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THE PLANNING AND ORGANIZATION OF A HEALTH LABORATORY SERVICE

Fifth Report of the WHO Expert Committee on Health Laboratory Services

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CONTENTS

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Geneva, 8-15 November 1971

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THE PLANNING AND ORGANIZATION OF A HEALTH LABORATORY SERVICE

Fifth Report of the WHO Expert Committee on Health Laboratory Services

The WHO Expert Committee on Health Laboratory Services met in Geneva from 8 to 15 November 1971. The meeting was opened on behalf of the Director-General by Dr H. Mahler, Assistant Director-General.

In his opening remarks, Dr Mahler outlined the problems facing the Committee, and reminded the participants that their main objective was to provide judicious recommendations for the establishment or strengthening of national health laboratory services throughout the world. He also referred to the need to consider how future laboratory developments might best be utilized, with equal emphasis on community and individual care.

1. GENERAL CONSIDERATIONS

Several aspects of the planning and organization of health laboratory services have already been studied by various committees [1] and study groups sponsored by WHO. However, recent advances in laboratory science, new concepts of the organization of " basic health services " that have implications for laboratory services, together with the experience gained in the last decade, make it necessary to review the present situation and analyse the trends in the development of health laboratory services in the different countries of the world.

In the last 10–15 years many foreign technical staff and even well-trained nationals have left the developing countries; the difficult problems created by this situation have not yet been solved. The structure of health laboratory services in these countries has followed three main patterns: (*a*) maintenance of the old organization set up by the former colonial

[1] *Wld Hlth Org. techn. Rep. Ser.*, 1957, No. 128; 1959, No. 161; 1962, No. 236; 1966, No. 345.

power; (*b*) adaptation of the former organizational structure to local possibilities; (*c*) application of the emerging concepts of the organization of health services.

There are also countries where serious errors have been made in the planning of health laboratory services. There is a need to review the different types of organization of laboratory services in all countries and see how the general principles and guidelines laid down by previous expert committees require to be adapted or modified.

The details of organization and administration of a national health laboratory service will vary from country to country, and it is impossible therefore to define a single type of service that could be applied everywhere. However, certain general principles may be acceptable to any health authority responsible for such a service. The following principles and considerations are particularly important:

(1) the need for an integrated health laboratory service, particularly when no real laboratory structure exists;

(2) the development and improvement of laboratory facilities at all levels, with particular emphasis on intermediate and peripheral levels and with equal concern for both curative and preventive medicine;

(3) the special importance of securing a harmonious relationship between epidemiological activities and laboratory services;

(4) the co-ordination at the national level of all laboratories involved in activities related to human health, including laboratories dealing with investigations of zoonoses;

(5) the scarcity of qualified technical staff and the consequent necessity to create, expand, and improve training facilities in each country;

(6) the problems related to the standardization of techniques and equipment, the use of new methodology, and the progressive introduction of quality control.

Most of the considerations and recommendations in this report are primarily concerned with developing countries; however, they may also be useful to more advanced countries wishing to improve their health laboratory services.

2. DEVELOPMENT OF HEALTH LABORATORY SERVICES IN THE LAST DECADE

2.1 General review

During the last decade there has been a definite improvement in health laboratory services in most countries of the world, but with much variation in quantity and quality. The variations are well marked, not only between countries but also within countries; for example, there are considerable differences in laboratory services between rural and urban zones and beween rich and poor areas.

The main difficulties encountered are not necessarily the same for each country; in general, however, a few problems appear common to most countries.

In many cases, laboratory resources at the central level have been developed at the expense of intermediate and peripheral laboratories, and sometimes there is overlapping where there are several central laboratories each concentrating on a single problem, such as malaria or tuberculosis. Many central laboratories have been sited in or near large hospitals; this has often resulted in undue emphasis on clinical laboratory work at the expense of investigations into community health, and has also interfered with other important functions of the central laboratory, i.e., training, referral, and quality control activities.

Shortage of money is also a major problem, but lack of a definite budget and restrictions upon wise management of that budget are equally serious. The smaller the budget, the more important is its planning; otherwise, very elaborate equipment may be provided in a poorly staffed laboratory lacking essential supplies or means for maintenance and repair.

The shortage of qualified personnel at all levels has been one of the major reasons for the difficulties experienced in creating a balanced health laboratory service: this deficiency has been accentuated by relatively poor conditions of service and the apparent lack of glamour of health laboratory work compared with research and clinical medicine. To improve this situation, it will be necessary to revise the undergraduate medical curriculum so as to place greater and earlier emphasis upon problems related to community health. Such changes may be possible where the health laboratory services can develop a close association with medical schools.

One of the most disappointing features of the last decade has been the failure in some areas to develop an epidemiological service or, where such a service does exist, to ensure a close liaison between laboratory and epidemiological services. This lack of co-ordination is especially regrettable in countries where communicable diseases are still the major health problem.

Failure to raise standards of work has been due partly to inadequate development of efficient channels of communication between the different levels of the health laboratory service and to the lack of effective technical supervision of laboratory staff.

2.2 New technological developments

Another significant feature of the last decade has been the appearance of new and elaborate techniques, such as those used in environmental health control, mass examinations, and special studies, together with the development of automation and new methods of communication. Directors of health laboratory services should critically review these techniques before introducing them.

2.2.1 *Environmental health*

Man's pollution of his environment has reached such a stage that it threatens his very existence: he has fouled the air with waste products from cars and industry, polluted water with mercury and chlorinated biphenyls, and contaminated the earth with pesticides and insecticides, to give only a few examples. Other problems not yet sufficiently considered are excessive noise, overpopulation, and possible radiation build-up.

Almost all of these problems have been widely recognized only within the last decade. The detection and monitoring of pollutants are very complex and extensive tasks, and in most countries it has not yet been decided whether they should become a heavy additional load on the health laboratory service or whether separate environmental laboratories should be created. The latter plan has been adopted in the USA and in the United Kingdom.

2.2.2 *Mass examinations and special studies*

The introduction of laboratory automation within the last decade, especially in the fields of biochemistry and haematology, has made it possible to increase the workload of a given laboratory many times over without a significant increase in staff. This has led to biochemical screening of selected populations and hospital patients, prior to clinical examination. The screening of hospital patients may be of some value, but there seems little to recommend the screening of general populations unless such programmes have clinical backing and have limited objectives, such as the detection of diabetics and prediabetics. This type of population profile testing is expensive and throws a heavy load on the laboratory; its value has yet to be fully assessed.

2.2.3 *Automation*

One of the most striking new developments in laboratory technology is automation. At first sight automation appears a highly attractive proposition for laboratories in developing countries lacking trained technologists, but it is not the answer. Maintenance is complex and obtainable only at great expense from a few distant centres. The advantages and disadvantages are discussed more fully in Annex 1.

Automation should not be confused with developments in instrumentation, such as mechanized tissue processing, automatic pipettes, and the like. Such mechanical aids are of great value in all countries.

