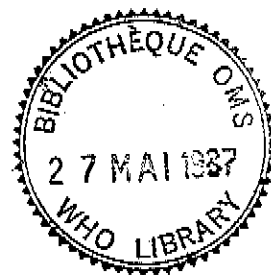




WORLD HEALTH ORGANIZATION

LABORATORY SERVICES AT THE PRIMARY HEALTH
CARE LEVEL





LABORATORY SERVICES AT THE PRIMARY HEALTH CARE LEVEL

CONTENTS

	<u>Page</u>
1. INTRODUCTION	2
2. CURRENT SITUATION	2
3. IMPLEMENTATION OF THE PROGRAMME AND FINDINGS	3
4. PREREQUISITE FOR ACHIEVING EFFECTIVENESS OF PERIPHERAL LABORATORIES	4
4.1 Relevance of health laboratory services and coordination with other health programmes	4
4.2 Supervision	5
4.3 Quality control	6
4.4 Logistical support	6
4.5 Reports and information	6
4.6 Training of laboratory workers for the primary health care level	7
4.7 Collection and dispatch of laboratory specimens	9
5. THE HEALTH CENTRE	10
5.1 Essential laboratory tests for use in a health centre laboratory	12
5.2 Equipment and reagents for a health centre laboratory	13
6. THE PRIMARY LEVEL HOSPITAL	17
6.1 Essential laboratory tests for use in a primary level hospital laboratory	19
6.2 Equipment and reagents for a primary level hospital laboratory	21
ANNEX I: COST OF LABORATORY TESTS AT THE PRIMARY HEALTH CARE LEVEL	28
ANNEX II: LIST OF SUPPLEMENTARY TESTS, EQUIPMENT AND REAGENTS	30

This document is not issued to the general public, and all rights are reserved by the World Health Organization (WHO). The document may not be reviewed, abstracted, quoted, reproduced or translated, in part or in whole, without the prior written permission of WHO. No part of this document may be stored in a retrieval system or transmitted in any form or by any means - electronic, mechanical or other without the prior written permission of WHO.

The views expressed in documents by named authors are solely the responsibility of those authors.

Ce document n'est pas destiné à être distribué au grand public et tous les droits y afférents sont réservés par l'Organisation mondiale de la Santé (OMS). Il ne peut être commenté, résumé, cité, reproduit ou traduit, partiellement ou en totalité, sans une autorisation préalable écrite de l'OMS. Aucune partie ne doit être chargée dans un système de recherche documentaire ou diffusée sous quelque forme ou par quelque moyen que ce soit - électronique, mécanique, ou autre - sans une autorisation préalable écrite de l'OMS.

Les opinions exprimées dans les documents par des auteurs cités nommément n'engagent que lesdits auteurs.

1. INTRODUCTION

The Thirtieth World Health Assembly (WHA) in May 1977 adopted a resolution (WHA30.43) deciding that the main social target of governments and WHO in the coming decades should be the attainment by all the citizens of the world by the year 2000 of a level of health that will permit them to lead a socially and economically productive life. In 1978 the International Conference on Primary Health Care, which took place in Alma-Ata, declared primary health care (PHC) as the key to attaining this target as part of development in the spirit of social justice.

In 1979, as a consequence of these health policies a reorientation of the WHO Health Laboratory Technology Programme took place. This reorientation was further supported by the adoption of resolution WHA32.16, that urged Member States to give due consideration to the development of health laboratory services, and requested the Director-General to develop appropriate technology for the use of health laboratories in developing countries, particularly in support of PHC.

Since these WHA resolutions were adopted, field operational studies on peripheral laboratories have been carried out in several countries and the experience gained has been incorporated into this document. These field studies were based on the document "Laboratory Services at Primary Health Care Level", LAB/79.1, 1979, which followed the resolution WHA29.74 adopted in 1976 requesting WHO to develop a programme of health technology relating to primary health care and rural development as part of the overall primary health care programme.

2. CURRENT SITUATION

In many developing countries, four levels might be considered in the organization and structure of primary health care and rural development. In some countries, certain echelons might be combined (particularly 2 and 3), or simply do not exist:

1. At the village level, health care is carried out by a village health worker, often under the monitoring of a village health committee and technically supported by the next levels of the village services system, aiming at the total well-being of the community. This includes the recognition, control and treatment, where possible, of important communicable diseases, child and maternal welfare, nutrition and hygiene.
2. Health work in a dispensary or sub-health centre, health post or clinic, which may serve several villages and be staffed by a small team of two or three health workers.
3. A health centre which provides support services and is part of the referral system for the village and dispensary health workers. The health centre could serve a population of 5000 to 10 000, though in some countries it covers a larger number of people. The staff could be four or more laboratory assistants working closely together as a team to promote health development in the area served. In some countries this team includes a medical officer.
4. The primary level hospital acts as the next place of referral. It receives patients requiring medical attention, including minor surgery and at-risk obstetrical cases, and provides technical and logistical support to the health centre team. The primary level hospital may also provide training facilities for health centre teams and village workers. In certain countries, this hospital is more developed and therefore not considered to be at the primary care level but at the intermediate level.

In some countries, mobile teams have been organized for the control of certain highly endemic diseases in rural areas. A small laboratory to assist in the detection and diagnosis of these diseases is part of this mobile team. This laboratory could perform simple tests on the spot and collect specimens to be forwarded to a higher level laboratory.

At present, in most developing countries, no laboratory service exists at the first two levels and only infrequently at the third level; it normally exists only at the primary health care level hospital. This fact is in accordance with the general policy of most of these countries which gives priority to the development of health services at the central level, rarely attaining the periphery. Only in the recent decade have some countries such as Honduras, Indonesia, Malaysia, Morocco, Nepal, Sudan and United Republic of Cameroon established laboratories in health centres. There is general agreement that in spite of the need for simple laboratory facilities at the village and sub-health centre levels, this is technically difficult to implement. The only activity which could be implemented, in certain cases, is the collection and dispatch of specimens and, more rarely, the performance of very simple tests like urine analyses or haemoglobin determinations.

In most countries, the administrative responsibility for laboratories at the peripheral level falls upon the health officer in charge of the units where the laboratories are located, e.g., the superintendent of the hospital, or medical officer or assistant in charge of a health centre. Final administrative, organizational and budgetary decisions of the health laboratory network of a region, province or similar structure at intermediate level are the responsibility of the respective health departments of the corresponding region. Although technical supervision and guidance on quality control, proficiency testing, provision of most reagents and equipment and selection and training of technical staff should be given by the central or regional health laboratory, these are provided in only a few countries.

