Training Health Personnel to Operate Health-Care Equipment

How to plan, prepare and conduct user training
A guide for planners and implementors

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Part 1. ORGANIZATIONAL FRAMEWORK

1.1. Introduction

In general, the poor state of health care equipment in developing countries, be it a medical apparatus or be it some hospital plant, is causing growing concern among health professionals. Of course, the best solution for the problem would be to introduce a rational maintenance and equipment management scheme. Though this idea must remain the ultimate goal, most developing countries cannot afford the rapid implementation of a national maintenance programme for (public) health services.
Surprisingly, most problems with health-care equipment can be traced back to fairly simple causes. According to a Swiss study <1>, 60% of accidents with medical equipment are caused by the operators. A similar percentage of user-caused defects or malfunction requiring repair and calibration to rectify them has also been recorded. In developing countries, the number of user-caused defects seems to be significantly higher. In general users in developing countries have not been trained to handle their equipment properly. This problem is often aggravated by low motivation, mainly due to inefficient management and insufficient incentives. Equipment belonging to non-government health-care services is mostly in better working condition because of the clearer definition and control of responsibilities, and thus better motivation of staff. But even without significant change in staff management, adequate user training will in the long run drastically reduce the failure incidence of equipment and plants. Cautious estimates indicate a decrease of 30 to 40%.

The unsatisfactory technological skills of the users are due to the following: firstly, the development of practically applicable general know-how during primary and secondary school education is often regarded as less important. Secondly, the often too theoretical orientation of vocational education in developing countries leaves almost no room for the development of technological skills. Therefore, user training must - in most cases - start from scratch. Nothing is "too simple" to be taught in handling equipment.

1.2. Objectives and Target Groups

Target Groups

Three main groups are involved in setting up effective user training:

1. The Planner/Administrator
   The Planners/Administrators are responsible for the overall development and organization of User Courses. They may be high-ranking officers in central or intermediate health administration levels or , i.e. the managers of technical co-operation projects.

Part 1 of this paper addresses the planner/administrator, giving information about methods, course organization, finances etc.

2. The Implementor.
   Implementors are in charge of the detailed design and implementation of user courses. They may be directors or senior staff members of medical or technical teaching institutions or local and foreign experts from technical co-operation projects.
   Part 2 of this paper discusses interesting issues for this group, i.e. how to design a course, teaching methods and teaching aids, conducting a course etc.
3. The Users
   Users in this context are a heterogeneous group, basically comprising medical doctors, nurses and technicians (for lab, x-ray etc.). With regard to the handling of equipment, the differences between these categories are not that pronounced. The difference lies more in the social sector. In some cultures, status consciousness may not permit the training of technicians together with medical doctors. Furthermore, cleaning of equipment may not be culturally acceptable for relatively high-ranking staff within a hospital. Circumstances like these must be taken into account, but in the majority of cases there is no need to develop separate courses for different health staff.

Objectives

The overall objective is that the user must be put in a position to operate the equipment and plant within his area of responsibilities without causing failure or malfunction. To achieve this the user must know

- how to properly operate the
- equipment
- how to adjust/calibrate the equipment
- how to carry out base-line maintenance
- how to keep records and to report
- where the limits of user intervention are.

Training must include all elements which are necessary to accomplish these objectives. Knowledge or skills which are merely desirable or "nice to know" should not be part of the training contents in order to maintain an acceptable input-output ratio.

1.3. Rationale

1.3.1. General Conditions

User training and the trained user can only be effective under certain conditions. Important preconditions for establishing a successful training course for a specific piece of equipment are that the equipment in question complies with the national standard and priorities and that the user's medical knowledge is adequate.

After training, adequate follow-up support should be provided. This would ideally involve specialist support by technically competent persons, e.g. a maintenance engineer at central or regional level, and a good supervision within the framework of district (or

regional) health management (Monitoring and Evaluation). In addition, there must be a constant supply of material to operate the item(s) in question.

1.3.2. User Training Method

A variety of different approaches exists when it comes to transfering know-how in health technology at user level. The spectrum of options ranges from informal "hands-on" instruction to formal vocational training at a recognized training institution. Courses can be conducted by maintenance personnel, suppliers and multiplicators of the respective target groups themselves. The latter approach is generally recommended, since acceptance or communication problems are minimized, though it initially needs considerable input. Courses may be organized by gathering target persons of a similar reference level from different health institutions to a suitable location, e.g. to a teaching hospital. The other option is to organize the courses at the health facilities themselves ("Flying Circus"). All these methods have advantages and disadvantages. In view of the typical circumstances of medical professions in developing countries, the training methods can be characterized as follows:

TYPE OF TRAINING	COSTS	ORGANIZATION	EFFECTIVITY	DEPTH	SPECIFICITY
On-the-job	low	easy	low	medium	high
By supplier	high	easy	moderate	great	high
Flying circus	moderate	moderate	high	adequate	medium
In-house	low	easy	moderate	low	high
External seminars	moderate	moderate	low	medium	adequate
During basic training	low	easy	very high	adequate	adequate

On-the-job instruction may be carried out by maintenance personnel. This staff category is still quite rare in developing countries. Effectivity is generally low, since generally speaking maintenance staff are not too well trained or experienced in giving instructions to non-technicians. Also their relatively low status within the hospital set-up may be an impediment.

Suppliers are basically in a position to provide a wealth of highly specific information to an extent that users may be given too much information for their needs. Many suppliers in developing countries are much more interested in selling equipment than putting efforts into client follow-up.

The flying circus, though rather demanding in terms of organization, can be very effective when carried-out by specially trained technicians/engineers and members of the tar-

get groups. Conducting courses within the users' working context provides an optimal opportunity to adapt the course contents to the user's real needs.

In-house courses, conducted by specially trained members of the target group can also be very effective, though they generally cannot cope with unexpected or untypical user problems.

Seminars at more or less centralized locations are economically appealing, but difficult for the target groups to attend. In particular at hospital level, the presence of the users is essential for the daily routine. Also, due to the distance from the working environment of the users, the training will tend to be more abstract.

Basic vocational training is a most important opportunity to impart essential technological know-how and corresponding behaviour, though the technological subjects can only be dealt with in a relatively general way. Short courses and seminars are less effective and should ideally only be a follow-up of the basic training. Medical schools and similar institutions in developing countries should take up the idea and impart practical technological skills.

All options considered, the "flying circus" should be preferred. The further recommendations given below relate to this method. In the end, a combination of basic training, systematic in-house seminars and on-the-job instruction would be ideal. The responsibility for planning and execution could, for example, be given to a medical school or an institution involved in hospital engineering. A close link to the decision makers within the health management must be maintained to ensure that the overall policy is being observed.

In any case it should be assured that more than 60% of a course period will consist of practical training. The ratio between practice and theory may vary according to the complexity of the equipment in question. Also, the course should be designed in such a way as to allow for short-term adjustments to unforeseen needs of the target group.

1.4. Establishing a Training Course

1.4.1. Background Information

Before a course for a specific piece of equipment, an equipment group or several different pieces of equipment can be planned, various questions relating to the qualitative and quantitative requirements of target groups and implementors must be raised and answered. The main issues to check are:

- range of equipment/plant to cover (priorities).In most health facilities the priorities, once set, will remain the same, but special local deviations may occur.