2.2.4 *Methods of communication*

Over the last few years the workload of health laboratories has increased markedly, particularly where automation is used. This often necessitates the introduction of improved methods of recording, reporting, storing, and retrieving test results, including the use of computers in a number of laboratories.

A further means of speeding up communication is the reporting of results by a telex or similar system directly to hospital wards and to distant peripheral laboratories. Where this system is introduced the results should not leave the laboratory until they have been scrutinized by a senior member of the staff.

2.2.5 *Other new developments*

New technological developments in the last decade range from the very simple to the very complex. Among the more important of the former are simple screening techniques, such as stick tests, improved culture screening tests for urine, and small-kit testing equipment. These are of considerable value, especially in peripheral laboratories, but their use must be carefully assessed before introduction and they must be continually supervised.

The introduction of micro-methods is proving very useful in paediatrics and in serological surveys, but these methods too must be carefully supervised. An important point to consider is the fact that significant titre levels obtained by micro-methods may be different from those obtained by macro-methods.

Other very useful advances include the development of a wider range of manufactured media and biological reagents and the extensive use of disposable materials.

New developments in other fields that will require further consideration are immunological surveys, nutrition studies and genetic studies, and the use of radio-isotopes in medicine.

3. PLACE OF THE HEALTH LABORATORY SERVICE WITHIN THE NATIONAL HEALTH SERVICE

A national health service ought to be an integral part of a country's economic and social plan for development. The health laboratory service plays a key role in providing an efficient and effective national health service and is one of its most important divisions. Whether the laboratory service adopted in any country is highly centralized, decentralized, or regionalized, will depend very much on the administrative structure of the country concerned and the availability of trained staff. However, local initiative in operational and day-to-day work should be encouraged at peripheral levels when possible. When decisions can be taken close to the population served, this will meet consumer demands, facilitate co-operation, and lessen delays.

Although the health laboratory service is an integral part of the national health service, it should, whenever possible, have a separate budget within the general budget of the ministry of health, and the director of the health laboratory service should have responsibility for this budget.

Integration [1] of hospital and public health laboratories is essential in developing countries. Separate emphasis on clinical or public health work narrows the scope of laboratory activities, whereas integration of both types of laboratory should prove beneficial by broadening these activities; it is desirable to encourage attempts towards achieving the maximum possible integration. Ultimately, it would be advisable also to incorporate within the health laboratory services such special laboratories as exist under autonomous national health campaigns, for example, those for the control of tuberculosis, malaria, or venereal diseases.

Where independent mobile laboratory teams exist they should eventually be integrated into the health laboratory services, but not until they have been replaced by fixed laboratory facilities.

Integration becomes imperative when manpower, equipment, and money are in short supply. There is no doubt also that there can be a great deal of duplication within large laboratories; this necessitates centralization within one laboratory of all techniques used by more than one discipline, such as studies on protein and enzyme chemistry.

At intermediate and peripheral levels, where both hospital and public health laboratories exist, the first step towards integration should be the appointment of an overall director.

The main argument against integration appears to be that it often leads to clinical work taking precedence over public health activities. In any type of integration it is essential to guard against this; community health is as important as individual patient care.

4. FUNCTIONS AND PERFORMANCE OF A HEALTH LABORATORY SERVICE

4.1 Functions

The functions of a health laboratory service are well described in the first [2] and, in particular, the third [3] report of the WHO Expert Committee

[1] The term " integration " is used here to mean the organization of all laboratory services within the framework of a national health laboratory service, whether or not the laboratories are physically separated; this applies to both administrative and technical aspects of organization.

[2] *Wld Hlth Org. techn. Rep. Ser.*, 1957, No. 128.

[3] *Wld Hlth Org. techn. Rep. Ser.*, 1962, No. 236.

on Health Laboratory Services. In the present report emphasis is placed mainly on changes that have resulted from recent advances.

(1) The primary function of a health laboratory service is to assist in the identification and control of all significant health problems in the country by providing information that is sufficiently specific and reliable to enable medical or health officers to take proper action. The types of problem that are " significant " will vary from country to country. For many years to come, communicable and parasitic diseases will constitute the most important health problems in many parts of the world; in such areas, therefore, health laboratories will be concerned primarily with microbiological work.

(2) Laboratory disciplines other than microbiology also have important public health applications, e.g., in haematological and serological surveys; in biochemical surveys of populations; in the study of environmental health problems; in cytological screening of populations; in the investigation and epidemiology of drug dependence; and in the study of geographic pathology.

(3) In some countries, the manufacture of biological products is a function of the health laboratory service. It is advisable for smaller countries to undertake this activity on a co-operative basis. It is not safe to accept biological products uncritically even from reputable manufacturers. Where possible, each country should establish an independent quality control unit for these products.[1] Where lack of resources and competent staff makes this difficult, international co-operation should be sought. WHO has assisted many countries in testing vaccines such as those against smallpox, cholera, and rabies.

Monitoring of the production process is sometimes the most effective method of ensuring a satisfactory end-product. In order to maintain quality, storage and transportation must also be supervised.

(4) Laboratories should publish any findings of epidemiological significance as rapidly and widely as possible; such information is very useful, not only to the country where it is obtained but also to other countries.

(5) One example of unprofitable use of laboratory resources is the indiscriminate examination of food handlers, although laboratory tests are of value in small well-defined groups, such as abattoir workers, after adequate clinical screening. Strict enforcement of the rules of food hygiene

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[1] A guide to the provision of the necessary technical facilities was published by WHO as Annex 3 to the twenty-second report of the WHO Expert Committee on Biological Standardization: *Wld Hlth Org. techn. Rep. Ser.*, 1970, No. 444, p. 71 (*Development of a National Control Laboratory for Biological Substances*).

is more useful than indiscriminate laboratory examinations. Strict review of the need for such examinations is a function of the chief of the laboratory.

(6) In the control of water, food, and other products of public health importance, the most important emerging problem is the fouling of water, earth, and atmosphere by man and man-made pollutants, already discussed in section 2.2.1. Although the problem is most evident in industrialized areas, practically no part of the world is free of pollution.

(7) The Committee agreed that good co-ordination and collaboration should exist between the health laboratory services and specialized forensic laboratories; in certain countries this may extend to the former carrying out some types of forensic investigation.

(8) One of the functions of the health laboratory service, preferably organized by its director, should be the provision of an epidemiological and statistical section adequate to meet the needs of all branches of the service. In countries with sufficient resources, this section could be incorporated in an information centre with data-processing equipment, responsible for keeping the whole service informed and up-to-date with all relevant information. This could with benefit be arranged in close co-operation with a quality control service in all branches of laboratory science. Such a service would, among other advantages, greatly help in case-finding and in the follow-up of tuberculosis or venereal disease contacts.

4.2 Level of performance

The Committee reiterated the importance of certain basic principles: laboratory results must be reproducible and comparable if they are to have any value; intermediate and peripheral laboratories must not overestimate their capacity in quantity or quality of work; equipment and techniques should be as simple as is consistent with efficiency; and maintenance services must be geared to handle the equipment in use.

One of the most important advances in maintaining satisfactory laboratory performance has been the introduction of quality control. Examples of simple and more complex methods of quality control are given in Annex 2.