The lack of linkages between the various levels of laboratory services greatly affects the quality of laboratory performance. In some countries there exist autonomous peripheral laboratories, mainly provided through missionary services. But, again, there is rarely close collaboration between these and government laboratories.

The lack of a well defined policy and coordination of all services involved, limits the efficiency and efficacy of the laboratory services as a support to health systems.

3. IMPLEMENTATION OF THE PROGRAMME AND FINDINGS

In 1979, a system of health laboratory services in support of PHC was developed and described in the document LAB/79.1. This document provided practical information on the planning and establishment of health laboratories in health centres and primary level rural hospitals. It also included a list of essential tests and relevant methods for both types of laboratories. This list was prepared taking into account general disease patterns and socioeconomic factors prevailing in developing countries, and suggested as a basis for allowing further adaptation to local conditions by national health authorities.

To assess under various conditions the appropriateness of the system proposed and avoid any new development merely to expand the network of health laboratories, the document was tested in field studies in Algeria, Burma, Honduras, Morocco, Nepal and Pakistan.

A protocol for the organization of the field operational studies was prepared, describing the criteria for selecting the countries, the objectives of the studies, the method and approaches to be applied and the four phases which complete each study: organization, operation, evaluation and follow-up action; as well as the inputs required from the government and those provided by WHO.

In order that the field studies serve their real purpose and allow the local health authorities to make a realistic assessment of what was locally feasible, WHO limited its interventions to the minimum. It mainly participated in: the initial planning phase of the study, the determination of the list of essential tests, and in the mid-term and final evaluation. It also provided, as an incentive, the laboratory equipment and reagents defined on the basis of the tests selected.

The usefulness of peripheral laboratories has been established as follows:

- (a) The existence of a network of laboratory services at the peripheral level should not only improve the quality of health care, but also provide relevant epidemiological data that would allow for a better surveillance and recognition of epidemic or unusual infections.

(b) It provides the health worker with laboratory support that will help in reaching an early and correct diagnosis, and which will therefore ensure the most suitable treatment for the patient whilst minimizing the cost of making the wrong decision. Furthermore, in many cases, the need for future hospitalization might be avoided, thus significantly reducing the cost of health care, whilst gaining in efficiency.

(c) It helps in making the decision whether to refer a patient to the hospital.

(d) It assists, through regular reports, in the surveillance and thus, in the control of prevalent communicable diseases as well as in the follow-up care of patients.

(e) It also has been shown, through experience, that the presence of such a network of these services at the peripheral level:

- provides greater motivation for physicians working at that level;
- improves the patients' perception of the care they are receiving, and improves the dialogue between physician and patient;
- increases the number of patients coming to the health centres. Some patients feel less stigmatized by attending general health centres rather than special clinics for diseases such as tuberculosis;
- motivates the local officials to collaborate with health authorities in the support of local health services.

(f) Peripheral laboratories increase accessibility of such services to the rural population. Studies in some countries have shown that only 10 to 15% of the patients referred from peripheral to higher levels for laboratory investigation had their tests carried out and, unfortunately, the results were often of no benefit to the patients because of the long delay in receiving them.

For optimal utility, the establishment and operation of peripheral laboratories should be governed by a national policy of the Ministry of Health. Furthermore, they must be integrated into the national health service and progressively take over the laboratory aspects of any vertical single disease system.

The availability of private medical care in some countries, at least in urban areas, as well as the distances between health centres and the nearest primary level hospital should be taken into account when deciding upon the need for the establishment of laboratory services in individual health centres.

4. PREREQUISITE FOR ACHIEVING EFFECTIVENESS OF PERIPHERAL LABORATORIES

4.1 Relevance of health laboratory services and coordination with other health programmes

To ensure the effectiveness of the laboratory services in improving the delivery of health care and reducing the prevalence of major diseases, close coordination and collaboration between the laboratory and the health programmes concerned are required. Such coordination is best achieved through integration, i.e. joint, parallel programming in planning clinical and epidemiological activities, and the necessary laboratory investigations for their support.

The field operational studies have shown the great value of periodic personnel discussions within the health team for: (a) maintaining high motivation and interest of the laboratory workers, (b) achieving optimal use of available local resources, (c) deciding what level of laboratory service should be provided, and (d) determining how to make the laboratory report meaningful to those (medical assistant, physician, epidemiologist, sanitary surveyors) who use it.

For the health laboratory service to be successful it is essential that it operates as a system, whereby the peripheral level laboratories are duly linked to the intermediate and central levels. In reorganizing laboratory services in response to the national health policy on primary health care, the intermediate and central levels should be developed in order to provide the necessary support (logistical, supervisory, etc.) to the peripheral level. The central laboratory organization should act as the focal point for all laboratory activities and, through provincial or regional laboratories, it should monitor their needs and effectiveness in support of the Ministry's overall health delivery system.

As different countries may have different needs, some flexibility should be provided for the development of a laboratory system.

4.2 Supervision

In the context of this document and its application in developing countries, supervision has a broader meaning than simply controlling the activities of peripheral laboratories. It should be a more supportive function, to include training, continuing education, logistical support, quality control and guidance in the daily activities of peripheral laboratory employees. Since adequate and appropriate supervision is essential for maintaining a competent staff, particularly those working in relative isolation in remote areas, training in supervisory principles and practices is necessary for those central and regional staff members having this responsibility.

Supervisors should not take a passive stance in their relationships with peripheral laboratories, but must actively initiate opportunities for contact and assistance. In some countries this may be difficult due to the remoteness of the peripheral laboratories, inclement weather, difficult terrain, etc. Even in such cases, efforts should be made to visit at least twice a year, and the visits coupled with checks on quality control activities, checking the inventory and condition of supplies and equipment, discussing problems, and answering technical questions. Such visits have also been shown to be important in motivating the employees and evaluating their suitability for advancement to higher positions. In fact, some officials in countries involved in developing peripheral laboratories feel that, despite any travel difficulties on-site, direct supervision is so important to the success of the system that it is best not to have a laboratory in an area that cannot be visited on a reasonable, periodic basis. In no case should the entire network of peripheral laboratories be visited less than once a year. It is recommended that such visits be made by a professional, responsible person who can recognize and diagnose problems.