- availability of technical documentation (user and maintenance manuals) in the correct language.

- the most important tasks (priorities) of the target facility(incl. job descriptions of key personnel).

Though the definition of tasks for health personnel of a certain country should only have to be assessed once, some developing countries show significant variations within their national boundaries.

- the composition of the target group(type and number of personnel, age pattern, educational backgrounds etc.).Obviously, the number and professional characteristics of the target group are essential information for course planning. However, age distribution may also serve as an indicator of professional experience and topicality.

- the socio-cultural characteristics of the target group and potential instructors. Occasionally some special characteristics may have to be considered, e.g. cast-related obstacles which might prevent a person operating and to maintaining equipment.

- the availability of instructors and multipliers. This question may gain special importance in connection with possible task priorities at the target health facility.The question also relates to the presence of suitable persons at local level, who could be actively involved as instructors or assistants (also refer to 1.4.2.1).

- the availability of a suitable room, which offers a chair or bench space and table space for writing for each participant. Often an outpatient or MCH waiting area are satisfactory places to use.

- availability of teaching material, such as blackboard, flip-chart etc. Nothing fancy is required, since most instructions should be conducted in a very practical and participatory way. This essentially means making use of demonstrations with direct involvement of the participants wherever possible.

- financial contribution of the target facility(ies).In an ideal decentralized financing system, based on cost-sharing, the target health facility should finance such training measures completely. In situations where these costs are covered by central or intermediate health administration levels, at least some approach to cost-centre accounting should be introduced as a basis for further planning.

- working schedule of the target facility(ies) (operation days etc.).A chain of several courses for different equipment, possibly stretching over several days, requires careful timing to minimize disturbances in the daily routine.

- means of communication of the target facility(ies).The questions raised in this chapter indicate that there is a great need for co-ordination and communication. Relevant channels (e.g. fax, phone, messenger) have to be found and made operable. (Seasonal) Accessibility and transport requirements must also be clarified.

(also refer to check form in **annex 1, page 19**)

It would be a good idea to question the target personnel about their perception of problems and needs (refer to sample in **annex 2, page 24**).

1.4.2. Organizing Courses

The essential inputs for the course planning can be derived from the background information collected . Such inputs include:

- teaching requirements (equipment priorities)
- personnel requirements
- material requirements
- logistical requirements including transport
- financial requirements
- timing

1.4.2.1. Instructors

Once it has be decided which subjects (equipment) should be covered at which health facilities, the number and specialities of instructors can be worked out. Suppose a set of 5 themes has to be taught at one health facility during one week (which would be a reasonable package), a minimum of two and a maximum of three instructors would be required. Provisions for accommodation and food must be made accordingly.

Quite often, it will be necessary to train the instructors first. This would call for the following activities:

- identification of suitable training institutions (national or overseas). Such an institution could be a medical school, a nursing school or a vocational training centre. Possibly a part of the training (for instance within the framework of technical co-operation) could take place at suitable institutions or manufacturers in industrialized countries. In so doing, a good insight can be gained into the relevant technology and also into recent developments. The disadvantage is that this approach tends to neglect the real problems in the field; but this could be complemented by additional systematic field training within the country.
  Bi- or multilateral partners in technical co-operation may be able to assist in organizing and financing "training of trainers".
- selection of suitable candidates, such as talented users, operators and also, especially when starting a user training programme, maintenance personnel. In many cases instructors can be found outside the public health sector, e.g. with non-government health services (religious groups!), vocational training institutions, universities, suppliers etc.

- training of 3-6 trainers as an initial booster for all subjects relevant to the set equipment priorities. Such training will be quite demanding. At least 5 days for each equipment group will be required on average.

1.4.2.2. Teaching Material

There are many things that have to be considered in this connection, hence the often unrealistic planning. It would, of course, be nice and useful to have teaching aids such as projectors, three-dimensional functional models of equipment and physical principles,

video equipment or even personal computers. Even if the purchase could be financed, the operational cost must be taken into account: e.g. projectors need bulb replacement and video equipment need tapes. Apart from cost considerations, the sustainability of teaching aids also depends on the technical environment. The service life of sophisticated items is not acceptable owing to the considerable stress they are exposed to; eg, transport over bumpy tracks or operation in dust ridden areas.

Therefore, the general rule is to keep teaching aids as simple as possible, in particular for decentralized training schemes. In most cases, hand-made posters, well-prepared hand-outs and the real equipment will do as teaching aids. Blackboards, pinboards and flannel-boards are other helpful accessories. Flannelboards are a particularly simple tool, which offers good flexibility when mounting demonstration material, including two-dimensional functional models whose parts may to some extent even be movable <2>. At least at the start of a user training programme, the team of trainers should carry the essential teaching aids with them so as to avoid organizational complications. In the long run, basic training aids should be available at each health facility for their internal use.

Essential teaching materials are operation and service manuals, at least for the more sophisticated equipment, such as autoclaves, infant incubators etc.. Very often the manuals at the target facilities are incomplete or missing (refer to section 1.4.1). In this case the documents must be acquired from the agent or manufacturer or other helpful resources (refer to **annex 3, page 26**). If possible, copies from manuals existing at other health facilities within the country can be made.

1.4.2.3. Cost

The expense of carrying out a user training programme mainly comprises the costs of fact-finding (background information), planning, preparation, implementation and evaluation:

* personnel
* mail, fax, phone
* transport (for field visits etc.)
* stationary
* material for teaching aids
* photo copies or printing stencils
* accommodation, allowances
* consumables for operating equipment during training

As already stated, the target facilities should contribute to the training costs. This applies in particular to the implementation step itself. The real cost can only be estimated for specific countries. It may be assumed that on average the costs are paid off after one to three years. This is because the better-qualified user will increasingly avoid operational mistakes and thereby reduce maintenance and replacement costs. Even in the - rather numerous - cases, where maintenance and replacement cannot be financed, indirect significant costs arise because the health facility in question can only operate with very low efficiency.

1.4.3. Timing

Decentralized training implies visits to health facilities in the periphery. To keep costs down, it is advantageous to bundle a number of facilities which belong to a manageable geographical area for one tour. As recommended under 1.4.2.1, the training team should be present for about one week at one health facility. Therefore, on average not more than 3 to 5 facilities should be covered by one tour.

After deciding which health facilities are to be included in a certain tour, a draft time schedule for the tour is developed which takes into consideration the working schedules of the target facilities and possible seasonal conditions such as holidays, road conditions etc. By co-ordinating the proposed dates with the target facilities, a final time schedule is developed. It is highly advisable to request confirmation of the final plan from each target facility.

Part 2. DESIGNING AN EQUIPMENT COURSE

2.1. Methodological Framework

2.1.1. Practice and Theory

The courses should be equipment oriented, though in certain cases it may be necessary to cover more general themes as well, such as hygiene etc.. As already stated, such courses must concentrate on the real needs. Because of the wide spectrum of equipment, the courses must kept as concise as possible (a few hours up to one, maximum 2 days). Also, the real needs in user training are of a very practical character. Theoretical elements must be kept to a minimum. To amplify the practical touch, theoretical instructions (mostly in physics, chemistry, maths etc.) should be accompanied by demonstrations or practical examples which are well known to the trainees from their daily work or family life. This sounds easy, but presupposes a good understanding of theory. A typical example is the principle of heat insulation explained with the different effects of grass or metal-sheet thatched roofs. The proportion of theoretical contents should not exceed 30% on average. To allow active participation of trainees, the number of participants should not exceed 12.