The accuracy of procedures must be analysed in every laboratory, whatever its level. This function of quality control is of fundamental importance. The central laboratory must introduce standardized techniques and a quality control system to maintain efficiency in all types of laboratory work. Contrary to what is sometimes believed, quality control is even more important in automated than in manual techniques.

One thing that is immediately apparent from the use of quality control is the need for refresher courses for staff from intermediate and peripheral laboratories.

5. PLANNING OF THE SERVICE AND LABORATORY DESIGN

5.1 Planning of a health laboratory service

Long-term plans should be developed by the health laboratory service within the framework of national health planning. These plans should extend to all levels of the health laboratory service, and must cover the total programme as well as all aspects of buildings, staff, and equipment. Planning should include the preparation of a reasoned case for submission through proper channels to the finance authorities.

The question of planning a laboratory " from scratch " in a developing country almost lacking laboratory facilities was also considered by the Committee. There should be no premature rush to put up a building. The choice of a director is of vital importance. The person chosen and perhaps his senior staff should be sent to suitable countries to profit from the experience of other directors: in the meantime an international laboratory team might be invited to work for 1–2 years in the country to assist in establishing a clear picture of the relative importance of the major diseases of the area. An inventory should be taken of any existing laboratory facilities so that a plan can be drawn up for their best use. A start in providing basic laboratory facilities could be made by utilizing simple, small, and movable (but not mobile) units, which could be enlarged by adding further units as need arises. There is little point in sending out epidemiological teams without laboratory support, as epidemiological data based on clinical diagnosis alone may lead to serious mistakes in national health planning.

The Committee expressed concern that national health planning committees commonly fail to consider the laboratory needs of their country.

5.2 Design of laboratories

In planning laboratory services it is necessary to consider very carefully the design of the premises in which the work will be carried out, as this is crucial to success. Clearly, design and total space will vary with the size and density of the population, the number of hospital beds to be served, whether a public health laboratory is to be included, and the complexity of the work that will be required from the service.

Most directors will have no previous experience of design of laboratories. A number of useful publications on this subject are available.[1]

[1] These include:

United Kingdom, Department of Health and Social Security (1971) *Building Note No. 15*, London;

Nuffield Foundation, Division of Architectural Studies (1961) *The design of research laboratories*, London, Oxford University Press;

Coleman, H.S., ed. (1951) *Laboratory design: Report by Committee on Design, Construction and Equipment of Laboratories*, New York, Reinhold;

Schramm, W. (1965) *Chemistry and biology laboratories: design - construction - equipment*, Oxford, Pergamon.

In designing laboratories, allowance must be made for possible extensions and adequate storage space in view of the fact that the workload can be expected to expand at the rate of 15–25 % per annum. It is necessary to allow not only for this overall growth but also for the fact that the demands on individual laboratory disciplines are not increasing at the same rate, e.g., in some countries work in biochemistry is increasing much more rapidly than work in microbiology.

The design of a central laboratory, therefore, must permit the easy expansion of facilities, with flexibility in the distribution of activities. Obviously, a laboratory should not be designed to occupy a single upper-level floor in a multistorey structure.

A module design should be adopted, with freely movable internal partitions to ensure flexibility. All benches and underbench units should also be freely movable.

Some laboratories are being built without windows; this has an advantage in that much more wall space is available for shelving. To minimize mental and physical discomfort of staff, such laboratories must be designed with adequate ventilation; control of noise, temperature, and humidity must also be considered.

5.2.1 *Central laboratory*

It is difficult to lay down detailed plans for setting up central laboratories. They should certainly comprise departments for all the main disciplines, preferably housed adjacent to a main hospital. However, although this arrangement may prove satisfactory at first, it is recognized that the increasing volume of hospital investigations may soon strain the capacity of the laboratory; it is essential to safeguard the facilities for public health and epidemiological investigations. Additional special departments could be included, such as a laboratory for isotopes, a virology unit, a serological reference laboratory, and animal house facilities. Decisions on all these points must be made at the national level.

5.2.2 *Intermediate laboratory*

The design of the intermediate (regional or district) laboratory will depend on whether the laboratory is to deal with samples collected at a number of small peripheral laboratories and health centres within a specified distance, or whether it will operate without the support of peripheral services. These laboratories are best located on the same premises as the largest hospital in the area and should provide a full service in laboratory medicine for this hospital and its satellites as well as for the general practitioners and public health authorities of the area. Such laboratories should preferably not be built within the main hospital structure, but must have ready access to wards and outpatient departments.

In the intermediate laboratory, the main departments should be:

(1) *a histopathology department,* perhaps including sections for forensic pathology and cytology;

(2) *a haematology department,* with a related section for blood group serology and blood transfusion;

(3) *a biochemistry department,* with a section for toxicology;

(4) *a microbiology department,* with a section specifically reserved for public health work.

Adequate and clearly defined storage areas are essential; otherwise the laboratory will rapidly become overcrowded with stores, and corridors will have to be used for storage, thus reducing the effectiveness of the laboratory.

5.2.3 *Peripheral laboratory*

This laboratory need not be large, as it will normally employ only two or three persons. It will deal with local health centre work, mainly using simple dipstick types of testing, which, properly supervised, will give much of the information that doctors require.

The equipment must include a microscope for blood, stool, and urine examinations and for direct bacteriological examinations, such as sputum tests for tuberculosis and skin smears for leprosy. All other tests should be carried out by the nearest intermediate or district laboratory.

6. ORGANIZATION AND ADMINISTRATION OF A HEALTH LABORATORY SERVICE

An integrated health laboratory service should comprise all medical laboratory disciplines. Since its organizational pattern will depend on its size and on the specific health problems of the country concerned, only general and administrative principles are discussed here. The study of public health laboratory services in several countries published as an annex to the first report of the WHO Expert Committee on Health Laboratory Methods [1] provides valuable information and guidelines applicable to the organization and administration of these services.

The health laboratory service, like other health services, should have a legal basis in a public health act or comparable legislation. This would guarantee the stability of the organization of the service, as well as defining its status and functions.

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[1] *Wld Hlth Org. techn. Rep. Ser.,* 1957, No. 128, pp. 33-49.

For the majority of developing countries, a unified laboratory service is both feasible and essential.

A balanced three-tiered structure is the ideal, with laboratories at the central, intermediate, and peripheral levels.

6.1 The director of the service

As already stated, the selection of a competent person as director of the health laboratory service is of vital importance. He must be medically qualified, a specialist in laboratory sciences with an understanding of public health, and well-informed about the health problems of the country. His status must be such as to enable him to present convincingly the role of the health laboratory service in the national health service. Both in long-term planning and in day-to-day control of technical operations, the director's authority should extend to all levels of laboratories.

The director of the health laboratory service should be responsible to the director of the national health service. He should have full authority and responsibility for the scientific and administrative direction of his staff; he must also have the freedom of action necessary to provide the link between the technical service and the administrative hierarchy. Although he may delegate both his scientific and technical duties and his day-to-day managerial responsibilities, he will remain responsible for all programme and administrative activities of the service. Good management by a competent director will provide technical development and will maintain and further improve working standards.

