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Preface

In any country, developed or developing, the majority of faults affecting laboratory and hospital equipment can be avoided if the user has a clear understanding of its operation. A lack of understanding of the construction and function of such equipment increases the degree of misuse and risk of damage and, in some cases, the danger to the patient.

Evidently, many of the laboratory, diagnostic imaging and hospital instruments currently in use are sophisticated and must be serviced by specialists in case of major breakdown. However, in many cases, breakdown can be avoided if certain basic rules of prevention are followed. Unfortunately, there are no textbooks and surprisingly little written information on the maintenance of basic laboratory, imaging and hospital equipment. Laboratories and hospitals in developing countries suffer particularly from the fact that much equipment is imported, while adequate information on maintenance and repair is rarely provided by the supplier.

This manual seeks to remedy the situation by providing practical guidance on the maintenance and repair of a range of laboratory and hospital equipment. The information it contains will be invaluable to staff responsible for ensuring proper care of such equipment during daily use, as well as to those conducting training programmes.

The views expressed in this manual are those of the individual contributors. Comments on the usefulness of this manual, and suggestions for improvements in future editions will be welcome, and should be addressed to Health Laboratory Technology and Blood Safety, World Health Organization, 1211 Geneva 27, Switzerland.
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1. Introduction

The maintenance of medical equipment is essential to ensure that it functions correctly and efficiently and ultimately to ensure proper clinical management of the patient. It is, therefore, important that adequate standards of maintenance are achieved. Yet, in some countries more than 60% of biomedical equipment is not used because of lack of facilities for maintenance and repair. These problems have no simple solution, and their implications are far wider than those associated with the maintenance of an individual piece of equipment.

Maintenance of equipment may be carried out by laboratory and hospital personnel employed to operate the instrument, by service personnel employed within a hospital service department, by technicians with special knowledge of a particular instrument, or by engineers with specialist expertise. This manual provides practical guidelines for use in health care institutions that do not have technicians or engineers with specialist expertise. It does not cover the more sophisticated equipment found in large hospitals. It is anticipated that, for these items, reference will have to be made to the manufacturer for assistance.

Fundamental training is essential for the operators of equipment and for the hospital maintenance staff so that the hospital may become nearly self-sufficient and able to keep its equipment in good working order. Good maintenance and servicing should be carried out as a partnership between the hospital and the manufacturer. Inevitably, however, the smaller the input by the manufacturer, the greater must be the input by the hospital. In many countries the manufacturers' presence, or that of their agents, is minimal and so also is their support. The level of support should be ascertained and taken into account during the process of instrument selection and purchase.

The aims of maintenance are to ensure that equipment attains the standard performance characteristics set by the hospital, the manufacturer's specification, and the clinical requirements. It should be carried out on a preventive basis rather than after a breakdown. A major breakdown is a sign that the maintenance and servicing programmes have failed.

While the selection and purchase of equipment are not directly relevant to the theme of this manual, they need to be mentioned briefly. The selection of appropriate equipment is essential if it is to carry out effectively the job for which it is required. This must take into account not only the current but also the projected workloads.

Some manufacturers offer contracts to lend equipment—even free of charge—but often the user has to agree to use, for example, reagents produced and sold by the same company. Quite often, their cost, in the long term, far exceeds the cost of purchasing other equipment and reagents. However, the cost of the reagents can be spread over a longer period of time.

When the final decision is made, the problems of installation must also be considered. The electrical supply must be compatible with the requirements of the instrument, including the necessary stability. Other necessary services must be available; for example gas and water supplies must be available in appropriate quantity and quality. The operating environment must be suitable. Temperature and humidity control must be available, if necessary. The level of lighting must be adequate, and there must be sufficient working space. If the equipment is bulky, as in the case of X-ray equipment and some laboratory analysers, there must be facilities for moving the instrument to its working area. Stairways, elevators and doorways must be wide enough, and appropriate lifting gear must be available.
The costs of acquiring and using any piece of equipment may be divided into two categories, capital costs and running costs. The capital cost is recognized at the time of purchase, but the running costs are frequently not fully appreciated. This may result in inefficient use or, in extreme cases, total abandonment of the machine. Running costs must therefore be determined prior to purchase; they are of four main types:
- maintenance,
- manpower,
- services,
- consumables.

The cost of maintenance carried out by the manufacturer will vary from country to country. The annual cost of a comprehensive service contract may be as high as 15% of the current capital cost of the equipment. This may not be the cheapest form of maintenance, but, if the manufacturer’s commitment is high, it is probably the most effective and is the most easily costed.

Manpower costs must include those of the operator and the personnel of the supporting services (excluding maintenance, which is considered above). Costs must include not only the salary, but all the costs of employment, such as insurance, employer’s contribution to pension schemes, and other costs or taxes, as appropriate.

Services must include the cost of electricity, water, gases, and any other similar supplies that are required and represent a significant sum.

The day-to-day running costs of all materials must be included under the heading of consumables. For laboratory analysers, this would include reagents, plastics, calibrating and control materials, etc., and for X-ray machines, film, contrast media, chemicals for development, etc.

Whereas it is important to know what the overall running cost of each piece of equipment is, when budgeting for replacement equipment, it may be more important to know whether the new instrument will be more or less expensive, overall, than the one it is replacing.

Selection, purchase, and installation of equipment must be primarily the responsibility of the head of the department and his or her staff. In making such decisions, both the capital and running costs must be taken into account. When choosing equipment, account should be taken of the availability of spares and the supplier’s willingness to train the hospital staff appropriately. Unfortunately, it is only too frequent that equipment has to be abandoned because its running costs have not been budgeted for. Often purchasing decisions are made outside the laboratory, for political or other non-specific reasons, and this contributes to the numerous pieces of medical and paramedical equipment that are not used effectively in many countries.