2.1.2. Teaching Approach

The target groups are heterogeneous in terms of professions and individual characteristics. Thus there is a great need for flexibility and variety of teaching methods, though the basic approach should be inductive. E.g. the instruction should start with the medical treatment as such, relate it to the equipment employed, and from there, derive features, functional and operational requirements. Different didactic elements, such as demonstrations, verbal explanations, working with written documents, note-taking, discussions etc. should be utilized during one course to keep the interest alive and to satisfy the learning approach of the various participants <3>:. some learn best when they can discuss things, some prefer to listen or to read. The courses should under no circumstances be structured in such a way that the trainer(s) finds himself in the most active role and the trainees only listen to monologues and follow instructions. A good balance between directed information input and a free exchange of information and opinions must be aimed for. For this reason, around 20% of the course time should be used for free discussions between all course participants. The timing of such discussions cannot be predetermined. Mostly, the discussions occur spontaneously. If not, they should be encouraged by the trainer.

2.1.3. Written Material

Users generally have substantial difficulties in understanding the very specialized and technical language of operational and service manuals and some translations leave a lot to be desired. It is therefore most important to constantly relate to the manuals and give relevant explanations. A good way of doing this is to have the trainees read selected passages read and then answer their questions.

Apart from the manuals, the whole course should be accompanied by specially designed written material. In the end, each trainee should have a concise document with all the

essential information on the subject, which could be used as reference during work. Regrettably, such manuals are not readily available on the market, so they have to be produced by the team of trainers. There are basically three ways to do this:

1. Dictate what seems essential and let the trainees write down what they think is necessary. This is the simplest and, at least for the trainer, laziest way of doing it. For the trainee it is much less easy. He is forced to write down every bit as fast as possible, because he or she would not be in the position to decide which information is worth being recorded. Unfortunately, this way of interaction between trainer and trainee is very common. The trainee should try to understand, and not aimlessly copy a plethora of information.

2. Compile a user's manual by writing short but sufficiently detailed instructions, adding relevant excerpts from publications (copies).
   This is quite a good way of furnishing the trainee with a well-structured and down to-the-point manual. The disadvantage is that handing out a ready document is only of limited didactic value for the course, because it does not actively involve the trainee to a great extent.

3. Compile a series of worksheets, which give essential information, but leave room for personal notes, and which contain small tasks for the trainee to solve (refer to sample in **annex 4, page 28**). The trainee can collect all worksheets (ring folder!) and use them as a standard manual during his work after completion of the course. This approach is quite demanding for the trainer, but stimulates the interest of the trainee to profit from this manual in a more direct and active way

2.1.4. Tests and Certificate

It is a good idea to carry out very quick and short tests after major topics. The test could consist of a small questionnaire, highlighting the most important issues covered (refer to sample in **annex 5, page 31**). The questions should be answered in written form (multiple choice may also be used). Filling in such a questionnaire should not take more than a couple of minutes. The correct answers are then given and explained by the instructor. The questionnaires are kept by the trainees; they only serve as a means of personal assessment and never as a control instrument for instructors or superiors. At the end of the course, an anonymous test about the most important issues covered should be carried out, including a small part which evaluates the perception of the trainees about the quality and relevance of the course (refer to sample in **annex 6, page 32**). The latter information should serve as feedback for the team of trainers and organizers for further adjustment and improvement of the course.

Each trainee is entitled to receive a formal certificate of attendance. Scores or other valuations of performance are not desirable. On the contrary, they would have an adverse effects in that trainees with low scores would be demotivated. Assessing performance can only be part of a supervision scheme. The certificate is an important factor of professional

prestige and motivation and satisfies the natural need for appreciation. The certificate should contain the course title, name, date and venue and should be signed by one trainer and a responsible person at higher level (e.g. Director of Medical Services) (refer to sample in **annex 7, page 34**).

2.2 The Syllabus

The courses are equipment oriented or relate to general operational issues. The following list contains most of the equipment felt to be essential for work at district level and two typical general themes:

* sterilizers
* cooling devices
* anaesthetic/ventilation machines
* suction machines for surgery
* infant incubators
* microscopes
* balances
* emergency generators
* water pumps
* hygiene
* maintenance management and supervision.

For each of these (and possibly other) topics a syllabus must be designed. The syllabus is the foundation of any systematic training. In other words, if there is no syllabus, there is no system. And without system, the course will end up in arbitrary and inconclusive efforts. Thus funds and time will be wasted and trainees as well as instructors will be deeply frustrated. The training success will be minimal, the cost maximal.

What does a syllabus contain? Basically it gives an outline of what is to be taught and how it is to be taught:

* at which target group the training is directed
* what objectives are to be achieved
* what contents are to be learned (summary, in chronological order)
* what the time requirements are
* what teaching methods and aids are to be employed
* how the teaching success is to be assessed.

(refer to sample in **annex 8, page 35 ;<3>**)

A syllabus is not a document which is once drawn up and then declared compulsory ad infinitum. Syllabi should be subject to modifications and amendments according to the growing experience in the field. An annual or bi-annual review is therefore recommended.

On the basis of the syllabus, the final planning of the finances and material can be carried out as can the step-by-step development of the worksheets for the trainees.

2.3. Conducting a Course

2.3.1. Where to begin

Before starting a course, all material and equipment must be organized and made available. The trainers are supposed to be punctual and time-conscious during the course. Punctuality should not be regarded as a virtue in itself, but as a matter of mutual fairness and of economical value.

Starting a user training scheme implies a new experience for both trainers and trainees who often know only little about each other. This may create a somewhat awkward and even embarrassing situation when the two parties meet for the first time and it is up to the trainer to generate a relaxed atmosphere for optimal learning conditions. A common method used to " break the ice ", is for the trainer to introduce himself - (of course after the usual greeting of the participants) - and briefly summarize his background and his expectations of the course. Afterward the trainees introduce themselves and summarize their expectations. The trainee has the "right" to have no expectations. This is mostly the effect of his uncertainty about the whole exercise, he or she may need some time to adapt. Putting pressure on trainees in this or similar situations frequently deepens their wariness. The mutual introduction can be a good opportunity to open the discussion about the situation of the trainees and their problems, eventually leading to a systematic presentation and discussion of the general and specific objectives of the course. Reference can be made at this point to the questionnaire received during the preparation of the course (refer to 1.4.1). This process both motivates the trainees and helps create an understanding of what the the course is all about.

It is advisable to briefly explain the structure and method of the course, because most trainees will not be much acquainted with the way the training is conducted. It is of paramount importance to make it clear from the beginning that the course is not designed to test individuals about knowledge or performance. All tests will be anonymous. No written or verbal scores will be produced, neither during the course, nor after completion. All participants are entitled to receive a certificate of attendance, except those who have missed considerable parts.

2.3.2. Introduction of Subject

The first subject-related theme is the definition of tasks as part of the task profile of the target health facility. Briefly this encompasses the typical health requirements and diseases of the population in the catchment area, the related activities of the health facility, focusing on the subject-specific tasks and the equipment needed to fulfill them. It is important to clarify the relative importance of the health-care method used and consequently of the respective equipment.