To guarantee the organizational effectiveness of the health laboratory service, the director's special responsibilities should include:

(1) continuous programme planning and evaluation;

(2) budget preparation and administration within the limits of the funds available;

(3) close collaboration with epidemiological services where they exist, and stimulating their creation where they do not exist;

(4) maintenance of adequate liaison with all pertinent health programmes outside the health laboratory service;

(5) ensuring that the head of every laboratory fully understands his responsibilities for laboratory safety and nominates a safety officer.

6.2 The advisory committee

Although much of the material in this section has already been published in the Committee's third report,[1] it is repeated here on account of its importance and for ease of reference.

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[1] *Wld Hlth Org. techn. Rep. Ser.*, 1962, No. 236, pp. 19-20.

An advisory committee should be appointed to provide the director with advice and consultation on broad areas relating to the development and organization of health laboratory services in the country. The areas of advice could include:

(1) the scope and organization of laboratory programmes, and the priorities of services in different disciplines of health laboratory sciences;

(2) manpower development for the health laboratory service, and continuous and refresher training for laboratory personnel;

(3) co-ordination of services, research functions, and further training with other governmental and with non-governmental organizations (e.g., department of agriculture, universities);

(4) the nature and scope of related services, such as epidemiological investigations and blood transfusion services;

(5) drafting and updating of laboratory regulations;

(6) any other matters pertaining to the service on which the director requests advice.

It is suggested that the committee should consist of:

(1) the director of the service, who should be the chairman and responsible for the agenda of the meetings;

(2) representatives from the epidemiological and other public health departments and from hospital laboratory and veterinary services;

(3) representatives from medical schools and national research councils, if they exist in the country.

This committee should be kept as small as possible for working purposes, but should have a balanced representation. The director should also be empowered to co-opt any suitable person to help deal with any special problem. The functions of the committee should be purely advisory and not executive.

The use of standing and *ad hoc* committees to advise the director of the health laboratory service or the director of the central laboratory on technical matters is encouraged. The membership of these committees should represent the country's best available expertise on the specific problem to be discussed.

6.3 Laboratories at different levels

The focal point of the service is the central laboratory, with its multiple functions of reference, training, applied research, supervision, provision of staff, supply (of reagents, media, and equipment), and equipment maintenance. While strict quality control should be exercised for all laboratories, the central laboratory should otherwise decentralize authority as much as possible while giving full support to the intermediate and peripheral laboratories. Morale and efficiency at all levels are greatly improved by frequent visits from the director of the health laboratory service.

In the last decade, the developing countries have gone far in establishing central laboratories. Emphasis must now be concentrated on laboratories at lower levels. The intermediate laboratories are now of key importance. Each one should be responsible for providing a good hospital laboratory and public health laboratory service in its area and for maintaining close links with the central laboratory, to which it should refer all difficult problems. It must also support and supervise the peripheral laboratories in its area.

The peripheral laboratories should be sited in rural hospitals or in the health centres; they should be staffed by laboratory assistants with at least one year's special training, who should be members of the basic health team. Close supervision of these peripheral laboratories is essential, whether by mobile teams or by a senior technician responsible for several peripheral laboratories.

Periodic evaluation should be carried out at each level of the laboratory services. This should include operation evaluation, quality control, evaluation of cost per unit of work, and examination of the work to assess the value of each activity in the prevention of disease and the promotion of health. This may lead to the elimination of unproductive work, such as the indiscriminate examination of food handlers.

7. RESEARCH ACTIVITIES

Basic research should properly be left to special institutions with sufficient manpower and equipment, such as universities and large research institutions. However, this still leaves great opportunities for applied research and development work within the health laboratory services, where the research technique of today may become the routine method of tomorrow.

Research can be conducted at all levels. In the central laboratories, obviously, there must be much work on reference techniques (e.g., identification of agents and vectors of infection, together with the production of antigens and immune sera to facilitate such identification), on environmental health and toxicology, on serological surveys such as those aimed at evaluating the immunological status of a population before and after mass vaccination, and on controlled testing of the safety and efficacy of vaccines. Proper budgeting of these activities is of course essential.

Development work in the central laboratories should include investigations into the selection and standardization of techniques and the selection of reagents best adapted to working conditions in the laboratories.

The preparation and control of effective and safe biological products requires the kind of research that can be undertaken only in a limited number of laboratories.

The opportunities for research in the intermediate and peripheral laboratories are less obvious, but competent personnel should be encouraged to grasp such opportunities as do arise.

It is particularly in epidemiological research that the intermediate and peripheral laboratories have most to contribute, i.e., in studies aimed at determining the nature and importance of the country's health problems — an area between service and research. This is especially important in developing countries where there are no satisfactory epidemiological studies.

Besides studies on communicable diseases, work is needed to ascertain the incidence of such diseases as cancer, leukaemia, and haemoglobinopathies and other genetically determined diseases, and to determine the distribution of metabolic abnormalities, such as goitre, that may have an environmental basis. The value of laboratory-based surveys, such as exfoliative cytology to detect cancer of the cervix and lung and biochemical profiles, could also be assessed by these laboratories. Many of these activities require no extra equipment or training, but time has to be set aside for them.

The introduction of research at all levels of laboratory work gives a profitable and necessary boost to morale. It is essential, however, to guard against the possibility of a worker undertaking research at the expense of his other duties in an attempt to get promotion without regard to the priorities of the health service. The director must point out that promotion can come without research; he must also determine research priorities and provide adequate training for research workers when necessary. All research must be adequately co-ordinated.

8. TRAINING OF STAFF

In 1966, the Committee's fourth report dealt with the training of health laboratory personnel (technical staff).[1] Since that time there have been so many important changes that the subject of the training of laboratory personnel—medical and other scientific staff as well as technical staff—again deserves detailed consideration. As an interim measure the subject is considered to a certain extent in the present report.

8.1 Medical officer specialized in laboratory science

This is a medical officer with special training and experience in laboratory sciences. After obtaining his medical degree, the medical officer

[1] *Wld Hlth Org. techn. Rep. Ser.*, 1966, No. 345.

should have a period in clinical medicine before embarking on his laboratory training. Thereafter he should spend at least 3 years mainly in in-service training in a recognized laboratory, preferably obtaining experience in all the main branches of laboratory sciences (i.e., histopathology, microbiology and immunology, haematology, and clinical chemistry). In some countries this is all that is possible at present. In those countries where it is feasible, however, a further period of 2-3 years' advanced training in one subject would complete the training for a medical specialist in laboratory medicine. Thus, a minimum period of 5 years is recommended before full accreditation.

8.2 Scientific officer

There is wide variation in the qualifications for the post of scientific officer in a health laboratory. In some countries pharmacists with 5 years of university training are qualified in most branches of laboratory science, including microbiology, biochemistry, and haematology, and could become scientific officers. Equally, some veterinarians may have the right sort of training to entitle them to be considered for such appointments. In other countries, graduates in basic sciences such as chemistry, biochemistry, physics, or biology may be appointed to a basic grade for 2 years, during which time they should acquire the expertise of medical laboratory sciences. Promotion could well depend on the acquisition of a higher degree or diploma in medical laboratory science. The best candidates could become heads of divisions within a laboratory (e.g., biochemistry).

