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EDUCATION COMMITTEE

A BASIC EDUCATION AND TRAINING FRAMEWORK FOR MEDICAL LABORATORY TECHNICIANS** IN CLINICAL CHEMISTRY

Prepared for publication by
H. G. J. WORTH [1], D. H. CURNOW[2], C. G. FRASER[3], C. J. PORTER[4], M. K. SCHWARTZ[5] and O. ZINDER[6]

[1]King's Mill Hospital, Sutton-in-Ashfield, Nottinghamshire, UK
[2]Queen Elizabeth II Medical Centre, Nedlands, Australia
[3]Ninewells Hospital, Dundee, UK
[4]Toronto General Hospital, Toronto, Ontario, Canada
[5]Memorial Hospital for Cancer and Allied Diseases, New York, USA
[6]Rambam Medical Center, Haifa, Israel

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†Deceased

**To avoid confusion as a result of different national definitions the term Technician is used in accordance with the WHO definition (see text)

A BASIC EDUCATION AND TRAINING FRAMEWORK FOR MEDICAL LABORATORY TECHNICIANS IN CLINICAL CHEMISTRY

The term Technician refers to the WHO definition of the Medical Laboratory Technician level B. Eleven basic training programme requirements are proposed. Different forms of training are considered, and their roles within an integrated training framework. A syllabus is presented which should be covered within this training framework. Comment is made on how specific training programmes may vary with local requirements as do the needs of other personnel. This programme is intended primarily for countries which do not already have a structured training programme for medical laboratory technicians in clinical chemistry.

INTRODUCTION

Clinical chemistry has developed as a branch of pathology, but has expanded at such a rate, especially over the last two to three decades, that it should now be considered as an applied scientific discipline in its own right. As such it is dependent amongst other things upon the skills and ability of its technical personnel. Nevertheless, training of these individuals has often been ill conceived and irrelevant to their daily duties. There are a number of contributory factors, not least of which is the rate at which the subject has expanded.

This background emphasises the need for basic training programmes in clinical chemistry if the subject is to maintain its role in making an important contribution to medical science. It must be thought of as a mature discipline encompassing knowledge of many of the older disciplines such as analytical chemistry, biochemistry, statistics, physiology, pathology and engineering, but at the same time including newer subjects such as immunology, radiochemistry and toxicology. Appropriate information from these disciplines must be incorporated into training programmes in the correct detail and balance. Local training requirements vary between countries for scientific and statutory reasons. Such differences have been considered in detail elsewhere (1), but have also been considered here in formulating the recommendations made in this document.

AIMS

The purpose of this document is to present the scope of knowledge and expertise that is required of workers who fall within the WHO definition of Technician level B in a clinical chemistry department. The work of such personnel ranges from supporting a rural health care programme in a developing country to working in a large department in a well equipped teaching hospital. Clearly the requirements of these are very different and it is not practical to cover the whole spectrum in detail. Consequently this document seeks only to define a framework for education and basic training. The Medical Laboratory Technician level B is defined by WHO as follows (2).

"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 expence of practical training. In microbiology, for example, it 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. Specilization 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 comptetence. If possible, the standards of these examinations and assessments should be internationally acceptable so as to allow ready exchange of technicians between countries".

In order to decide the training requirements of this group, their position in relation to other technical staff levels must be considered. WHO defines four other levels (2). Level A, termed senior technician is senior to level B, requiring at least 3 years practical experience and the completion of further studies in a specialised field, or alternatively a science graduate with at least 2 years practical experience. Levels C and D are termed technical assistants and have 8 to 10 years schooling; these workers carry out simple and repetitive routine work under supervision. Level E staff are termed laboratory aides and probably have less schooling than level C and D staff; these workers carry out simple, repetitive, preparative procedures.

It is realised that in many countries personnel are expected to carry out work in other branches of pathology, but the Commission/Committee does not consider itself competent, nor does it have a remit, to become involved in these aspects. However it accepts that Clinical Chemistry may form only part of a larger training prgramme in pathology.

