addressed. One of the main points made in Nicosia was that it was only one link in a chain including policy formulation, the establishment of health care technical services, and so on. If progress is to be made, each link must be strengthened. Dr Bloom's emphasis on these other aspects is therefore to be welcomed, but the difficulty should not be underestimated of educating and training staff who will formulate and implement policies. He says that some initiatives have been hampered by training problems, but it would be more realistic to say that most initiatives have failed and that only a minority have made a discernible contribution to national health care.

A common reason for the failure of well-intentioned aid programmes designed to develop manpower is a lack of understanding in donor countries of the economic, industrial, educational and cultural environment in recipient countries. The programmes offered may be no more than slightly modified versions of courses designed for staff in very different societies. The technology of training in a developed country may be no more appropriate to a developing country than is highly specialized and sophisticated medical equipment.

With regard to the reluctance of donors to commit funds for extended periods, a matter referred to by Dr Bloom, the Nicosia meeting felt that donor countries or agencies were often unaware that not only equipment but also provision for its maintenance was necessary. The meeting urged that not less than 20% of funds

allocated by donors for the provision of equipment should be used to maintain or repair it during the three years following the expiry of any period of warranty, and that the amounts in question should be held in trust or otherwise administered as agreed by the parties involved.

The Nicosia meeting expressed views similar to those of Dr Bloom concerning the short life of equipment that is not adequately maintained. However, he does not mention that much equipment purchased by or donated to developing countries never even begins to function. It is worth drawing attention to the installation of major items of equipment, such as large X-ray units, autoclaves, mortuary cabinets and stand-by generators, for which programmes are necessary to coordinate the various stages of building and the provision of services with the delivery of the equipment, its commissioning by the manufacturers' engineers, and its handing over to the user. On a recent visit to an African country I saw equipment valued at many millions of dollars which had virtually been abandoned because it had been delivered to an

Mismanagement starts in health ministries and spreads through the offices of regional health authorities, hospital boards and hospital directors.

unprepared site. The expertise required to manage major installation projects will seldom be available until a health care technical service is well established; before this, know-how in project management

should be purchased from either the supplier or a health ministry in a developed country. This may appear expensive but will avoid wastage and actually save money.

However, long-term improvement in the utilization of health care equipment requires careful attention to the matters outlined by Dr Bloom. This is not a field of small importance, to receive attention once major organizational problems of health care have been solved. On the contrary it is vitally significant, as is well illustrated by the following extract from the report of the Nicosia meeting.

"In one South American country it is estimated that the replacement value of medical equipment is US\$ 5 billion. Forty percent of this is not functioning,

representing a loss of assets of \$ 2 billion. The annual bill to properly maintain the equipment, added to that for purchase of equipment and devices would be \$ 650 million. For comparison, the drug bill of the country is \$ 400 million, although this smaller expenditure receives much more scrutiny."

A problem of this magnitude demands action. It is not enough to initiate projects at the technician level. The mismanagement of medical equipment starts in health ministries and spreads through the offices of regional health authorities, hospital boards and hospital directors. These are the places where the principles outlined by Dr Bloom should be learned, and where engineers, scientists and others capable of applying them should be appointed. □

V.A. Mihel'son & B.M. Dmitrienkov

—An important element in the health-for-all strategy

Technological progress has put powerful analytical tools in the hands of physicians. Diagnostic procedures have increased in scope and speed, a higher order of information has become available, and medical examinations have become less traumatic.

In the USSR, these developments have led to the allocation of considerable resources for the maintenance of medical equipment.

Unfortunately, the need for after-sales service has often been overlooked. Ideally, of course, one should have the kind of budget advocated by Dr Bloom, with planning of the procurement, distribution, repair and replacement of equipment over a number of years.

Dr Bloom is quite correct in his assessment of the importance of maintenance for both stable diagnostic capacity and the efficient use of equipment over six to ten years. It undoubtedly makes good economic sense to establish a special department for the repair and maintenance of complex apparatus.

It is important that the training of qualified staff should cover coordination and cooperation with manufacturers. If a manufacturer intends to stay in business for a long time and step up his activity as a medical equipment supplier, it is clearly in

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his interest to set up an effective after-sales service.

In addition to a central repair and maintenance facility, there should be fully trained technicians capable of carrying out maintenance on equipment where it is installed. A good maintenance service in every department that uses sophisticated modern machinery helps to reduce the incidence of breakdowns and diminishes both the burden on the more highly qualified central service and the time required for repairs. Much less money is needed for such a service than for dealing with breakdowns where expensive equipment is neglected. When the equipment is acquired the maintenance technicians should help to assemble it, thus consolidating the training they have received, and, along with medical personnel, should be instructed in its use.