In practice this would mean that blood pressure measurement for example would be explained as an essential method in ante-natal care, in accidents and similar cases. As this part is fairly theoretical, it would be advantageous to present posters depicting relevant statistics or important manipulations.

2.3.3. Equipment Principles

With the help of posters and - if available- models, the physiological background should be refreshed briefly. The next step will reveal whether this was sufficient : presentation of the most frequently used types (in our case a mercury- and a dial-type sphygmomanometer) and a question-and-answer session about the different designs. If necessary, fundamental science subjects, such as physics, chemistry or physiology, must be explained in brief. In our example the principles of pressure, elasticity and blood circulation could be required.

Having achieved a basic understanding of the different designs, the advantages and disadvantages must be discussed and the design(s) used at the target health facility (or even within the whole national health system) identified by the trainees. All course activities to follow must concentrate on the types in use. Assuming that, in our example, this would be the dial-type sphygmomanometer, we would continue by elaborating on different models, in this case e.g. cuffs with integrated stethoscope compared to the model with a separate one. Advantages and disadvantages of the different models should be analysed.

The next step should go into the details of the instruments found at the target facility. All components must be identified and their role defined. Special material properties must be discussed, such as corrosiveness, strength and durability. In our example, the cuff and also the connecting tubes are made of materials which can be very short-lived. During this training unit, demonstrations and practical exercises with the real equipment should be given great attention. Sphygmomanometers can partly be disassembled (not the measuring unit!) and reassembled. For this exercise it would be advisable for the instructors to bring some sample(s) to avoid damage to the instruments of the target facility. At the same time, the instructors must ensure that the trainees fully understand the safety aspects of operating the equipment in question. Mercury-type blood pressure machines are particularly dangerous when the gauge breaks and the mercury, which is highly poisonous, is being spilled. Not only user safety aspects must be taught, but also detrimental effects on the patient due to incorrect or incautious handling must be highlighted and thoroughly explained.

After this first practical approach, the trainees should try to write down (only in key-words), how they routinely operate the equipment. In our example this could read:

- deflate cuff
- put cuff on patient's arm
- close valve
- etc.

In addition, they should list the main problems they encounter with the equipment, e.g.

- air is leaking
- stethoscope does not transmit clearly
- etc.

By evaluating the outcome of this exercise, missing operational steps, wrong operations and typical faults can be identified. The result could be put into a table which could link

typical user faults with typical equipment problems. In the case of sphygmomanometers the table may contain:

TYPICAL EQUIPMENT PROBLEMS	USER FAULTS	OTHER CAUSES
brittle tubes, air leaks	exposure to excessive sun-light	poor quality of material
leaking mercury	rough handling	
distorted sound (stethoscope)	wrongly placed membrane	termites obstructing tube
etc.		

By including non-user-related causes mis-interpretations can be avoided:
Not all problems can be solved through user training.

2.4. Equipment Preparation, Operation and Care

2.4.1. The Concept of IDEAL Instruction

For the predominantly practical training subjects which will be described in the sections to follow, a high-intensity method is required. It may be called the IDEAL Method. IDEAL is an acronym and stands for:

I - Introduce and explain
D - Demonstrate procedures/manipulations
E - Exercise procedures/manipulations with trainees
A - Adjust trainees' performance
L - Let trainees explain procedures/manipulations

This approach combines active and passive involvement of the trainees in a way that optimally promotes practical understanding and skill during a relatively short period of time.

2.4.2. Preparation

Being prepared to apply a health-care method quickly and effectively and to utilize the respective equipment in emergencies and routinely is at the same time trivial in tis obviousness but nontheless imperative. Of course, in the case of blood-pressure measurement, there is not much more to do than ensuring that the meter, the stethoscope and the patient's records are readily available. Things are however much different when dealing e.g. with more sophisticated equipment, such as ultrasound. Here we would have to teach (in the IDEAL way) how to use a comprehensive checklist (refer to sample in annex 9, page 38) so that the equipment is on stand-by, ready for switching on and application. In this example it must, among other things, be assured that recorder or

video printer-paper and transducers are installed and that contact gel is at hand. Also, the operational manual should be within reach.

2.4.3. Operation

Coming back to our blood pressure example, the following step focuses on the application of the instrument. A step-by-step flow-chart-type instruction sheet would be useful to ensure the correct order and completeness of procedures (refer to sample in **annex 10, page 39**). The instructor must not only describe and demonstrate all procedures in detail, but also give reasons for each specific step, for example:

> One rule in blood-pressure measurement says that the cuff should always be applied to the same arm (left if right-handed) of an individual patient. The reason is that in most cases a non-pathological difference between left and right can be measured. Always keeping to one side ensures that the comparability of measurements taken at different times is not distorted by this factor (reproducibility).

Adjustment and calibration may also be part of the user's duty. In the case of mercury-type blood-pressure machines, the users should know how to adjust the scale.

Teaching operational skills also means underscoring the fact that equipment application in most cases implies direct patient contact. In this respect two essential principles must be adhered to:

1. the patient has a right to know what is happening to him. Whereever possible he has to be informed accordingly and to be treated in a polite and kind manner. The utilization of health facilities greatly depends on the behaviour of health staff. E.g. a study in Tanzania undertaken in 1992 <4> showed that more than 16% of patients would accept to pay charges for hospital services if the attitude of doctors alone were to improve. The course could raise the trainees' awareness with the help of role-playing.

2. the safety measures for the patient must be part of training and safety consciousness must be encouraged. Even a simple gadget such as the sphygmomanometer deserves some attention in this respect; ie. the danger of spilled mercury. Hygiene is always a critical point to observe.

A reminder: though worksheets form the didactic backbone of the course, the training of operational skills in particular calls for intensive practical exercises, as given in the IDEAL way.

2.4.4. Caring for the Equipment

This aspect is at least as important as the previous one. Caring for the equipment means taking on responsibility and, in practical terms, base-line maintenance including cleaning. In some rare cases, even simple repairs may be carried out by user personnel. The term maintenance and, in its basic form, base-line maintenance is frequently regarded with amazement, because it is not perceived as a task which concerns other people than technicians or engineers. It must be made clear during the course that maintenance is a

tool within health management and thus affects almost everyone and everything in health services.

Base-line maintenance is a simple procedure which, when implemented, allows operating personnel to avoid trivial failures. Taking the blood-pressure machine as an example, the base-line maintenance procedures are only few, but should, as with any other equipment, be compiled in a flow-chart-type description, a trouble-shooting chart and a brief but comprehensive repair prescription where applicable (refer to sample in **annex 11, page 40**). It would contain topics such as how to clean the manometer with a damp cloth, possibly using very little detergent, what to do if the system blows air or gives irregular measurements and how to change a brittle inflation bulb. The training documentation must also contain the limits of user interventions, an aspect which must be stressed during training. Often a tendency to over-estimate one's own repair capabilities, in particular after having undergone a user course, can be observed. Over-confidence must be countered: too many pieces of equipment have been "disrepaired" by well-meaning but rash health staff.