To expand the opportunities for contact and assistance, peripheral laboratory workers are also brought to the regional or central laboratories for brief, periodic visits to report on activities, pick up supplies, and receive consultation and information on tests and procedures. However, such direct supervision cannot take place with necessary regularity for the reasons previously cited. In order to assure that the work in the peripheral laboratories is up to standard, the central laboratory must delegate certain supervisory authority to laboratories at the regional level. In Morocco, for example, there are three levels of supervision and management with different, but complementary objectives. The central level has national responsibilities and must limit the frequency of supervisory contacts in order to concentrate on its main goals. Supervision, therefore, is done through, and coordinated with, the regional laboratories. Supervisory visits to peripheral laboratories are preceded, and followed by, working sessions with the appropriate regional laboratory personnel. Copies of written reports regarding such visits are sent to both peripheral and regional laboratories affected. The regional level provides continuous local contact. It includes quality control and continuing education among its supervisory responsibilities. In order to reduce expenses, visits are combined with other purposes. At the local level, the health centre or hospital director provides supervision, with responsibilities for maintaining a continuous dialogue between the laboratory and the professional staff, and for ensuring that all directives and recommendations are implemented.

In order to make best use of resources it is necessary to decide what supervision is supposed to accomplish and how best to accomplish it. A check-list of procedures and observations to be made should be compiled at the central level for use by all supervisors. The person involved in supervision of the peripheral laboratories should develop a written programme for the entire year, and it should include a schedule for quality control and logistical support. Written reports are necessary for all major administrative actions so that follow-up can take place.

4.3 Quality control

Quality control is essential for achieving consistently reliable laboratory results at all levels of laboratory service. At primary health care levels, its methodology should be very simple and adapted to local possibilities and resources. Although the laboratory assistants in the health centre laboratories will have been taught elementary principles of quality control such as care of equipment and reagents, quality control will mainly be carried out by a supervisor. Direct supervision through periodic visits by senior laboratory staff is the most efficient method. Careful observation, checking of methods, reagents and equipment and advising and teaching can be effective in identifying and correcting faults and difficulties even if visits are relatively infrequent. The checking of randomly selected patient specimens or slides at the time of the visit, or the dispatch of a certain number of positive and negative slides to a higher level laboratory or in the opposite direction is also a useful procedure.

The primary level hospital laboratory might also participate in a more elaborate quality assessment programme, organized by the central laboratory. In addition to an internal quality control programme based on good general laboratory practice, with regular basic checking of equipment and reagents, the provision of control specimens by the central laboratory as part of a country-wide quality control programme would be an ideal solution for which to aim.¹

4.4 Logistical support

It is the responsibility of the central laboratory to establish, on the basis of the tests which are to be provided, a minimum list of supplies and reagents for peripheral laboratories, and to maintain these supplies at a sufficient level to avoid lapses in the work schedule. In order to accomplish this on a continuing basis, it is necessary to develop an inventory control system. This requires information on usage rates, shelf-life, delivery times, sources of supply, and quantity.

Standardization of equipment, and a reduction in the number of manufacturers supplying it, results in savings on bulk purchases and repairs, and facilitates training in operation and maintenance. Companies which supply manuals and information on service are preferred to those which do not. Moreover, automated equipment is not considered due to its high initial cost, difficulty of maintenance, and the amount of workload in most peripheral laboratories.²

In some of the countries which participated in the field study, peripheral laboratories are located in communities where some supplies, materials, or minor repairs are available. Taking advantage of these local resources, where possible, and where approved by the central laboratory, can expedite and facilitate the continuous and smooth operation of the peripheral laboratory. For this purpose, such peripheral laboratories may have some funds of their own. However, they are generally required to ask the advice of the central laboratory with regard to their use.

4.5 Reports and information

A stipulation for systematic reporting by laboratories at all levels of the network is a necessary tool for monitoring and managing the laboratory services. In addition to data on diagnostic activities, reports should also include information necessary for quality control activities, for epidemiological surveillance, and to provide logistical support.

¹ Principles of Quality Control, LAB/76.1, 1976; Guidelines for a Basic Programme for Internal Quality Control of Quantitative Analyses in Clinical Chemistry, LAB/81.3, 1981; Chemistry and Quality Control for District Laboratories, LAB/83.9, 1983; Quality Assurance in Haematology, LAB/86.5, 1986.

² Supply, Maintenance and Repair of Health Care Equipment in Developing Countries, LAB/83.8, 1983; Specifications for Production/Assembly of Basic Laboratory Equipment, LAB/84.2, 1984.

While experience indicates a variety of practices in developing countries, it is generally felt that a monthly reporting requirement will meet the needs of most systems for routine activities. Any test results of specified epidemiological significance should, of course, be reported immediately to the chief of the health unit. In so far as the utility of the reports for general epidemiological purposes is concerned, it is important to indicate those test results which are verifications of earlier results, so that accurate statistics of disease incidence may be compiled. Furthermore, whilst the monthly report may be used to indicate any supplies accidentally destroyed or depleted, or any sudden breakdown in equipment, a six month report of stock levels and needs is felt to be generally sufficient.

In order to develop a functional system of laboratories and fully utilize the information which is generated by such a system, reports should be sent to the regional or next higher level laboratory, where they can be appropriately analysed and incorporated into other reports from the area, then forwarded to the central laboratory for final analysis and incorporation into the health data for the country. (This does not preclude the aforementioned requirement for providing immediate notification of test results of epidemiological significance.) Periodic reports sent to the higher levels of the laboratory system provide a basis for discussions with the peripheral laboratory staff and for determining what guidance may be needed by them.

If peripheral laboratories are left to devise their own forms for reporting purposes, the information and format vary so widely that compilation is very difficult. It is necessary, therefore, to develop a standardized format for all laboratories at similar levels. It should permit the rapid accumulation of related data, give adequate information to the health system, and yet be easily handled by personnel at the peripheral laboratory level. The printed forms, to be provided by the central laboratory, should include not only monthly, biennial, and special reports, but also forms to be used in submitting specimens and requesting test results from the laboratory.

Some countries studied have taken the position that the flow of information in the laboratory system should not all be in one direction. It is generally felt that peripheral laboratory staff should receive information from the central and regional laboratories periodically. This reduces the risk that they would feel isolated and indicates that their work is a vital contribution to the total health care system in the country. Such information has usually been provided during periodic meetings attended by laboratory staff from the peripheral and central, or regional level. Another possible mechanism for providing information to peripheral laboratories is a newsletter in which they can be told how they are operating in comparison with other peripheral laboratories, information on new methods and reagents, disease problems, interesting test results from other laboratories, and career opportunities. Depending upon the circumstances in each country, such a newsletter can be solely for laboratory staff, or such items can be included in a Ministry of Health newsletter and prepared in cooperation with other departments.