Experience in the USSR has shown that the high potential in medicine cannot be realized if equipment is not properly maintained. No single country is capable of supplying the health sector with all its apparatus together with a satisfactory standard of maintenance. What happens is that firms in different countries specialize in the manufacture of particular types of equipment and are thus able to provide the highest possible quality at the keenest prices.

The policies of purchasing establishments or organizations should take into account the views of leading specialists. The tendency of trading organizations to buy large quantities of the cheapest equipment with a minimum of spare parts and non-reusable materials is not advantageous in the long term. Such equipment breaks down relatively rapidly and, in the absence of spare parts and after-sales service, may fall into disuse within a year or two.

Reputable equipment, purchased with the appropriate quantities of non-reusable materials and with an assurance of after-

In addition to a central repair and maintenance facility, there should be fully trained technicians capable of maintaining equipment where it is installed.

sales service, can be expected to give eight to ten years' use, a more viable prospect.

Cooperative organizations dealing with various medical technologies could be set up to provide after-sales service and repair in large medical institutions. This kind of decentralized arrangement is more flexible and effective than a state body responsible for contacting foreign companies and organizing the repair of all the equipment that has been purchased. If leading specialists are involved, contacts between medical institutions are improved, and this makes it much easier to ascertain maintenance requirements and resolve practical problems.

The World Health Organization, through its connections in many countries, is in a position to ascertain which equipment best meets today's requirements and has the best maintenance conditions. The Organization also has the capacity to run seminars on maintenance, train specialists, and provide supervision and technical assistance.

There can be no doubt that providing health care institutions with equipment and proper maintenance is an important element in the health-for-all strategy.

Nandor Richter

*—People need machines,
machines need people*

Equipment used in the health field may be potentially dangerous, yet maintenance systems capable of diminishing the risks are scarce. This is partly because the quantity of advanced apparatus in use has rapidly become very large.

With regard to the acquisition of equipment, there is often a tendency to purchase the cheapest available, irrespective of the possible consequences. As Dr Bloom points out, the choice of a supplier should depend in part on the appropriateness of equipment to local needs and on the quality of support services. Operation and maintenance may be made unnecessarily difficult by inconsistent importing practice.

National and international organizations are obliged to tackle these problems. At present the principal ways of doing so are to set up service courses, train some people at graduate or postgraduate level, appoint

It is important to provide continuing training for maintenance personnel so that they can keep up with the rapidly changing medical equipment scene.

experts from abroad for short periods, and provide financial support. Unfortunately, the results achieved have not been commensurate with the intellectual and material investment, and have tended to be

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short-lived. Lasting progress may be secured if uncoordinated projects give way to systematically organized technical networks. An organization in which technical experts and economists cooperate with physicians may be able to accomplish the desired results.

An inventory of equipment has to be drawn up and replacements should be made as required. The equipment needs of hospitals and other health institutions have to be determined. Central and regional maintenance bodies should be established and should operate in close collaboration with service units in factories and with trading companies. It is important to provide continuing training for maintenance personnel so that they can keep up with the rapidly changing medical equipment scene. Such an organization should work with physicians and economists at the medical planning phase and should contribute to the advice given to politicians. It should also be able to create the information background necessary for planning and investment.

Technical experts and physicians working in medical institutions should have proper status, possibilities of advancement, and acceptable salaries. If these vital requirements are not met, the quality and consistency of service can be expected to decline.

The expertise required for establishing organizations of this kind is already available in several developing countries, where the international organizations could do much to start system-orientated work. Leading politicians in these countries should be encouraged to initiate progress along the lines indicated.

Many schemes in developing countries have declined after the discontinuation of

international support and the loss of valuable contacts. A concentrated, systematic approach is essential. The provision of equipment is not in itself enough: people have to be trained to use, maintain and repair it. The International Union of Physical and Engineering Sciences in Medicine, which is represented in more than thirty countries, operates in this spirit and endeavours to cooperate with WHO and other international organizations. □

The countries of the Third World offer very limited market opportunities to most manufacturers, who consequently find that they cannot set up profitable after-sales service networks as they do in the

The selection of equipment is the buyer's prerogative; ensuring that it serves its intended purpose is the joint responsibility of user and manufacturer.

K. Thairu

—Manufacturers and users in joint endeavour

It is amazing that the health care profession, whose task is to "maintain" and "repair" people, finds it so difficult to organize the repair and maintenance of the equipment it uses. One reason for this is that many health professionals have a wrong attitude towards health care equipment and technology, leading to an irrational approach to acquisition, repair and maintenance. A rational approach can only be achieved through some understanding of the equipment.