After having finished work with a given piece of equipment, the user will have to follow shut-down procedures, which could consist of closing a gas supply, switching of water and/or power, cleaning again, protecting against dust with a cover, storage, protection against unauthorized manipulation etc.. With the sphygmomanometer it is only the storage which can be fairly problematic in damp climates, because the cuff fabric is prone to become infested by mould. The user must therefore learn how to avoid this, in this case e.g. by fitting a low wattage bulb (15 W) in the storage cabinet.

Though (base-line) maintenance is a very practical set of skills, it must be complemented by administrative activities. It often happens that a user cannot solve his maintenance problem by himself. He must therefore be able to identify the major typical faults of the equipment in question and know who can be contacted within and outside the health facility and how. He may have to fill in forms to order services from in-house personnel or from a technician of the provincial hospital or obtain service from the local supplier. In cases where a comprehensive maintenance system is established, the user must also learn his role within the system, especially regarding supervision, procurement etc..

2.4.5. Finalizing the Course

Finally, when all contents of the syllabus have been dealt with and after all of the trainees' questions have been answered (they often have to be encouraged to ask questions), a final written test and course evaluation must be carried out as described in section 2.1.4. The course is closed by handing out the certificates.

For the trainees the exercise is now completed whereas the team of trainers will have to do some additional "homework", i.e. analyse the course. They have to identify strong and weak points in order to modify the course. Modifications are necessary as a rule. This analysis also forms the basis for reports that may have to be submitted to superiors.

Annex 1 User Course Planning Checklist

Target Facility	Considered	Not Yet Considered	Not Relevant
Classification Type of facility Sections No. of Beds	☐	☐	☐
Personnel Type of personnel No. of personnel Qualifications	☐	☐	☐
Work Schedule Peak-load Periods Holidays	☐	☐	☐
Communication and Accessibility Telephone Telefax Courier Regular supply visits Road conditions Public transport	☐	☐	☐

Target Group	Considered	Not Yet Considered	Not Relevant
Number of Participants	☐	☐	☐
Qualification of Participants Doctors Nurses Wardmaids Lab. Technicians Other	☐	☐	☐
Experience of Participants Age distribution Years of service	☐	☐	☐
Socio- cultural Background of Participants	☐	☐	☐
Food & Accommodation for Participants	☐	☐	☐

Equipment	Considered	Not Yet Considered	Not Relevant
Number and Type of Equipment	☐	☐	☐
Documentation User manual Service manual Instruction Leaflets Books other	☐	☐	☐
Equipment Available for Demonstration	☐	☐	☐
Equipment for Practical Exercises	☐	☐	☐
Accessories & Consumables Filters Handpieces Chemicals etc.	☐	☐	☐
Supplies for Equipment Power Gas Water	☐	☐	☐

Instructors	Considered	Not Yet Considered	Not Relevant
Number of Instructors	☐	☐	☐
Qualification	☐	☐	☐
Teaching Experience	☐	☐	☐
Practical Experience	☐	☐	☐
Contracts	☐	☐	☐
Transport	☐	☐	☐
Accommodation	☐	☐	☐

Room(s), Workspace	Considered	Not Yet Considered	Not Relevant
Size of Room(s) For instruction For group work For practical exercises	☐	☐	☐
Tables and Chairs	☐	☐	☐
Facilities of room Water Gas Windows/light Shutters/curtains to darken room	☐	☐	☐
Environment Accessibility Noise Space for participants during breaks Toilets	☐	☐	☐

Teaching Aids & Materials	Considered	Not Yet Considered	Not Relevant
Blackboard/Chalk	☐	☐	☐
Flip chart/Paper/Pens	☐	☐	☐
Flannelboard	☐	☐	☐
Pinboard/Papers/Cards/Pins	☐	☐	☐
Video-recorder/TV	☐	☐	☐
Slide-projector/Screen	☐	☐	☐
Overhead projector/Slides/Pens	☐	☐	☐
Equipment for Training Tools Consumables & Spares Manuals	☐	☐	☐
Diagrams/ Charts	☐	☐	☐

Course Organization	Considered	Not Yet Considered	Not Relevant
Invitations Participants Instructors Officials	☐	☐	☐
Opening/Closing Ceremony Time/Location Guest of Honour Guests	☐	☐	☐
Course Schedule Working Hours Breaks	☐	☐	☐
Refreshments Breaks Lunch	☐	☐	☐
Social Event for Participants Educational Tour Visit of Local Sights	☐	☐	☐
Office Materials Photocopier/Paper/Toner Puncher/Stapler	☐	☐	☐
Accommodation Participants Instructors	☐	☐	☐
Writing Materials Folders Paper Pens/Pencil	☐	☐	☐
Name Tags	☐	☐	☐

Finances	Considered	Not Yet Considered	Not Relevant
Costs			
Rent Rooms Photocopier	☐	☐	☐
Communication Telephone / Fax Letters other	☐	☐	☐
Materials Writing Materials Demonstration Materials Consumables Parts Handouts	☐	☐	☐
Opening/Closing Ceremony Refreshments	☐	☐	☐
Instructors Salary Allowances	☐	☐	☐
Participants Accommodation Allowances Travel Allowances	☐	☐	☐
Income			
Target Facility	☐	☐	☐
Intermediate Health Administration	☐	☐	☐
Central Health Administration	☐	☐	☐
Sponsors Technical co-operation projects Companies	☐	☐	☐

Annex 2 User Questionnaire

Advances in medical technology have led to a significant increase in the number and types of medical equipment. In addition, import from different countries has led to a great variety of equipment, which in turn poses difficulties and problems for the user with regard to correct handling and maintenance. To ease the problems, special " User Training Courses " are planned to assist the user in correct handling and basic maintenance. This questionnaire is designed to collect important information enabling the design of appropriate courses.

Please take your time to answer the questions in detail.

Your Name: _____
Your position within the health facility: _____

Please classify your health facility:

- ☐ Referral Hospital Your Department: _____
- ☐ Provincial Hospital Your Department: _____
- ☐ District Hospital Your Department: _____
- ☐ Health Centre Number of Beds : _____

What type of equipment do you (and your colleagues) consider most important. Please try to list in order of priority.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

Which equipment is most often used ? Please give manufacturer and type.

	Equipment	Type	Manufacturer
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

Which type of equipment quite often causes problems? Please describe problems.

		Problems
Equipment:	_____	_____
Type:	_____	_____
Manufact:	_____	_____
Equipment:	_____	_____
Type:	_____	_____
Manufact:	_____	_____
Equipment:	_____	_____
Type:	_____	_____
Manufact:	_____	_____
Equipment:	_____	_____
Type:	_____	_____
Manufact:	_____	_____
Equipment:	_____	_____
Type:	_____	_____
Manufact:	_____	_____

Do you have operating manuals for all your equipment ? Yes ☐
No ☐

Do you have equipment which cannot be operated due to lack of manuals / information. Please specify.

☐ No
☐ Yes _____
_____

Please describe other problems you have concerning equipment.
(i.e.: storage, consumables, supplies etc.)

_____
_____
_____

Thank you for your co-operation.