4.6 Training of laboratory workers for the primary health care level

The training of laboratory workers should be oriented according to health priorities. They should receive adequate training, enabling them to perform their duties with a sense of responsibility. This implies not only practical competence but also a basic understanding of the clinical purpose of the tests performed, and an appreciation of the role of the laboratory in the health service. Such training will also enable physicians assigned to peripheral areas to have confidence and trust in the laboratory support they receive.

Laboratory workers at the primary health care level must be able to perform a variety of haematological, biochemical and microbiological tests. They should be accepted as part of the health team, and should work in close cooperation with other members of this team. In establishing a syllabus for training laboratory workers, careful attention should be given to actual health needs, to the availability of resources in the country, and to the definition of educational objectives. An indiscriminate adoption of syllabuses used in the developed countries should be avoided. Reasonable achievement in training, and satisfaction in the assigned post and in career prospects, are important incentives for encouraging and motivating the laboratory worker. While certain flexibilities may be necessary, the training programme will generally be structured according to the tests which are to be provided at the peripheral laboratories. However, it should include not only the test methodology, but its purpose and such characteristics as its sensitivity, specificity, and whether it is useful for screening, for confirmation, etc. In addition, the training should include the areas of:

- preventive maintenance of equipment;
- quality control and biosafety;
- specimen collection and packaging;
- simple managerial skills, e.g. record keeping, ordering, etc;
- knowledge of sterile techniques; and
- simple mathematics.

It is generally necessary to provide training for two entry levels of laboratory positions. The basic level is the health laboratory assistant, who will usually work at the health centre. The training programme for the primary level hospital should be more extensive, reflecting the more complex laboratory work which is done there. Although in larger primary level hospitals it may be necessary to provide some staffing at the laboratory assistant level, provision for recruiting laboratory technicians for this level is highly recommended. This should ensure adequate supervision of junior staff.

Health care laboratory assistants should, if possible, be recruited from the local region in which they will be working. They should have satisfactorily completed a general education programme of six to eight years. Experience has shown that, in most developing countries, a minimum of six months training is sufficient for the health laboratory assistant. This training period has been shortened by virtue of the fact that the training objectives can be clearly specified and based upon the tests for which performance is required.¹ The actual length, of course, will depend upon the students' prior knowledge of the elementary sciences, particularly chemistry, biology, and basic mathematics. As a part of the formal course work, laboratory assistants should be given in-service training under supervision. In fact, in the countries studied, the major emphasis was placed on this type of training. In Honduras, for example, 60% of the training at this level was of a practical nature, while in Nepal and Morocco it was 70% and 75% respectively. After the initial training period, the supervisor should arrange for the assistants to attend periodic refresher training at the referral laboratory in order to maintain competence and upgrade skills. Whenever possible, provision should also be made for career development for this category of laboratory worker.

To qualify for training as a laboratory technician, applicants should have at least nine years of education, and preferably should be high school graduates. Depending upon their general background and education, their training programme should be of two to three years duration. The training should cover the most important laboratory disciplines with a strong emphasis on practical work, and should take place in an organized institution. It should also include enough theoretical knowledge for the students to understand the basic principles of laboratory technology. The syllabus of the course should not only comprise the routine laboratory procedures, but also quality control techniques, maintenance and simple repair of basic equipment, supervision of junior staff, recording and reporting of results, and general principles of laboratory management. In the final year of training, it is suggested that laboratory technicians spend at least three months in an "in-service training" programme. They may also spend some time serving in a health centre laboratory to become acquainted with rural or poor suburban areas. This should help to maintain the standard of work at the health centres and provide the technicians with some experience in work supervision at this level.

Laboratory technicians should realize that they are members of the hospital team with a responsibility for integrating the work of the laboratory into the total work of the hospital. In order to meet this responsibility, their training should include such basic principles of supervision and management as how to plan and organize the activities of the laboratory, determine staffing and supply needs, motivate employees, evaluate the personnel and activities of the laboratory, keep records and prepare reports and control the budget.

¹ Manual of Basic Techniques for a Health Laboratory, World Health Organization, 1980.

Experience has shown that other members of the health team might perform simple laboratory tests such as urinalyses and haemoglobin determinations in certain cases. This might be true when no laboratory worker is available or when the health centre is still in a developmental stage and workload is not sufficient to support a full-time laboratory assistant. For this purpose, they should receive adequate training and technical supervision from a competent laboratory worker. In Nepal, for example, laboratory work at the health centre level is done by health post workers who have been provided with an additional two months training in laboratory procedures. This was felt to be important for reducing costs and increasing interaction and relationships between health worker and patient. This situation is unique, however, because these health post workers have already received from one to two years training at the university level in health care delivery. Moreover, such alternative manpower sources should not be considered in primary level hospitals where test requirements are more sophisticated.

The training programme for laboratory assistants and technicians should be formulated at the central level to ensure uniformity and quality of the training and appropriate recognition for the trainees. Whilst initially it may be necessary to provide training at the central level, it is advisable to train laboratory assistants in the nearest district or regional hospital where facilities are available. In this case, the training should be performed by senior laboratory technicians with experience in pedagogical methodology and new audio-visual techniques. If possible, they should be well-trained tutor technicians, involved in assisting the supervisors by visiting the peripheral laboratories to carry out: quality control duties, responding to questions about methodology, and providing refresher training. As these tutor technicians have a responsibility to perform duties which require special knowledge, skills and abilities, great care should be taken when selecting them.

Regardless of the background and motivation of the laboratory personnel and the excellence of the training programmes, it will be necessary to monitor the accuracy of their test results on a periodic basis. A quality assessment programme which involves the sending of specimens for analysis every quarter should be maintained, and training should be directed at solving any identified problems.¹

4.7 Collection and dispatch of laboratory specimens

The existence and satisfactory performance of peripheral laboratories depends upon the development of a viable system of linkages between them and the central laboratory. Such a system should include training, consultation, supplies, test results, periodic reports and the general exchange of information. An additional, very important part of this linkage system, is the collection and shipment of specimens the peripheral laboratories are unable to test to central reference laboratories. Care must be taken not to require more of the peripheral laboratories than is realistic, and a hierarchy of complexity should be established in which each level complements the others. It should be noted in this regard that additional research and information is needed on: (a) methods for shipping specimens which will allow them to withstand the rigours of transport and still yield reliable results, and (b) more rapid, inexpensive, and simple tests which can be done at the peripheral level, as referral may not always be practical due to a poor transportation system.