BASIC REQUIREMENTS

Before it is possible to lay down a framework for a training programme it is necessary to define the professional abilities expected of the trained individual. These are summarised in the following statements of basic requirements:

1. A high standard of analytical competence.
2. An understanding of laboratory instruments and the ability to operate and maintain them.
3. An understanding of the principles of basic sciences and mathematics.
4. The interpretation of analytical data.
5. Ability to communicate with clinical personnel.
6. Ability to teach and train more junior personnel and to take responsibility for their performance.
7. Ability to express oneself coherently, verbally and in writing.
8. Knowledge of the correct use of library facilities.
9. The ability to work effectively under pressure at any time during the 24 hours.
10. Complete honesty concerning ones own performance and that of others.
11. Justified confidence in ones own ability.

These statements are not ranked in order of importance and greater importance may be attached to some than others in specific training programmes. Their relative importance will vary according to the local situation, for example, in some more rural environments 6 and 8 may not be considered important, (although this would not be the case in all rural situations). Points 4 and 5 may be of greater importance for the technician working in a rural environment than one in a teaching hospital. Many other examples could be cited which demonstrate that the relative importance of each basic requirement varies according to the situation, but it is important that they all be included in the framework.

FORM OF TRAINING

Education and training can never be said to be finished. It is a continual process in which the individual increases his or her experience and acquires new skills and knowledge of a speciality which is itself changing in form and complexity. However, at the level B stage a formal training programme is necessary in order that the basic requirements may be taught. It is important that a form of training is defined for this period. This should consist of:

a) Formal lecture and practical training programme

The lecture programme should cover the theoretical background of clinical chemistry and include those elements of medicine, physics, chemistry and mathematics that are necessary for a thorough understanding of clinical chemistry. Practical classes should be related to lecture courses and cover analytical techniques relevant to clinical chemistry. This programme would be appropriately organised by a technical institution or university department whichever is the more appropriate. The trainee, if not a fulltime student, would be released from his normal duties to attend such courses.

b) In-House training

Instruction and supervision during the execution of normal day-to-day duties is an important part of the overall training programme. Rotation throughout the various sections of the laboratory is important to ensure all aspects of the work are covered, including assessment of reported results. This may require secondment to other laboratories to learn special techniques. Patient contact should be considered an integral part of in-house training. Supervision should be carried out by a designated supervisor.

c) Tutorials and seminars

The trainee should be able to attend tutorials and seminars locally and be encouraged to take an active part. Participation is an important aspect of these forms of education as it helps the trainee to learn to express himself in a logical and coherent way.

d) Scientific meetings

Attendance at scientific meetings is largely an extension of the above form of training. It enables the trainee to obtain detailed information in an area in which he may wish to specialise and also to broaden his background in areas that formal courses may not have covered. Participation helps to build confidence in his own ability. These forms of training should be considered as aspects of an integrated system because the overlap of content should be considerable. In addition participation would not be considered as finite and confined to a formal training period. As previously mentioned, education and training are continual processes, and when the formal period is completed learning should continue through all these forms of training.

So far no statement of the duration of training has been made, and this has been omitted intentionally for a number of reasons. For example, entry requirements differ between countries and will be dependent upon the exact job the trainee is to carry out. Similarly, the level and type of competence required will vary according to the job. In addition it is not relevant to try to define the time base when considering general principles. What is important, however, is that throughout the whole period these forms of training are adopted. A time base is considered under a later heading, Specific Training Programmes.

TRAINING SCHEDULE

The following schedule includes, by heading, the scope of topics which must be covered before the trainee may be considered competent. It is not intended to give a detailed content as this depends on the local level of training required. The sequence of items is not related to their importance

a) Chemistry

The fundamentals of organic, inorganic, physical and analytical chemistry.

b) Biochemistry

The biochemistry and metabolism of proteins, carbohydrates, lipids, nucleic acids, amino acids, vitamins, steroids and other hormones. Oxidation processes, control mechanisms and

simple enzyme kinetics. Basic immunology and immunochemistry, including the reticuloendothelial system. Erythrocyte formation.

c) Physical Sciences

A basic knowledge of optics, electricity, electronics, radioactivity and atomic physics. An understanding of mathematics and statistical methods relevant to clinical chemistry.