8.3 Technical staff

8.3.1 *Medical laboratory technician (level B)* [1]

In most countries, the medical laboratory technician is the backbone of the technical staff: he is responsible for the bulk of the full-time work of most laboratories and his professional status must be jealously preserved. Consequently, this category of technical personnel is dealt with first.

Entrants to this grade are required to have completed at least 10 years, and preferably 12 years, of secondary education. Training can be undertaken in one of 3 ways.

(1) *Full-time institutional training*. This is usually carried out at technical colleges or universities. There is a tendency in some of these courses to cover a very large field of work, emphasizing theoretical training at the expense of practical training. In microbiology, for example, it

[1] The designations " level A, B, C, D, E " are those used in *Wld Hlth Org. techn. Rep. Ser.*, 1966, No. 345, pp. 5-9.

has been known for courses to deal only with non-pathogenic bacteria, thus hardly preparing the student for his work in clinical microbiology. Frequently, too, these students are not at first as dedicated as are most student technicians trained in a medical laboratory.

(2) *Wholly laboratory-based training.* This system has worked well in the past, but only when the laboratory is fully geared to teaching. Often the student is too heavily involved in routine duties. Teaching laboratories must have qualified teaching personnel on their staff. Some support may well be sought from other teachers.

(3) *Combined (sandwich) system.* In this system, the student is taught both theory and basic practical work at a technical college and receives in-service training at a recognized laboratory throughout his training period. This combination can be accomplished in a variety of ways. Many countries have encouraged " day release ", whereby one whole day each week is spent at technical college. Alternatively, if distances are too great, longer periods may be spent at the college, perhaps with " residential " courses of 2–4 weeks or more arranged when the concentrated scientific basis of the subject is taught at the technical college.

A total of 3–4 years is recommended for the training of medical laboratory technicians, the length of time depending on national requirements. Whenever possible, each country should set up training facilities within its own borders.

The syllabus should be agreed on a national basis, and important decisions may have to be made by each country on the extent of the syllabus. The training should be broadly based, covering an introduction to each branch of laboratory science. Specialization could then follow qualification. However, a few countries are already accepting a minimum introduction period and qualification at medical laboratory technician level in one discipline only.

Whatever is decided, the course should be validated by an examination or some other acceptable form of assessment and by the granting of a certificate of competence. If possible, the standards of these examinations and assessments should be internationally acceptable so as to allow ready exchange of technicians between countries.

8.3.2 *Technologist (senior technician, level A)*

This is an advanced grade, and the technologist will normally be required to take technical charge of one of the divisions in a multi-discipline laboratory. The grade can usually be entered in one of two ways:

(1) Promotion to this grade should be open to medical laboratory technicians with 3 years of practical experience who have completed further studies in a more specialized field (e.g., microbiology, biochemistry).

(2) A university or technical college graduate in science, preferably in a medical laboratory science, should also be eligible for this grade after 2 years' practical experience. Such graduates wishing to become scientific officers would be expected to obtain a higher qualification, as described in section 8.2.

8.3.3 *Technical assistant (auxiliary, junior, levels C and D)*

Entry to this grade requires a minimum of 8 years' schooling, and preferably 10 years. A technical assistant will eventually do important but simple and fairly repetitive routine laboratory work, and will normally be required to work under supervision.

8.3.4 *Laboratory aides (level E)*

Although laboratory aides perform much more limited work than trained technicians, their value should not be overlooked; they are widely used in most countries. In the medical laboratory there are very many repetitive or boring tasks to be carried out, e.g., the separation of serum from clotted blood samples, the dipstick testing of urine, and the making and pouring of media. By on-the-job training even individuals of limited education and capability can learn such tasks quickly. Where such workers are employed, they must always be under the supervision of a trained laboratory technician.

8.4 Continuous training of staff

All grades of laboratory staff should be given periods of special training throughout their professional career in order to maintain and improve standards and to acquaint them with new advances in their respective fields.

It is equally important to provide special facilities for the training of teacher technicians, not only in technical subjects but also in the methodology of teaching. WHO has an important role to play in this area.

8.5 Further information

Details of entry requirements, length of training, and possibilities of promotion for the staff of health laboratories are given in the accompanying table.

The Council of Europe recently adopted a resolution " on the minimum standards of training and equivalence of qualifications of medical laboratory technicians ". This is reproduced for information as Annex 3.

More detailed information on certain aspects of the training of technical laboratory staff is provided in Annex 4.

USUAL QUALIFICATIONS FOR HEALTH LABORATORY PERSONNEL

Grade or post	Required educational level	Special training required	Promotion possibilities
Medical officer specializing in laboratory science	University degree in medicine	3-5 years' specialized postgraduate training	
Scientific officer	University degree in basic science, e.g., biochemistry, biology, pharmacy	2 years' postgraduate experience; higher degree, e.g., Ph.D. or M.Sc.	
Technologist (senior technician, level A)	Complete secondary education (12 years)	University or technical college, plus 2 years' practical experience	
Medical laboratory technician (level B)	Secondary education (10 or preferably 12 years)	3-4 years	Technologist (level A), after practical experience and further specialized studies
Technical assistant (auxiliary, junior, levels C and D)	At least 8 (preferably 10) years of primary education, possibly with some secondary education	1 year	Medical laboratory technician (level B), after further secondary education, practical experience, and further technical studies

9. INTERNATIONAL COLLABORATION AND THE ROLE OF WHO

Modern laboratory functions and techniques are now so complex that many countries, both developed and developing, need economic and technical assistance from external sources.

This assistance may be international, bilateral, or multilateral. For example, many countries help developing nations by assisting with the construction and equipment of laboratories and by providing experts to ensure proper operation of the laboratories and to train national specialists. This collaboration, together with exchanges between universities and research institutes, makes it possible for developing countries to improve the scientific and technical level of their work.

WHO has a stimulating influence in this area and may also provide direct assistance. Its activities include:

(1) providing short-term consultants and other experts in laboratory science and technology to assist in the planning, organization, and development of a health laboratory service and in training the necessary staff;

(2) providing financial aid on a limited scale in the form of fellowships, laboratory apparatus, and equipment, support for important research work by individual scientists as well as by institutes, and for certain inter-

national institutions, particularly the WHO reference centres and collaborating laboratories.

(3) assisting in making available bibliographies and scientific documentation, and in listing references on relevant scientific subjects.

(4) convening expert committees and scientific groups and publishing their reports and recommendations, e.g., in the fields of communicable disease control, community health, environmental pollution, and drug dependence.

The WHO reference centres and collaborating laboratories also provide assistance by supplying standard reagents, cell lines, and sera, by typing difficult microbiological strains, by identifying rare blood groups, by testing biological products and reagents, by conducting quality control programmes, etc. In addition, these centres may carry out epidemiological studies and research on disease control programmes.