The collection and dispatch of specimens could take place at all levels of primary health care, particularly at health centres and primary level hospitals. In a number of countries, transport of specimens is difficult due to weather conditions and other problems. Furthermore, experience has shown that patients are not always able to go to the referral laboratory. Efforts should be made, therefore, to develop a system which includes transport facilities for both specimens and patients, as well as the supplies, material, and personnel which must move back and forth between components of the health care system. It may be necessary to use local facilities such as taxis, buses, ambulances, and other means for sending specimens and other material back and forth. When using such transport facilities, it will be even more important than usual to adhere to biological safety practices in packing and sending potentially infectious specimens.

¹ Manual of Basic Techniques for a Health Laboratory, World Health Organization, 1980; The Training of Health Laboratory Personnel (Technical Staff). Fourth Report of the WHO Expert Committee on Health Laboratory Services. Technical Report Series No. 345, 1966; The Planning and Organization of a Health Laboratory Service. Fifth Report of the WHO Expert Committee on Health Laboratory Services. Technical Report Series, No. 491, 1972; Second Part of Bench-Level Procedure Manual on Basic Bacteriology, LAB/87.1, 1987.

The establishment of a reliable system of collecting and transporting specimens will be more beneficial to the rural population. While such a system is primarily the responsibility of the laboratory worker, other health workers at the sub-health centre or even village level could collect and dispatch specimens, if specifically trained for this purpose.

From the health centre, specimens are normally sent to the primary level hospital laboratory. If the primary level hospital laboratory is unable to perform the test, the specimen would be sent from there to a regional laboratory. However, in certain circumstances specimens might be dispatched directly to a higher level referral laboratory, depending upon transport facilities and the type of tests to be performed. This is the case usually pathological specimens intended for histological examination. Whatever the final destination or routing of the specimen, a referral system will only work if the results are sent back in sufficient time for them to be of use.

It is the responsibility of the referral laboratory to supply the necessary containers to be used, as well as pertinent information on collection methods. In certain countries they are directly provided from the central laboratory as part of a general programme of standardization of laboratory technology.

5. THE HEALTH CENTRE

As has been outlined above, there are large variations in the number of people covered by a health centre and its staff. However, for the convenience of the present paper and to facilitate the determination of the range of tests and analyses to be done, an attempt is being made to give an indication of an integrated health centre's functions and staffing. Such a centre will provide ambulatory curative and preventive care and may have a few beds for patient observation until referral to the hospital, if necessary. Its main function will be to serve as a facility for patients referred from the other levels (dispensaries, village health worker) for screening purposes, for the delivery of preventive services or other public health activities, and ante- and post-natal care including family planning, nutritional advice and health education. Administratively and functionally it is linked to the primary level hospital, is staffed by a team of personnel, including a medical assistant, a fully-qualified nurse, a midwife and a minimum of two or three auxiliary staff, and would probably cover a population of around 10 000. However, this may vary according to some factors such as geographical accessibility or weather conditions.

The laboratory at this level will be of an integrated type where both clinical and public health activities will be performed, although at a very simple level. A list of the most common diseases in developing countries for which this type of laboratory might play a determinant role includes:

1. Parasitic diseases diagnosed by direct microscopic examination or after staining:

Malaria

Onchocerciasis

Trypanosomiasis

Filariasis

Schistosomiasis

Vaginal trichomoniasis

Amoebiasis, ancylostomiasis and other parasites diagnosed in stools.

2. Bacterial diseases diagnosed by microscopic examination after staining:

Tuberculosis

Leprosy

Gonococcal infections

Meningococcal and pneumococcal meningitides.

3. Other conditions, particularly noncommunicable, such as anaemia, diabetes and eclampsia.

The number of outpatients attending the centre and the derived number of tests expected per day or month should be carefully considered in determining the need for a laboratory in a given area. However, with the establishment of a polyvalent health centre laboratory, fragmentation of the workload caused by small monovalent laboratories such as those specialized in the detection of malaria, tuberculosis, filariasis, etc., will be avoided.

Experience has shown, as discussed in Annex I, that the expenses of operating a laboratory in a health centre are modest in relation to the large benefits to be derived. However, a prerequisite to setting up a laboratory at this level is adequate space, a supply of safe water, a stable source of electricity, and sterilization facilities. When considering arrangements for a laboratory in a health centre, two possibilities may occur:

1. Available facilities in an existing health centre can be adapted to the needs of a laboratory.
2. When a new health centre is being built, detailed plans can be included for establishing a new laboratory.

In the first case, flexibility and adaptation to existing, allocated space is essential. However, there are minimal requirements to be met, e.g. a bench length of 2.5 m, with a sink against a wall with a window; a cupboard for storage of laboratory materials, and a desk for registering specimens and recording results. A separate room should be provided for the laboratory, so that the laboratory staff can work without interruption from people attending the health centre.

When a new health centre is to be built, optimal floor space can be planned. In general, a room of 18 m² is estimated as adequate for laboratory work at a centre.¹

The health centre should be staffed by a trained laboratory assistant who should be part of the health centre team and be able to assist in other health activities when there is insufficient laboratory work. He should receive technical and logistical support and supervision from the nearest laboratory of higher level.

The main functions of this laboratory assistant are:

- (a) to perform all simple routine analysis and direct microscopy in parasitology, bacteriology, haematology and chemistry (urine and spinal fluid) following written instructions;
- (b) to collect and dispatch biological analyses;

¹ Kleczkowski, B.M. and Pibouleau, R. Approaches to Planning and Design of Health Care Facilities in Developing Areas. Geneva: World Health Organization, 1983, p. 53-54. (WHO Offset Publication No. 72, Vol. 4).

- (c) to keep a record of expended material, chemical reagents, and supplies and to order new stock; and
- (d) to prepare a monthly report of activities.

In some countries, where the demand for laboratory support is slight or has not reached its full potential, laboratory assistants are permitted to perform other duties in the health centre. This has helped in motivating the laboratory assistants and in integrating the work of the laboratory with that of the health centre. In other countries, the scheduling of the laboratory workload, the assistance provided to epidemiologists, and the amount of work in general, has required the laboratory assistant to do only laboratory work. This will vary from country to country, with the size of the health centre, and with the services it offers. In general, however, if there is enough work to support a full-time laboratory assistant, it is preferable to have that person perform only laboratory duties in order to gain and maintain proficiency.