As Dr Bloom points out, maintenance problems have some of their origins in acquisition policy, weakness in which has led to the accumulation of millions of dollars' worth of defunct equipment in many developing countries. If the factors that contribute to poor policy were understood a lasting solution might be found.

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industrialized countries. The volume of sales in the developing countries would not justify such an investment, they argue. For their part the equipment salesmen find that it pays to adopt a "wait and replace" attitude. In time, the equipment they sell breaks down and, since after-sales service is inadequate, they sell newer models and thus remain in business. Essential equipment is sometimes discarded because of very minor faults. Expensive mobile X-ray units have, on occasion, ceased functioning because of small mechanical problems in the vehicles that carry them. There is therefore an urgent need for change in the way equipment is acquired and managed. Furthermore, salespeople and manufacturers ought to adopt an ethical marketing code.

As Dr Bloom says, it is necessary to involve donors and the private sector. There is also a need to improve the interaction between manufacturers and users. An ethical code should be agreed on by both regarding the sale of equipment. The selection of equipment is the buyer's prerogative; ensuring that it serves its intended purpose is the joint responsibility

of user and manufacturer. The "wait and replace" tactics of middlemen cannot be justified on humanitarian and economic grounds. Equipment is costly and the services for which it is intended are not given when breakdowns occur. Middlemen strongly resist any change that might reduce their profits, but the economic difficulties facing most governments are bound to have an effect. No country can afford an extravagant equipment replacement programme. More systematic, logical and economic methods of acquiring and managing equipment are urgently needed so that it lasts as long as possible.

With regard to the rationalization of tendering, after-sales maintenance, and training, it is worth examining a set of guidelines that have been successfully used in one institution: the following conditions have to be fulfilled by persons wishing to submit tenders or quotations.

- The supplier must have a local representative who can provide after-sales service.
- The local representative must have a demonstrable capacity to service and maintain the equipment.
- The manufacturer must give a two-year guarantee against faulty manufacture.
- The manufacturer or his local representative must install the equipment free of charge and commission it.
- The manufacturer, at his own expense, must undertake to train local technicians in the maintenance of the equipment.
- The manufacturer must maintain the equipment, free of charge, for between six months and one year, during which time he must train the user's technicians.

- The manufacturer must guarantee the availability of spare parts for each item of equipment during its projected life, which may be up to 10 years.
- Within the guarantee period, any equipment found to have a fault that cannot be permanently rectified is replaced at the manufacturer's cost. Alternatively, the customer may opt for a full refund.
- For each item of equipment, the user must be supplied with full technical information and with maintenance and repair manuals written in his or her official technical language.
- Manufacturers or their representatives must undertake to train users on the correct use of each machine immediately before commissioning so as to ensure that the equipment will serve its purpose and not be damaged by misuse.

The guarantees do not cover wilful damage or damage through misuse. Even when the guidelines are observed, problems still arise because of weaknesses in the user's system for handling equipment. To be able to get maximum use of equipment the user should recognize the need for and establish a secure career structure for maintenance and repair personnel along the same lines as for other health personnel. This ensures availability within ministries of health (and/or ministries of public works) of complete teams of maintenance personnel, ranging from junior technicians who do preventive maintenance to engineers who can design and modify equipment.

There should be discussion between the health care equipment industry, ministries of health, ministries of finance and planning (including personnel development), and donors, with a view to

drawing up a new code for the marketing and management of equipment and for the training of users and their technicians and engineers.

Dr Bloom's idea of standardization of equipment at the regional level has a lot of merit but may be impracticable except in respect of safety and conformity to specifications. If manufacturers and their agents are selected by potential customers using the criteria given in Dr Bloom's paper and if the suggestions made above are taken into consideration, only firms that can maintain equipment properly will be able to sell it. In any case, with the help of technical advice, the specifications of most modern equipment can easily be interpreted and compared with those of rival makes without standardization. Technical evaluation by experts and well-informed users will also indicate which makes of equipment are superior to which. For this reason, a health care equipment data base would be most useful to health workers in developing countries. The suggested regional approach supported by institutions in developed countries would be very helpful in this connection. □

Wang Binseng

—An integrated approach

The main ideas put forward by Dr Bloom are essentially correct, although some of his suggestions would be hard, if not impossible, to implement in many places for political and financial reasons.

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There seem to be four basic reasons for failures in the management of equipment.