Annex 3 Possible Resources for Manuals

Resources for Manuals , Documentation and Information:

Local:

Universities, especially with medical faculty,
Medical schools and training Centres
Teaching and Referral Hospitals
Central Medical Stores or Supply Facilities
Private Hospitals and other private health facilities
National or other laboratories
Agents / Representatives of Manufacturers of Medical Equipment
Veterinary and Agricultural (Research) Institutions
Technical Universities and Institutions of Higher Learning
Material Testing and Quality Control Institutions

International:

World Health Organization (WHO)
Division of Strengthening of Health Services
1211 Geneva
Switzerland

Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH
Department of, Health, Population and Nutrition
P.O. Box 5180
6236 Eschborn 1
Germany

WHO Regional Training Centre
Higher Technical Institute
P.O.Box 2423
Nicosia
Cyprus

NHS Training Authority
Eastwood Park, Falfield
Wotton -under-Edge
Gloucestershire, GL 12 8 DA
United Kingdom

West of Scotland Health Boards
Department of Clinical Physics and Bio- Engineering
11 West Graham Street
Glasgow, G4 9 LF
United Kingdom

Department of Medical Electronics and Physics
St. Bartholomew's Hospital Medical College
Corterhouse Square
London EC 1N 6BQ
United Kingdom

Institute International Superieur de Formation des Cadres de Santé
Hospices civils de Lyon
162 Avenue Lacassagne
69003 Lyon
France

Mombasa Polytechnic
Department of Medical Engineering
P.O. Box 90420
Mombasa
Kenya

Medical Engineering Training Centre
via GTZ-PVB
P.O. Box 926238
Amman
Jordan

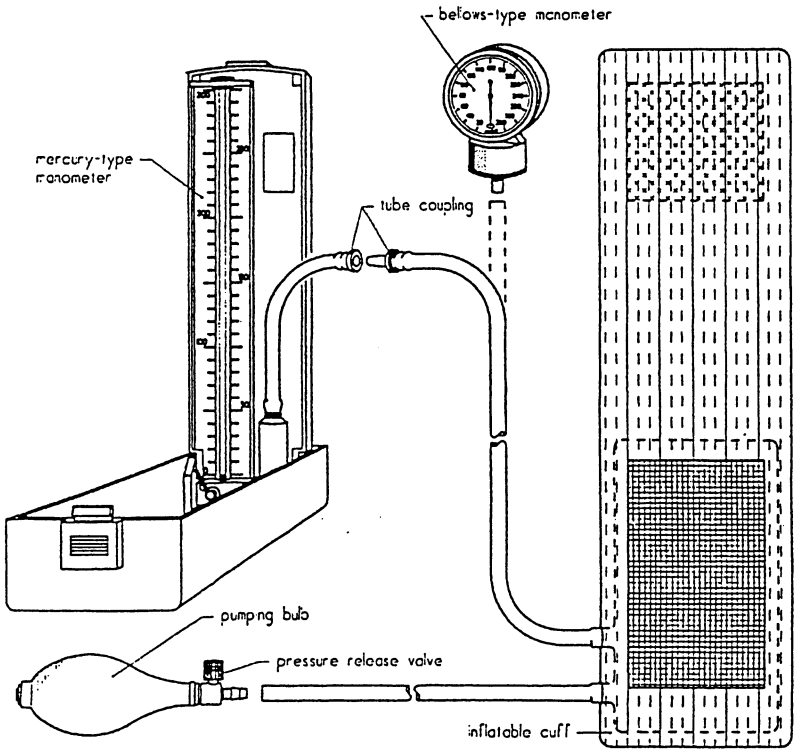
Training of Hospital Maintenance Technician
BP 16
Diourbel
Senegal

Hospital Maintenance Project
P.O. Box 1021, MCPO
1299 Makati, Metro Manila
Philippines

Annex 4 Worksheet

Main Parts of BP Apparatus

The most common hand-operated BP apparatus have a mercury- or bellows-type manometer. The diagram shows the main parts of such equipment. Please put the correct names to the parts



- Mercury-type manometer
- Bellows -type manometer
- Pumping bulb
- Cuff
- Bladder
- Rise pipe
- Mercury tank
- Tube coupling
- Pressure release valve
- Scale (mmHg)

1. Pumping Bulb
   The pumping bulb is made of rubber. It has two uni-directional valves - inlet and outlet valve.
   Pressing the bulb forces air to the cuff, thus inflating the cuff. While releasing the bulb, outside air is drawn into the bulb

	pressing the bulb	releasing the bulb
inlet valve		
outlet valve		

Please fill in "open /closed" as appropriate.

Notes:

2. Rubber tubing and tube coupling The rubber tubing connects the parts of the BP apparatus. a: Old or cracked tubes may cause leaks and impair readings b: Tubes should have a length of at least 76 cm. c: Tubes must have "easy-to-connect" airtight connectors.	Explanation for a-c:
3. Pressure release valve The pressure release valve is opened to slowly reduce the pressure in the system. By turning the release knob, the pressure may be released at a slower or faster rate. The pressure release valve should be closed during pumping.	Typical pressure fall rates: During measurement: .....mmHg Minimal achievable fall rate: .....mmHg Notes:
4. Cuff The cuff consists of a closed rectangular rubber bag (bladder) enclosed in an envelope made of strong fabric. To adjust the cuff to different arm sizes, they have a clip or velcro tape.	Notes:
5. Bladder The correct bladder size must be used. The size is dependent on the circumference of the patient's arm. If the bladder is too large or too small wrong readings may be obtained.	Recommended sizes: Adult large: ..... Adult normal: ..... Child : ..... Infant: ..... Newborn: ..... Notes:

5. Mercury-type manometer The pressure in the cuff pushes mercury from the mercury tank into the rise pipe. The value of the pressure is read from the scale at the top end of the mercury column Notes:	Advantages and disadvantages: + ... + ... + ... + ... - ..... - ..... - ..... - .....
6. Bellows-type manometer These gauges are smaller and easier to use. Sometimes they are joined to the pumping ball. The pressure from the cuff is led to a small chamber having a top and bottom of flexible metal - the bellows. If pressure increases, the top of the bellows is pushed upward. This movement is used to deflect the pointer via a system of rods and gears. Notes:	Advantages and disadvantages: + ... + ... + ... + ... - ..... - ..... - ..... - .....

Note: Most scales of manometers are graded in mmHg. Some manufactures however supply models which use kPa (Kilo Pascal) as a measuring unit.

Conversion Table: 1 mmHg = 133 Pa = 0.133 pa
1 kpA = 1000 Pa = 7.5 mmHg

The " normal " blood pressure of 120/80 mmHg equals ...../..... kPa

Annex 5 Quick Test

Main parts of BP apparatus and their function.