d) Clinical Chemistry

Knowledge of assays which test function and detect pathological processes in liver, kidney, heart, gut, muscle, bone, central nervous system, hypothalamus, pituitary, thyroid, parathyroid, pancreas, adrenal, ovary, testis, fetoplacental unit and prostate and their interpretation. Inborn errors of metabolism including basic genetics. Neonatal and paediatric clinical chemistry. Water and electrolyte homeostasis, acid/base balance and blood gas analysis. Iron and other trace metals. Haemoglobins and porphyrins. Lipids and lipoprotein. Specific proteins, coagulation and fibrinolysis. Quality control, calibration and standardisation. Screening and profiling. Laboratory safety and management. Use of computers.

e) Instrumentation

Photmeters, spectophotometers, fluorimeters and nephelometers. Centrifuges, osmometers, pH meters, balances, microscopes and gamma and scintillation counters. Blood gas analysers, flame photometers and atomic absorption equipment. Discrete, continuous flow, multichannel and centrifugal analysers. Gas and liquid chromatographs and electrophoresis equipment. Principles of computers and microprocessors.

f) Analysis

Correct and safe use of laboratory equipment. Volumetric and gravimetric analysis, colorimetry, fluorimetry, flame photmetry, atomic absorption, blood gas analysis, ligand assay (immunoassay), electrophoresis, chromatography and ion specific electrodes. Understanding of the chemistry and principles of the methods used. Evaluation and comparison of methods. Specimen processing and data handling.

g) Physiology

Cellular and tissue structures. The basic mechanism of function of liver, kidney, heart, lung, gut, muscle, bone, nervous system and exocrine and endocrine glands.

h) Pharmacology and Toxicology

The effects of the more commonly used drugs and toxic compounds. Methods of measurement in biological fluids and the significance of such measurements. Simple pharmacokinetics and pharmacodynamics. Effects of drug interference on other assays.

SPECIFIC TRAINING PROGRAMMES

The aim of this document has been to cover the scope of requirements for education and training in clinical chemistry, therefore the Form of Training and Training Schedule have been considered in general terms covering all aspects which fall within the WHO definition of a Medical Laboratory Technician level B. It could be said that the trainee who met all the Basic Requirements and was competent to the highest level in all aspects of the Training Schedule would be capable of becoming a laboratory director of the highest calibre. Consequently different emphasis must be put on the Basic Requirements, the Form of Training and the Training Schedule according to the aims of Specific Training Programmes.

It now becomes important to include a time frame. The trainee candidate who falls within the level B definition has a good academic background, the equivalent of high school level, and is therefore capable of pursuing a specific training programme while working in a clinical chemistry laboratory. Such a course would probably extend over at least three years on a day release basis and would include "in-house" training in the candidate's own laboratory. If day release was not practicable then presumably block release training would be available for a comparable time, or an equivalent full-time training programme.

The main emphasis should be put on producing analytical competence, imparting a basic understanding of chemistry and biochemistry, and an understanding and appreciation of instrumentation. At this stage the interpretation of data and contact with clinical staff may be relatively unimportant. Research and development and laboratory management might be omitted totally, although this is dependent upon local requirements. Generally there would be no

commitment to research and development in the initial stages of training (which include that of the Medical Laboratory Technician level B) and contact with clinical personnel is of little importance, but these become of major importance at the graduate level. Thus as the emphasis on the Basic Requirements changes so also must the interpretation of the Form of Training Schedule, for example patient contact may mean visiting clinics to take blood from patients at one level and attending ward rounds and offering biochemical advice at another level.

CONCLUSIONS

This document attempts to produce a framework for a training schedule which is applicable to personnel concerned with the technical aspects of clinical chemistry regardless of the country in which they work and the exact nature of their work. If these requirements are compared to those of other levels of training in clinical chemistry, it is seen that the Basic Requirements change very little through the whole spectrum, but the emphasis of their importance changes.

It must be stated that, although the aims of this document may seem obvious to the expert, they may be of much value to those entering the field of structured training programmes in clinical chemistry for the first time.

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