International co-operation also includes the provision of advice on any of the matters referred to in this section. Such activities may be conducted or co-ordinated by WHO.

10. RECOMMENDATIONS

1. The establishment of a health laboratory service as an integral part of the national health service should be based on a public health act or some other legislation. The health laboratory service should be an integrated laboratory service, with a separate budget within that of the ministry of health.

In developing countries it is essential to integrate hospital and public health laboratories at intermediate and peripheral levels. Where the two types of laboratory are in existence, the first step towards integration should be the designation of a joint chief.

2. Long-term planning of a health laboratory service should be instituted, within the framework of national health planning.

A study on the design of laboratories at all levels — central, intermediate, and peripheral — should be undertaken by all countries.

3. The activities of a health laboratory service should be directed equally towards community health and individual patient care.

The service should comprise laboratories at central, intermediate, and peripheral levels, with particular emphasis on the intermediate level.

4. A director of a health laboratory service should have full authority for the scientific and administrative direction of the service, including continuous programme planning and evaluation; he should have the help

and advice of a standing committee and such other technical committees as he may need.

In countries where this has not yet been done, a director of health laboratory services should be appointed as quickly as possible.

5. Health centre activities are improved by the inclusion of laboratory work at the peripheral level. The health centre team should include a technical assistant or medical laboratory technician, according to the availability of manpower.

6. Technical supervision should be ensured throughout the health laboratory service. Quality control must be applied at all levels and the central laboratory must introduce standard techniques and a quality control system.

WHO should continue to encourage international studies on quality control.

7. The Committee welcomes the action of WHO in establishing an international haemoglobin cyanide reference preparation, and recommends that further studies be encouraged for developing international standards in all branches of medical laboratory sciences.

8. Each country should establish independent control units for biological products. If necessary, international aid should be sought for this work.

9. Although infectious and parasitic diseases are the most important health problems in most countries, the responsibilities of the health laboratory service should also include other health activities, such as haematological, biochemical, and cytological surveys of the population, environmental health studies, epidemiological studies of drug dependence, and studies of geographical pathology.

10. The establishment in each country of an epidemiology department within the ministry of health is recommended. This department should collaborate closely with the health laboratory service in collecting and analysing information about the significant diseases of the country. Epidemiological studies must always have laboratory support; decisions based on clinical diagnosis alone may lead to serious mistakes.

11. There should be effective liaison and exchange of information between the health laboratory service and other laboratories and services dealing with human health problems.

Laboratories should publish findings of epidemiological significance as rapidly and widely as possible, because such information is very useful not only to the country where it is obtained but also to other countries.

12. Automation may appear a highly attractive proposition for laboratories in developing countries that lack trained technologists. However, its advantages and disadvantages (including maintenance problems) should

be carefully considered (e.g., by cost-benefit analysis) before it is introduced into any country. Automation increases the need for quality control.

Work simplification and mechanization to simplify procedures and to increase accuracy should be encouraged.

13. The Committee suggests that WHO should consider convening another meeting of experts to examine all aspects of training of both scientific and technical staff in the various disciplines of laboratory medicine.

14. Training programmes should be based on national requirements. Training activities should be encouraged at the national level, and every country should plan manpower utilization according to needs and available facilities.

15. Each country should provide training facilities for medical laboratory technicians, preferably based on a combined system of in-service and institutional training. Qualification and registration should be validated by an examination or other acceptable method of assessment and by the granting of a national certificate.

WHO should consider organizing inter-country training programmes for teachers of medical laboratory technology.

16. Health laboratory services should be encouraged to conduct research, mainly of an applied nature. While the central laboratory should concentrate more on methodological and other research activities, the intermediate and peripheral laboratories, whenever facilities and staff are available, should deal mostly with epidemiological problems.

Acknowledgements

The Committee wishes to record its thanks to the following members of the WHO Secretariat for their special contributions to its deliberations: Dr F. Lothe, Health Laboratory Services; Dr G. Quincke, Regional Adviser on Health Laboratory Services, WHO Regional Office for Africa; Dr D. Vazquez, Health Laboratory Services; Dr A. Wahba, WHO Microbiologist, Algeria.

Annex 1

AUTOMATION

To assist in the clarification of this subject, the following terms are explained:

Manual methods are considered to be procedures in which the separate steps of a process such as measuring, mixing, heating, colour reading, and handling of data are carried out individually by the health laboratory personnel.

Work simplification techniques substitute for hand operations the use of devices such as precalibrated self-filling and self-emptying measuring devices for samples and reagents, and flow-through cuvettes that obviate the need for emptying and cleaning after each use. These aids speed the work considerably and improve accuracy.

Mechanization is a material handling process whereby the need for human intervention is reduced to the minimum. Most laboratory innovations of the last decade have been of this type.

Automation implies an inherent capability of self-correction by a feedback mechanism. Thus the machine recognizes the presence of errors and brings about an automatic correction sequence. It must therefore be recognized that automation as such is not yet available or feasible in many health laboratories. Electronic data-processing (EDP) is the automation of data collection, calculation, and presentation.

There are several reasons why laboratories ask for automation. The main and most valid reason is an increasing workload that can no longer be managed by available staff. Consequently, any test that is in constant demand and accounts for a large proportion of the laboratory work would qualify for automation. Another reason is that at the end of a long and tedious day technicians are fatigued and the results tend to be less accurate. Automation helps to speed up the tests so that many more may be undertaken, while full built-in quality control ensures that a high degree of accuracy can be maintained. However, it should be remembered that in an ordinary routine laboratory these common tests may account for as much as 80% of the total number of operations, but represent only a small segment of the range of tests demanded. This means that nearly three-quarters of the total number of types of technical process still have to be done by hand. Every possible facility for mechanization should therefore be given to laboratories of all levels.

Automatic self-filling pipettes and burettes, flow-through cuvettes, and easy scale read-out all make biochemical work move quickly and easily. Digital conversion units save much time and effort. Similar mechanization is available for many haematological and microbiological techniques.

Automation should really include electronic data-processing, with computerization of results and a print-out system. This is very sophisticated machinery and should be considered only for very large laboratories with a great turnover of specimens. Retraining of laboratory personnel would be required, and a maintenance service is an absolute necessity.

When automation is provided it will usually induce a greater demand to fill the capacity of the machine. Such things as hospital profiles for all new patients and even population surveys will soon be added to the workload of the automated laboratory. This in itself will present very great problems in specimen identification, which must be made as exact and nearly foolproof as possible without delaying the work of the laboratory; in nearly every case a special identification system will be required. Similarly, a bottleneck in reporting may cause delays. To avoid this a print-out system should be added, but even with all safeguards that can be built into the system no report should leave the laboratory until it has been seen by the responsible specialist. This becomes even more essential when there is a telex system for reporting directly to the hospital, the ward, or even a doctor in the provinces. Interpretation of results by a laboratory medical specialist may still be of vital importance.