1. List the 4 major parts of a BP apparatus

a: _____
b. _____
c: _____
d: _____

2. Which is the appropriate bladder size for an normal adult

- ☐ 12 * 35 cm
- ☐ 4 * 20 cm
- ☐ 12 * 28 cm
- ☐ 9 * 20 cm

3. Which parts of a BP apparatus are made of rubber and might get brittle

- ☐ pumping bulb
- ☐ rise pipe
- ☐ mercury tank
- ☐ bladder
- ☐ manometer
- ☐ tubes
- ☐ release valve
- ☐ cuff

4. Inlet and outlet valve are fixed in the

- ☐ manometer
- ☐ cuff
- ☐ pumping bulb
- ☐ tubes

5. Though each person has his own "normal" blood pressure, the most commonly named is

_____/_____ mmHg

6. The "normal" blood pressure given in kPa is

- ☐ 32 / 20 kPa
- ☐ 16 / 10 kPa
- ☐ 8 / 4 kPa

Annex 6 Course Evaluation Sheet

1. Course Organization

1a. Duration of course
- ☐ too short
- ☐ adequate
- ☐ too long

1b. Working time / day
- ☐ too long
- ☐ adequate
- ☐ too short

1c. Number and duration of breaks
- ☐ too many
- ☐ too few
- ☐ too short
- ☐ too long

1d. Classroom arrangement
- ☐ excellent
- ☐ good
- ☐ fair
- ☐ poor

1f. Please comment on other organizational matters:

_____

_____

2. Contents of the course

2a. Discussion of topics
- ☐ too detailed
- ☐ appropriate
- ☐ too global

2b. Relevance of theoretical part to your daily work
- ☐ very relevant
- ☐ relevant
- ☐ not relevant

2c. Relevance of practical exercises to your daily work
- ☐ very relevant
- ☐ relevant
- ☐ not relevant

2d. Balance between theory and practical exercises
- ☐ too much theory
- ☐ adequate
- ☐ too many exercises

2e. Most interesting subject area _____

_____

2f. Most uninteresting subject area _____

_____

3. Presentation of Course

3a. Number of instructors

- ☐ too few
- ☐ adequate
- ☐ too many

3b. Quality of theoretical instruction

- ☐ excellent
- ☐ good
- ☐ fair
- ☐ poor

Please comment : _____

_____

3c. Quality of instruction and assistance during practical exercises

- ☐ excellent
- ☐ good
- ☐ fair
- ☐ poor

Please comment : _____

_____

3d. Number of handouts and materials

- ☐ too many
- ☐ adequate
- ☐ too few

3e. Quality of handouts and teaching materials

- ☐ excellent
- ☐ good
- ☐ fair

Please comment : _____

_____

4 General

4a. Did the course meet your expectations ? Please give reasons.

_____

_____

_____

4b. Most important area(s) to be improved:

_____

_____

4c. Suggestion for topics for further courses:

_____

_____

4d General remarks/comments:

_____

_____

_____

_____

Annex 7 Course Certificate

Ministry
of
Health

Special Course Certificate

This is to certify that

_____

has completed a course on

Use and Basic Maintenance
of
the following equipment:

_____
_____
_____
_____
_____

from _____ to _____ at _____

_____ _____
Date Course Tutor

_____ _____
Date Director of Medical Services

Ministry
of
Health

Annex 8 Syllabus Unit

Course:	Use and "Base-line" Maintenance of Medical Equipment
Target Group:	User of Medical Equipment
Entry Requirement	Completion of relevant training (Nurses, Lab Technician, etc.) 1-year practical experience in health institution Ward assistants with at least 3-years experience may also be admitted.
Duration:	1 day (8 hrs of instruction) Theory (T): 2 ½ hrs, Practice (P): 5 ½
Assessment:	Continuous assessment of the course after each topic (anonymous) Final written test (anonymous)
Certification:	Certificate of attendance Special Course Certificate of Ministry of Health
Subject:	BP Apparatus

General Objectives: At the end of this course, the trainee should be able to:

- appreciate the value of BP apparatus
- verify functional state of BP apparatus
- correctly use the BP apparatus
- perform "base-line" maintenance.(user maintenance)

Objective	Contents	Time	Method	Materials
Topic: Medical Background At the end of this topic, the trainee should be able to :				
- describe parts and function of the circulatory system	Heart, artery, lung, vein, organs, nutrition, oxygenation, waste discharge, systolic and diastolic pressure	T: 30 min	T: Instruction, discussion, individual work	Worksheets, posters, models, diagrams ptional: video, slides
- appreciate the value of BP apparatus in diagnosis and therapy	typical application, accidents, heart disease, etc.	T: 15 min	T: Instruction, group work	Handouts, worksheets
- explain underlying physical principals	Pressure, units of pressure, laminar and turbulent flow, Korotkoff sounds	T: 15 min P: 90 min.	T: Worksheets, demonstration P: Group experiments compare water column against mercury column Korotkoff sounds	Demonstration material Transparent horse pipe, BP manometer, measuring tape, connectors Plastic tube, water tab, Stethoscope.
Topic: Main Parts of BP apparatus At the end of this topic, the trainee should be able to:				
- identify main parts of commonly used BP apparatus	Housing, pumping bulb, cuff, bladder, manometer (diff. types), tubing, connectors, mercury tank, rise pipe etc.	T: 10 min P: 45 min.	T: Instruction, group discussion, demonstration P: group work assembling BP apparatus	Diagrams various BP apparatus Parts of various BP apparatus
- explain the purpose and function of each part	see above.	T: 10 min.	T: Instructions, worksheets demonstrations, individual work	Various BP apparatus Worksheets
- describe advantages and disadvantages of diff. types	advantages, disadvantages	T: 10 min.	T Discussion	Various BP apparatus

Objective	Contents	Time	Method	Materials
Topic: Use of BP apparatus At the end of this topic, the trainee should be able to:				
- prepare the patient for BP measurement	Correct positioning of patient, creating relaxed atmosphere	P: 30 min.	P: Demonstration, role play	Posters, diagrams Optional: slides, video film
- perform measurement	Selection and application of cuff, measurement of blood pressure	T: 15 min P: 30 min	T: Instructions, demonstration P. Group exercises taking measurements	Various BP-apparatus User manuals
- describe possible reading errors and safety precautions	Bias of recorder, Terminal digit preference, viewing angle risks	T: 15 min P: 30 min	T: Instructions P: Group work, comparing results	Various BP-apparatus User manuals Various BP-apparatus
Topic: Base-line Maintenance at the end of this topic, the trainee should be able to :				
- establish functional state of equipment	cleanliness, function test, leakage, accuracy of manometer	P: 30 min	Demonstration, checklists group work	BP apparatus various BP apparatus
- perform base-line maintenance	cleaning of equipment, function-test, exchange of parts	T: 15 min P: 30 min	Instruction, demonstration Group exercises	various BP apparatus, maintenance sheets
- decide on appropriate action in case of problems	repair, part exchange, request for service	T: 15 min P: 45 min	Instruction, group work Group exercises: part replacement, request for service, repair	Various BP apparatus, Request sheets, maintenance sheets

Annex 9 Checklist for " Stand-by Preparation "

BP apparatus, Mercury-type Manometer

☞ Equipment Check

Manometer correctly set to zero	☐
No air leakage	☐
Adjustment of pressure release speed	☐