5.1 Essential laboratory tests for use in a health centre laboratory

Besides the availability of resources and manpower, the following factors are important in deciding which tests should be undertaken at the health centre level:

1. The priority health needs of the people according to local prevailing conditions.
2. The location of the health centre, including the distance from the referral hospital and the availability of transport facilities.
3. The collection and sending of specimens for testing to the hospital laboratory and the time taken for return of the results.
4. The need for immediate action in emergencies.
5. The adequate training of the laboratory personnel.

Considering these factors, a list of essential tests to be carried out at the health centre level has been prepared, including classical and simple methods. In some countries, reagent test strips and kits are being used, e.g., in urinalysis. However, due to their cost and problems related to use in tropical conditions (high temperature and humidity), a careful study should be carried out before their introduction into the laboratory.

This list comprises the strict minimum that a laboratory can perform using very simple equipment and reagents.

<u>TESTS</u>	<u>METHOD</u>
<u>Blood</u>	
Erythrocyte sedimentation rate (ESR)	Westergren method ¹
Differential and/or examination of blood film for cell morphology	Romanowsky stained film
Haemoglobin	Comparator ²
Leukocyte count	Counting chamber
Parasites	Direct and Romanowsky stained preparations

¹ The Wintrobe method may also be used.

² When possible a colorimetric method is recommended.

Urine

Bile pigments	Fouchet's reagent
Glucose	Benedict's method
Ketone bodies	Rothera's test
Protein	Sulfo-5-salicylic acid method
Sediment for leukocytes, erythrocytes, casts, and parasites	Direct microscopy
Specific gravity	Gravimetric method

Sputum

M. tuberculosis	Ziehl-Neelsen stained smear
-----------------	-----------------------------

Stools

Protozoa and ova	Direct saline and iodine preparation
------------------	--------------------------------------

Skin

M. leprae	Modified Ziehl-Neelsen stained smears
O. volvulus microfilariae	Direct wet preparation

Pus and exudates

Bacteria	Gram stained smear, especially for gonococci
Trichomonas in vaginal discharges	Wet preparation

The level of laboratory services provided at the health centre level should be related to: the level of general health care which can be provided; the capacity of the health care personnel to utilize the test results; and the resources available for laboratory support. The above list is considered to be the minimum which should be provided. Other tests may also be appropriate at the health centre level. These are listed as Supplementary Tests in Annex II.

5.2 Equipment and reagents for a health centre laboratory

A. Major equipment

1. Balance, hand type, capacity 1000 g, sensitivity \pm 0,1 g, with weights
2. Bench lamp for microscope
3. Blood cell counting chambers (bright line) with cover glasses and WBC pipettes
4. Box, microscope, 100 slides
5. Centrifuge balance, 15 ml tubes
6. Centrifuge, electric or hand driven, 4/6 head for 15 ml tubes with lubricant, cushions, shield metal, 15 ml tubes and spare brushes
7. Lamp, alcohol (brass) or Bunsen burner (if gas available)

8. Lovibond or similar comparator with pipettes, test tubes and appropriate discs
9. Microscope, monocular, including following accessories:
 - neutral filter
 - mechanical stage
 - condenser and mirror (plain and concave)
 - eyepieces X5 and X10
 - objectives X10, X40 and X100
 - plastic cover
10. Rack, staining, micro slides (brass block and glass rods) for a sink
11. Refrigerator, 74-112 litre capacity, 110-220 V, electric or kerosene or other
12. Timer, interval 1 hour (steps of one minute)
13. Westergren stand for erythrocyte sedimentation rate, with Westergren tubes

B. Minor equipment

1. Basin utility, 3 litre capacity
2. Beaker, 100 ml (glass or polypropylene)
400 ml (stainless steel or glass)
1000 ml (stainless steel or glass)
3. Bottle, aspirator, plastic (polyethylene or polypropylene) 250 ml capacity
4. Bottle, dropping, polypropylene, squeeze type, 60 ml capacity
5. Bottle, narrow-mouth, round, screw cap, amber, polyethylene x 250 ml
x 500 ml
x 1000 ml
6. Bottle, specimen container, 10 ml capacity
7. Bottle, universal container, glass, wide neck with aluminium screw cap with rubber liner, 28 ml capacity
8. Bottle, urine specimen, graduated, glass, 180 ml capacity
9. Brush for bottle and flask
10. Brush, test tube, diameter 13 mm, 16 mm
11. Bulb, rubber
12. Centrifuge tube, ungraduated, 15 ml, conical
13. Clamp, test tube, 125 mm, spring wire
14. Container, sputum specimen
15. Container, stool specimen
16. Cover glass, micro slide, 22 x 22 mm, thickness 0,13 mm, box of 50

17. Cylinder, polypropylene, single scale, x 10 ml
x 50 ml
x 100 ml
x 250 ml
x 500 ml
18. Flask, Erlenmeyer, narrow mouth, heat resistant, x 50 ml
x 100 ml
x 250 ml
x 500 ml
x 1000 ml
19. Flask, volumetric, (if reagents are locally prepared), preferably glass stoppered, x 50 ml
x 100 ml
x 250 ml
x 500 ml
x 1000 ml
20. Forceps, for microscope slide and cover glass
21. Funnel, polypropylene, 65 mm diameter
100 mm diameter
160 mm diameter
22. Lancet, disposable, box of 1000
23. Needle holder, 125 mm long
24. Pail, galvanized steel, 12 litre capacity
25. Paper, filter, qualitative, diameter 90 mm
125 mm
185 mm
26. Paper, lens cleaning, 100 x 150 mm, book of 50 sheets
27. Pipette, serological, 1 ml x 0,01 ml
2 ml x 0,01 ml
5 ml x 0,01 ml
10 ml x 0,01 ml
20 µl for haemoglobin estimation
28. Rack for pipettes
29. Rack, test tube, 12 places, 22 mm holes
14 mm holes
10-11 mm holes
30. Slides, micro, plain 75 x 25 mm, box of 72
31. Spare bulbs for bench lamp for microscope
32. Stoppers, different sizes, rubber and cork
33. Syringe, plastic and glass 2 ml
5 ml
10 ml
20 ml
34. Test tube, without lip, hard glass, heat resistant, 75 x 10 mm
100 x 13 mm
150 x 16 mm