Flexibility of automation

Automatic equipment performing only small groups of tests is to be preferred to the more sophisticated kind performing 15–20 tests. Any decision to use the latter kind of equipment should be based more on the medical requirements than on the large number of tests that the machine can perform. This would be in line with the trend in laboratory work towards physiopathological investigations, i.e., the analysis of systems with all related laboratory investigations, e.g., renal, liver, respiratory, or thyroid function tests.

Training of technicians

A word of warning is needed with regard to the training programmes recommended for medical laboratory technicians. Where automation is introduced the full training of these technicians becomes more important rather than less so, for without it they will have no basic understanding of the procedures.

Annex 2

QUALITY CONTROL

Internal quality control

All health laboratories should have quality control programmes in order to maintain good and comparable standards of performance and to provide regular monitoring of results. Clearly, different methods will be used in the different branches of the laboratory, but the basic principles remain the same.

Each laboratory should incorporate control material with every batch of tests. It is now accepted practice to incorporate sera of known reactivity in serological tests for syphilis and other conditions. Similarly, known controls are used in blood transfusion work. In histochemistry known positive and negative tissues are used with each batch of stain, e.g., in tests to detect iron in tissues.

In biochemistry, standard solutions are usually prepared in the laboratory and used in each batch of tests. Reference samples are also employed.

In microbiology, apart from serology, there is also an important need for quality control in, for example, antibiotic sensitivity tests, work on the recognition and typing of bacterial strains, and bacteria counts.

At the end of each day the results of each test, e.g., blood urea and sugar tests, should be plotted. The distribution curve will generally follow a pattern in any one laboratory. Any change in the distribution curve should alert the staff to the possibility of a decline in accuracy.

In laboratories using any form of automation, quality control is even more important but perhaps easier to arrange. " High and low " specimens must be included at regular intervals in every batch tested in order to assess any " drift " in the machines. The use of computers will also provide early warning systems for errors.

External quality control

Arrangements should be made for the central laboratory to prepare " unknown " control sera, etc. and distribute them to participating laboratories, so that a check is available on performance. The results should be notified to the other laboratories as soon as possible. If they are not within an acceptable range (e.g., standard deviation of ± 2 in chemical tests), inquiries should be made so as to identify and eliminate the cause of the error. It may be found that the precision and reproducibility are excellent, but that the results are regularly too high or too low, i.e., inaccurate. Small adjustments may be all that is needed in such cases. If, however, there is neither precision nor accuracy, major changes in the routine technique may be necessary. The best laboratories achieve precision with a high degree of accuracy.

In quality control programmes dealing with quantitative determinations, the levels of results are significantly influenced by the method and reagents used. Since adequate standardization of methods and reagents is not yet in sight, quality control programmes should pay more attention to the reproducibility of results than to the absolute values obtained, provided that the range of normal values in each laboratory is defined and is acceptable to the clinicians.

International quality control

In order to permit comparison of survey results between countries and to obtain meaningful statistics, international quality control programmes should be arranged in respect of those determinations where methodology is sufficiently developed and stable reagents are available. This is already being done with haemoglobin standards. It soon becomes apparent if the laboratories of one country are consistently recording lower or higher results than those of most other countries; in such cases the national programme of quality control can be adjusted to enable the laboratories to report more precise and accurate results.

It is essential to exchange sera and information on methods if comparisons are to be meaningful.

Simple methods of quality control

Simple methods have been devised as a preliminary measure until more elaborate external or internal procedures using unknown controls can be applied. These techniques may be of particular value in certain developing countries.

On-the-spot control

This method is advocated for laboratories with little or no central supervision or where the medical or non-medical scientific staff is inadequate to maintain supervision of the technical staff.

The procedure consists of forming a group of qualified laboratory technicians with teaching experience in the various laboratory disciplines, directed whenever possible by a team leader appointed by the central laboratory. This team, possibly provided with a mobile unit and selected specimens, visits peripheral and intermediate laboratories and asks the technical staff there to perform certain analyses. The results are evaluated and compared with the standards, and at the same time the techniques and equipment used are assessed. A very useful additional member of the team is a specialist in laboratory instrument maintenance and repair, who would check all the equipment.

The strict control of laboratory methodology, which is greatly helped by an up-to-date manual accredited at national level, increases laboratory efficiency.

A regular dialogue between the laboratory's scientific staff and the various users of the laboratory will provide valuable information about the true value of the laboratory's reports and may lead to a readjustment of the range of tests supplied by the local health laboratory service.

Annex 3

RESOLUTION ON MINIMUM STANDARDS OF TRAINING AND EQUIVALENCE OF QUALIFICATIONS OF MEDICAL LABORATORY TECHNICIANS

Resolution (70) 8 of the Committee of Ministers of the Council of Europe, adopted by the Ministers' Deputies on 7 March 1970

The Committee of Ministers,

Considering that the aim of the Council of Europe is to bring about a closer union between its Members by means, inter alia, of the adoption of common standards in the social field;

Considering that medical laboratory technicians are indispensable to the efficient functioning of medical laboratories and similar institutions;

Bearing in mind that it is desirable that their status as members of a separate profession be uniformly recognised in all member countries;

Considering that an essential preliminary to such recognition is the adoption of minimum standards for the training of medical laboratory technicians,

1. Addresses the following recommendations to the governments of member states;

2. Invites the governments of member states to keep the Secretary General informed every three years of action taken in connection with this resolution.

I. Definition and function

1. Medical laboratory technicians will hold the diploma or licence awarded by the government of a member state of the Council of Europe or an organisation or institution recognised by that government following successful completion of the programme of theoretical and practical training as specified below. They will be the equivalent in member countries of the level " B " technicians as mentioned in Appendix B as defined by a committee of experts of WHO (see Appendix C).

2. Basic functions

(a) Responsibility for the accurate technical performance of all routine and special laboratory procedures assigned to them by medical, scientific or senior technical staff principally in the fields of clinical chemistry, microbiology, immunology including serology, haematology and immuno-haematology, and histopathology and cytology.

(b) Participation in the supervision, teaching and training of subordinate technical personnel.

II. Training

Training of medical laboratory technicians should follow the ensuing principles with a view to minimum standards of training:

(a) For *admission* to training, the candidates must have successfully completed the required term of ordinary secondary education, or its equivalent, as specified by law or national regulation, this education to include adequate instruction in mathematics, physics, chemistry and biology. If a school leaving qualification is not obtained, an entrance examination to the training course should be held.

There should be no discrimination against either men or women.

(b) The *training* programme should be related to the educational level attained before admission and should be based on the summary programme set out in Appendix A. For persons with school leaving qualifications, theoretical and practical training should cover not less than 2,200 hours. Training should include at least 25 % theoretical instruction and not less than 50 % practical instruction. The remaining 25 % may consist of either theoretical or practical instruction. The training programme should provide a detailed syllabus with the number of hours devoted to each subject.

Where a person does not have a school leaving qualification the theoretical and practical training should cover not less than 2,700 hours, of which the extra 500 hours should be devoted to supplementing the general and scientific knowledge of the student.