☞ Availability of Cuffs

Adult size	☐
Children	☐
Infant	☐
Newborn	☐

☞ Stethoscope

Adult	☐
Infant	☐

☞ Chair and Armrest for Relaxed Position of Patient ☐

☞ Paper, Pen and Patient Records for Recording Results ☐

Annex 10 Instructions for Use

BP Apparatus, Mercury-type Manometer

Patient position	Patient may sit, lie or stand. The arm on which blood pressure is measured must be supported at heart level
Prepare patient	Patient must be relaxed. Arm must be bare. Normally left arm is used if patient is right handed
Select correct cuff size	Adult large Adult Child Newborn
Place cuff on arm	Fasten cuff around bare upper arm. Centre of bladder must be over brachial artery
Pump up cuff	Close pressure - release valve. Pump up pressure rapidly to approx. 200 mmHg
Place stethoscope	Chest piece of stethoscope must be placed over the brachial artery at the inner side of the elbow
Release pressure	Open pressure release valve slowly. A good deflating rate is approx. 2-3-mmHg/sec
Read systolic pressure	Read systolic pressure as soon as you hear the first sound of the pulse
Read diastolic pressure	Let pressure continue to decrease. Read diastolic pressure as soon as pulse fades and disappears
Record results	Note results. Check for plausibility. Consider possible bias or errors. Repeat reading if necessary.
Remove cuff	Prepare equipment for next patient or for stand-by

Annex 11 User Maintenance and Trouble-Shooting

User Maintenance

1.	**Cleaning**	Clean instrument carefully, using damp cloth and mild detergent. Do not use excessive water Avoid contact with oil and other chemicals with instrument	
2.	**Visual Check**	**Expected Result**	**Action**
	Check for damages	All parts of equipment must be undamaged	**Inform Technician if your findings differ**
	Check all rubber parts	Rubber parts may not be cracked or brittle	
	Check for spilled mercury in housing	If found, close apparatus, put in plastic bag and inform technician immediately	
	Check mercury column	Mercury column must be clearly visible and shiny	
3.	**Function Test**	**Expected Result**	**Action if different result is obtained**
	Pump up pressure to 300 mmHg	Mercury level must react quickly to increasing pressure	Inform technician
	Open release valve to maximum capacity at once.	Mercury must quickly (2 or 3 sec.) fall to zero	Inform technician
	Check mercury level	Mercury column must indicate zero	Inform technician
	Close pressure-release valve. Pump up cuff to 200 mmHg.	Pumping should be smooth and easy	See Trouble-Shooting Chart
	With cuff pressure of 200 mmHg, wait 10 seconds.	Pressure may not fall more than 2 mmHg. during that time	See Trouble-Shooting Chart
	Open release valve	Pressure fall rate must be adjustable from fast to slow; down to 1 mmHg/second	Inform technician
4.	**Transport and Storage**	Close valve on mercury tank Close equipment Seal equipment in plastic bag or plastic container Avoid vibrations Store equipment in cool, dry place Avoid exposure to sunlight	
5.	**Technician Maintenance**	Have equipment checked regularly by technician. Use correct service request forms Ensure technician is fully informed about all problems.	

Trouble-Shooting

The following chart may help to detect and correct user faults.

In case of other problems, or if problem persists, please inform technician
Use correct service request forms and describe problem precisely

Fault	Possible Cause	Remedy
1. ☹ Pumping Bulb cannot be squeezed	☝ Valve on mercury tank closed	Open valve ☺
	☝ Tubes blocked. Possibly squeezed or twisted .	Check all tubes connecting pumping ball, cuff and manometer
2. ☹ Pumping does not increase pressure in the system	☝ Apparatus not correctly assembled	Check connection ☺ between pumping bulb and cuff Check connection ☺ between cuff and manometer
	☝ Pressure release valve is not closed	Close pressure-release ☺ valve
3. ☹ System does not maintain pressure	☝ Connectors leaking	Fix tube connectors. ☺ A drop of water may help to seal.
	☝ Leak in bulb, bladder or connecting tubes	If available, try other ☺ cuff or other bulb. Forward faulty part to technician

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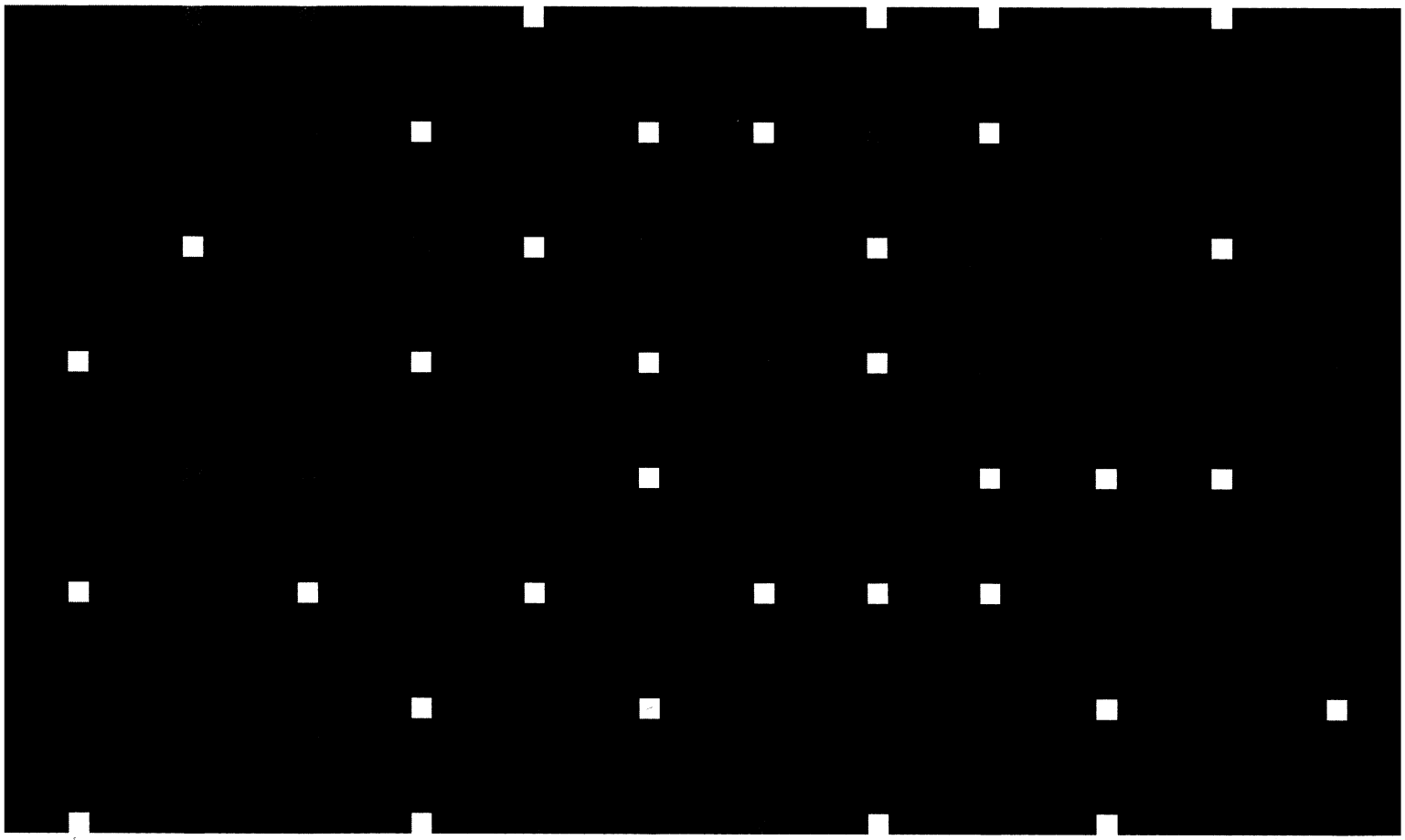

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