35. Thermometer (0-50 °C)
36. Tubing, rubber or PVC
37. Urinometer
38. Wax pencil
39. Wire, nickel-chromium, SWG 22

C. Reagents

1. Acetic acid, glacial (leukocyte count)
2. Acetone (Gram stain)
3. Alcohol, ethanol 95% (stains and other purposes)
4. Ammonium hydroxide, concentrated (ammonia sol. 25% w/v) (Rothera's test)
5. Barium chloride, 2H₂O, crystals (Fouchet's reagent)
6. Copper sulfate, 5H₂O, crystals (Benedict's test)
7. Crystal violet (Gram stain)
8. EDTA (ethylene diamine tetra acetic acid) (anticoagulant)
9. Ether (enrichment of parasites)
10. Formalin (35-40%) (parasite enrichment and antiseptic)
11. Fuchsin, basic, biological stain powder (Gram and Ziehl-Neelsen stains)
12. Gentian violet, stain (leukocyte count)
13. Glycerol (enrichment of parasites and staining)
14. Hydrochloride acid, concentrated (Ziehl-Neelsen stain)
15. Iodine, resublimed, crystals (Lugol for parasite staining and Gram stain)
16. Iron chloride (Fouchet's reagent)
17. Malachite green (parasite staining)
18. Methanol (Ziehl-Neelsen stain)
19. Methylene blue, biological stain powder (Ziehl-Neelsen)
20. Oil, mineral, for immersion
21. Potassium cyanide, granular (Modified Drabkin's solution)¹
22. Potassium ferricyanide, crystals (Modified Drabkin's solution)
23. Potassium iodide (Gram stain)
24. Romanowsky stains

¹ Due to the danger involved in the preparation of Modified Drabkin's solution for haemoglobin, the reagents should be prepared at the central level and provided to the health centres.

25. Sodium carbonate, anhydrous crystals (Benedict's test)
26. Sodium chloride (saline solution)
27. Sodium dichromate, crystals (cleaning solution)
28. Sodium azide (preservation of serum)
29. Sodium nitroprusside (Rothera's test)
30. Sulfanilic acid (Fouchet's reagent)
31. Sulfo-5-salicylic acid, solution 20% (urine, protein)
32. Thymol, crystals (specimen preservation)
33. Tincture of merthiolate, 1% (general preservation)
34. Trichloroacetic acid (Fouchet's reagent)
35. Tri-sodium citrate, 2H₂O (Benedict's test and ESR)
36. Universal indicator paper, pH 1-10, 500 strips
37. Xylene, 1 litre bottle

6. THE PRIMARY LEVEL HOSPITAL

A primary level hospital should be recognized as the first referral hospital beyond the health centre where at least some beds for medical and obstetrical care and surgical emergencies might exist. It could be identified with a general hospital having basic facilities. In many countries, this hospital corresponds to a district hospital. The functions of this hospital depend upon several variables, such as population density, environment, accessibility, manpower, and availability of equipment and supplies. However, it is generally agreed that this hospital has 30-50 beds and covers a population of about 30 000 to 100 000 inhabitants. These figures may be widely modified by geographical conditions and concentration of population.

The primary level is organized for dealing with major health problems and for being used as a referral centre for peripheral health services. It should, in turn, refer to higher service echelons those cases considered too complicated, or for which more precise and difficult diagnosis or treatment is required.

The primary level hospital has facilities for investigation and management of inpatients and outpatients. The outpatient department has functions similar to those of the health centre, although on a larger scale.

The inpatient department has the following activities:

- (a) general medicine;
- (b) general surgery, including surgical emergencies;
- (c) obstetrics, including surgery for prevention and treatment of complications.

Certain specialized services could be added as the need occurs to deal with the range of prevalent diseases and conditions. Depending on the availability of staff and equipment, the hospital could also have a rehabilitation service. It could be used as a base for mobile health services. As a support to all the above services, an elementary X-ray unit and a laboratory will be required.

Any list of laboratory tests performed in a primary level hospital should be based on the activities and functions of this hospital and the actual priority needs for laboratory support. The laboratory service attached to such a hospital does not perform a large range of laboratory tests. It will concentrate on tests and analyses to assist in the diagnosis and treatment of individual patients, and should also be used as a public health laboratory for epidemiological control and promotion of health. Among these laboratory activities, some will be essential and others supplementary, according to health priorities and local conditions, availability of trained manpower, financial resources, equipment and supplies.

Although in some developing countries, there is an acute shortage of trained laboratory staff, it is recommended that the laboratory of the primary level hospital should have at least one qualified laboratory technician and, as far as possible, two laboratory assistants and aides. However, in laboratories with a big workload, more laboratory staff may be required.

The basic functions of the laboratory technician will be:

- a. to perform all routine tests, including quality control, and some special laboratory procedures as they might be required by the hospital staff;
- b. to collect and dispatch specimens;
- c. to assist in the training and technical supervision of laboratory assistants and any other subordinate personnel;
- d. to prepare and list reagents;
- e. to maintain the laboratory equipment in good condition;
- f. to prepare a monthly report of activities; and
- g. to take measures on laboratory safety.

This laboratory should be a part of the laboratory service network and thus be closely linked to the nearest regional or provincial hospital, i.e. higher level laboratory. From this level, it will receive technical advice and supervision and necessary laboratory supplies, including reagents which are ready for use. Facilities should also be available to enable this primary level laboratory to purchase essential laboratory supplies in case of emergencies.

The range of laboratory tests to be undertaken in the primary level hospital will include all the tests recommended for the health centre and some additional basic tests in clinical chemistry, haematology, bacteriology, and parasitology which are important for clinical and public health activities. Due to the importance of communicable diseases, every effort should be made to establish some basic bacteriological culturing facilities at this level, including coliform tests in water. If culture media (already prepared for use in simplified techniques) are regularly provided by the central laboratory, many of the technical difficulties might be overcome.

Due to the integration of public health and clinical laboratory activities at the peripheral level in many developing countries, these laboratories will have to perform tests of public health importance which are not directly related to hospital patient care. Examples of such activities include water testing and microbiological tests required to assist in the control of epidemics.