(c) The *training programme* should:

(i) provide sufficient background knowledge of scientific principles and their application to medical laboratory technology in order to facilitate assimilation of scientific and technical developments;

(ii) lead to knowledge of the principles and the practice of:

— clinical chemistry,

— microbiology, and immunology (including serology),

— haematology and immuno-haematology,

— histopathology and cytology.

(d) The formal training should be terminated by a final *examination* given or supervised by the nationally recognised authorities. This examination should be in two parts: theoretical — written — and practical.

(e) After successful examination a diploma or its equivalent should be granted either by governmental or nationally recognised authorities. This diploma should indicate that the course followed was specially designed for medical laboratory technicians, and it should, where possible, contain the official professional title recognised by the government or nationally recognised authorities.

III. Mutual recognition of diplomas

The diploma or its equivalent referred to in Article II *(e)* should be the basis of mutual recognition by member governments or their nationally recognised authorities. However, before permitting a medical laboratory technician who has obtained his diploma in another country to perform the functions set out in Article I.2 above, the host government or its nationally recognised authority may require him or her to complete a period of practical experience not exceeding two years in a medical laboratory approved by it.

Appendix A

SUMMARY TRAINING PROGRAMME

Allocation of minimum training hours for a course lasting 2 200 hours

A. *Theory*	550 hours
Sub-divided as follows:	
1. General subjects [1]	30 hours
2. General medical laboratory sciences [1]	150 hours

[1] The syllabus should contain at least the following subjects for study:

General: mathematics, physics, general chemistry, miscellaneous studies (legislation, ethics, etc.)

Medical laboratory sciences: laboratory management; human biology (including anatomy, physiology and cell physiology); biochemistry (including molecular biology); statistical methods and mathematical evaluation of results; applied physics (microscopy, electronics of equipment, etc.).

3. Clinical chemistry 4. Microbiology and immunology (including serology) 5. Haematology and immuno-haematology 6. Histopathology and cytology	370 hours

B. *Practice*

Fields 3-6 mentioned above . . . . 1,100 hours

C. *Additional period to be allocated to strengthen any part of the syllabus at A and/or B* . . . . 550 hours

Appendix B

TERMINOLOGY OF TITLES USED FOR MEDICAL LABORATORY TECHNICIANS — LEVEL " B " — IN COUNTRIES REPRESENTED IN THE COUNCIL OF EUROPE

Austria	Diplomierter medizinisch-technischer Assistent (diplomierte medizinisch-technische Assistentin)
Belgium	Assistant(e) de laboratoire clinique gradué(e)
Denmark	Hospitalslaborant
Federal Republic of Germany	Medizinisch-technische Assistent(in)
Finland	Laboratoriosairaanhoitajien (laboratory nurse) Sairaalalaborantit (hospital technician)
France	Technicien supérieur d'analyse biologique et laborantin d'analyses médicales
Iceland	Meinataeknir
Italy	Tecnico di laboratorio medico
Netherlands	Medisch analyst(e)
Norway	Laboratorietekniker
Sweden	Laboratorieassistent (technician) Laboratoriesköterska Laboratorie-sjuksköterska (laboratory nurse)
Switzerland	Medizinische Laborantin (Laborantine médicale)
United Kingdom	Medical laboratory technician (state registered)

Appendix C

EXTRACT FROM THE FOURTH REPORT OF THE WHO EXPERT COMMITTEE ON HEALTH LABORATORY SERVICES [1]

3.3.2 *Non-graduate certified technician* (level B)

Basic functions:

(a) Performance of all routine and some special laboratory procedures.

(b) Assisting in the training and supervision of subordinate technical personnel

(c) Assisting in teaching.

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[1] *Wld Hlth Org. techn. Rep. Ser.*, 1966, No. 345, pp. 7-8.

Scope:

This job is primarily concerned with either

(a) The performance of routine laboratory work, the exact nature of which is determined by the laboratory discipline in which the incumbent is employed and by the type of work in progress,

or

(b) The preparation of specimens and reagents needed by laboratory course work, the maintenance of equipment and stocks used, and the setting-up of the necessary apparatus.

Detailed functions:

(a) Collection of such specimens as he is trained to collect and as local traditions and regulations permit.

(b) Performance of standard laboratory procedures as assigned....

(c) Preparation and testing of reagents and media.

(d) Preparation of simple standards, solutions, suspensions, etc.

(e) Operation, cleansing and maintenance of equipment.

(f) Performance of any other technical work assigned.

(g) Submission of reports of all results and keeping of records of all procedures performed and results obtained.

(h) Requisition of supplies and maintenance of inventory of same, where required. Maintenance of stock inventory.

Supervision received:

From medical and scientific staff and graduate technician.

Supervisory responsibilities:

Supervision of assistant technicians (levels C and D) and laboratory aides.

Annex 4

FURTHER CONSIDERATIONS CONCERNING THE TRAINING OF HEALTH LABORATORY TECHNICIANS

In some countries, health laboratory technicians are being given single-subject courses right from the beginning of their training. Thus a student technician with a complete secondary education, having covered scientific subjects at school, is allowed to start immediately in one department of a laboratory (e.g., the biochemistry department), and attends classes and demonstrations and receives training in that one discipline only. This specialization is in one way valuable as it permits the trainee to reach a much higher standard but it has the drawback that it does not allow him to choose his subject after seeing the whole range of laboratory work. It is assumed that with his higher training in one discipline he will be in a better position to adapt quickly to laboratory work and learn both the technical and scientific aspects of his subject. There is no doubt that this pattern is becoming increasingly common as more and more expertise in a single subject is required from each technician.

There is a trend to adopt a " sandwich " system, placing some aspects of technician training in the hands of educational authorities, i.e., technical colleges or universities (see section 8.3.1). These colleges are undertaking a great deal of the basic scientific teaching and give some practical experience; however, the " in-service " experience, which is so essential to training, is still undertaken in hospital laboratories. This combination seems to be working.

In other cases the whole of the training is undertaken by special schools, covering the whole range of possible tests, their scientific basis, control, and interpretation. The fully-trained technician then goes into the laboratory and meets the practical realities for the first time. In view of the highly specialized nature of the work carried out in a laboratory, the combined " sandwich " type of training may be preferable. Here the student technician has the advantage of performing both practical and theoretical work right through his training. The benefits of this type of training have been validated by wide experience in other fields.

It is essential that any laboratory providing training for technicians should satisfy requirements concerning:

(1) the number and variety of the tests undertaken;

(2) the calibre of its senior staff;

(3) arrangements with a technical college or university for the provision of theoretical training.

In a large, busy laboratory adequate senior staff must be allocated for the purposes of training. It is preferable not to use small laboratories with very few staff. Some senior technical staff will necessarily carry out administrative duties; they might also act as teachers, depending on their aptitude and availability.

Technicians need to be trained according to the type of work they will carry out. In technical colleges and universities, theoretical scientists will provide the basic training of a technician. If training is laboratory-based experienced technicians will do most of the training, supplemented by scientific staff from colleges.

Senior technicians who wish to teach students and junior technicians should undertake training for this task in teacher training colleges and in colleges of advanced technology. They will then be able to undertake the teaching of technicians in their own laboratories or in centralized institutions.