- *Lack of training, experience and awareness among decision-makers regarding the management of modern technology.* These people tend to treat equipment in the same way as drugs or buildings. Equipment needs continuous care, maintenance and spare parts. It deteriorates and rapidly becomes obsolete, making frequent replacement necessary. Furthermore, it requires comparatively sophisticated users and service personnel.
- *Equipment is often primarily considered to be a status symbol.* Instead of purchasing items that would adequately meet the needs of patients, many doctors insist on acquiring equipment that is superficially the most impressive, regardless of price, performance, and, often, real efficacy and safety.
- *Greed and short-sightedness of manufacturers and suppliers.* This is evident in the sale of excessively sophisticated equipment to hospitals and countries that do not have the technical and financial resources necessary to operate, maintain and update it.
- *Selfishness of so-called "donation", "aid" and "cooperation" programmes that are actually sales-promoting schemes.* These have stimulated the purchase of large quantities of costly equipment, without any commitment to dealing with problems of operation and maintenance.

Most of the problems mentioned by Dr Bloom can be placed in the following categories.

- ★ *Deficient planning.* Health planners often ignore the costs of maintenance

and replacement of equipment. Furthermore, long-range planning, as proposed by Dr Bloom, is almost impossible in most developing countries due to the lack of political and economic stability.

- ★ *Irrational procurement methods.* In spite of the large amount of money involved and the enormous social impact,

Changes will have to be brought about by users, rather than by companies or donors.

procurement is usually handled by administrators or physicians with little knowledge or experience of technology management. Standardization, as proposed by Dr Bloom, could be advantageous; care would have to be exercised, however, since excessive dependence on a few suppliers can become a serious handicap.

- ★ *Lack of qualified personnel.* The extreme sophistication of health technology requires qualified staff, ranging from the technicians who operate and repair equipment to the managers who are responsible for planning and procurement. It should be stressed, however, that it is useless to establish training programmes if there is no adequate salary and career perspective, since in this event trained people would move into private industry.
- ★ *Difficulty in obtaining spare parts and technical documentation.* As regards spare parts, the real problem is usually a shortage of money. Technical documentation may be obtainable from

other hospitals. However, the proper solution to these problems is to include in purchase contracts a demand for at least one complete set of technical literature with each item and to require the sale of spare parts and supplies during the life of the equipment.

Dr Bloom is entirely correct in saying that changes will have to be brought about by users, rather than by companies or donors, as the following account illustrates. An integrated policy for health equipment in the State of São Paulo, Brazil, was introduced in May 1987 as part of a larger effort to reorganize and restructure the entire public health system, consisting of about 540 hospitals, 1000 outpatient clinics and health centres, and 10 research centres and manufacturing facilities. Right from the beginning it was clear that the new health system had the following major roles with respect to technology: it was the major consumer of equipment in the State and its purchasing power could be used to induce research and development; being the public health authority, it was responsible for the regulation of all health devices manufactured and sold; and as the main health service provider it was in a position to serve as an example of proper technology management. The new policy for health equipment therefore tries to integrate research, development and regulation with all phases of the acquisition and use of each item of equipment, namely planning, procurement, acceptance testing, utilization, maintenance, repair, refitting, and obsolescence.

To implement this policy, a multidisciplinary technical group was created. Directly under the Secretary of Health, it is responsible for all issues related to equipment and serves as a link to other departments in the State as well as to equipment manufacturers and suppliers. It participates in equipment

planning at all levels of the health system by providing technical expertise, including a computerized data base. It coordinates all centralized procurements, establishing delivery schedules, technical specifications, documentation, warranty, and after-sales services. It also issues the final acceptance of each piece of equipment that is delivered and installed, after careful testing by users and technicians.

Through the establishment of new engineering teams in large hospitals and research and manufacturing centres, the group is engaged in the creation of a network of technology management and maintenance throughout the health system. Besides doing repairs and maintenance, these teams perform acceptance testing, user training, supervision of services provided by dealers, some refitting and refurbishing, and consultations in their own institutions. So far, three teams have been set up; five are being planned and many others will have to be created.

Working closely with manufacturers and the regulatory branch of the health

secretariat, the group is trying to improve the quality of equipment produced in the country and to decrease the amount imported. For example, minimum technical specifications have been drawn up for the most commonly used equipment and clear selection criteria have been set so that manufacturers can judge whether they should invest in more stringent quality controls and/or new product development. Universities and research institutions are frequently invited to participate in these tasks.

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It is clear that, instead of just dealing superficially with problems, efforts should be made to tackle their real causes.

Although each hospital, state government, or national health system has to find its own path, international organizations can provide valuable guidelines and help to raise the awareness of health authorities through seminars, conferences and training programmes. The establishment of regional reference centres with accurate updated information and expert advisers would also be extremely useful. □