6.1 Essential laboratory tests for use in a primary level hospital laboratory

<u>TESTS</u>	<u>METHOD</u>
<u>Chemistry-blood</u>	
Albumin	Bromcresol green
Amylase	Starch-iodine
Bilirubin (total and direct)	Jendrassik-Grof test
Glucose	o-toluidine
Urea	Diacetyl monoxime thiosemicarbazide
<u>Chemistry-urine</u>	
Bilirubin	Fouchet's reagent
Blood	o-toluidine
Glucose	Benedict's test
Ketones	Rothera's test
Physical examination	
Pregnancy test	Latex slide
Protein	Sulfo-5-salicylic acid
Sediment for leukocytes, erythrocytes, casts, and parasites	Direct microscopy
Urobilinogen	Ehrlich's reagent
<u>Chemistry-stool</u>	
Occult blood	Aminopyrine
<u>Chemistry-cerebrospinal fluid</u>	
Globulin	Pandy's phenol test
Glucose	o-toluidine
Total protein	Sulfo-5-salicylic acid
<u>Chemistry-water</u>	
Chlorine ¹	o-toluidine or N,N-diethyl-para-phenylenediamine (DPD)
Nitrate	Phenoldisulfonic acid

¹ These tests are frequently performed by the sanitary surveyors rather than the laboratory staff.

Haematology

Bleeding time

Blood grouping, typing, and
cross-matching

Cell morphology, including
differential white cell count

Clotting time

Coombs test

Erythrocyte sedimentation rate

Haemoglobin

Packed cell volume and
mean cell haemoglobin concentration (MCHC)

Reticulocyte count

Leukocyte count

Blotting paper

Romanowsky stained thin film

Lee and White method

Antiglobulin human serum

Westergren method¹

Hemiglobincyanide²

Haematocrit

Brilliant cresyl blue

Counting chamber

Microbiology-blood

Parasites

Direct and Romanowsky stained
preparations

Microbiology-skin

Parasites

Direct and Romanowsky stained
preparations

Fungi

Direct wet preparations

Microbiology-skin and nasal mucosa

M. leprae

Modified Ziehl-Neelsen stained smears

Microbiology-sputum

M. tuberculosis

Ziehl-Neelsen stained smears

Microbiology-pus and exudates

Bacteria

Gram and Ziehl-Neelsen stained smears

Microbiology-cerebrospinal fluid

Cell count

Counting chamber

Bacteria

Gram and Ziehl-Neelsen stained smears

Parasites

Direct wet preparation

¹ The Wintrobe method may also be used.

² Formerly called cyanmethamoglobin.

Microbiology-stools

Ova and parasites

Direct examination with and without concentration and staining

Microbiology-urine

Bacteria

Nitrite

Parasites

Direct wet preparation

Microbiology-vaginal swabs

Trichomonas

Direct wet preparation

Candida

Gram stained smear

Microbiology-water

Bacteria

Coliform count

Other tests, such as rapid coagulase, latex, and other rapid methods, should be considered for introduction at the primary level hospital. In addition, bacterial culture and antibiotic susceptibility testing¹ should be performed at this level whenever possible. Other supplementary tests may also be performed at this laboratory level if they are related to the priority health needs and technical facilities and if resources are available (see Annex II).

6.2 Equipment and reagents for a primary level hospital laboratory

A. Major Equipment

1. Balance, analytical, capacity 100 g, sensitivity \pm 0,1 mg
2. Balance (type Ohaus) capacity 1000 g, sensitivity \pm 0,1 g, with weights
3. Battery 6/12 V storage mercury/zinc type (if electricity is not available)
4. Bench lamp for microscope
5. Blood cell counting chambers (bright line) with cover glasses and WBC pipettes
6. Box, microscope, 100 slides
7. Burner, kerosene, vertical pressure type
8. Centrifuge, electric or hand-driven, 4/6 head for 15 ml tubes with lubricant, cushions, shield, metal 15 ml tubes, and spare brushes
9. Centrifuge, microhaematocrit
10. Colicounter
11. Colorimeter, photoelectric, single cell type, electric or battery operated, filters from 500-750 nm:
 - Green 500-560 nm
 - Orange 595-610 nm
 - Red 610-750 nm
12. Coverglass, micro slide, 22 x 22 mm, thickness 0,13 mm, box of 50

¹ Second Part of Bench-Level Procedure Manual on Basic Bacteriology, LAB/87.1, 1987.

13. Distilled water unit, if reagents are locally prepared
14. Incubator, electric or other power source (30-70 °C)
15. Lamp alcohol (brass) or Bunsen burner (if gas available)
16. Microscope, binocular, including following accessories:
 - neutral filter
 - mechanical stage
 - condenser and mirror (plain and concave)
 - eyepieces X5 and X10
 - objectives X10, X40 and X100
 - plastic cover
17. Oven, small, hot air
18. Rack, staining, micro slides (brass block and glass rods) for a sink
19. Refrigerator, 75-120 litre capacity, 110-220 V, electric or kerosene, or other
20. Sterilizer, steam, portable
21. Timers, interval 1 hour (steps of one minute), two each
22. Transformer, step-down type, output 110-115V/50-60 Hz from input 220-230V/50-60 Hz (has to be ordered with equipment when necessary)
23. Waterbath, serological, with thermostat, large (110-220V/50-60Hz)
24. Westergren stand for erythrocyte sedimentation rate, with Westergren tubes

B. Minor Equipment

1. Basin, utility, 3 litre capacity
2. Beakers, 100 ml (glass or polypropylene)
 - 400 ml (stainless steel or glass)
 - 1000 ml (stainless steel or glass)
3. Bottle, aspirator, plastic (polyethylene or polypropylene), 250 ml capacity
4. Bottle, dropping, polypropylene, squeeze type, 60 ml capacity
5. Bottle, narrow mouth, round, screw cap, amber, polyethylene,
 - x 250 ml capacity
 - x 500 ml "
 - x 1000 ml "
6. Bottle, specimen container, 10 ml capacity
7. Bottle, universal container, glass, wide neck with aluminium screw cap with rubber liner, 28 ml capacity
8. Bottle, urine specimen, graduated, glass, 180 ml capacity
9. Brush for bottle and flask
10. Brush, test tube, diameter, 13 mm, 16 mm

11. Bulb, rubber
12. Bulbs, spare, for bench lamp for microscope
13. Burette, calibrated to 0,1 ml, 25 ml capacity
14. Clamp, test tube, spring wire, 125 mm
15. Clamp, with holder for burette, adjustable
16. Container, sputum specimen
17. Container, stool specimen
18. Cylinder, polypropylene, single scale, x 10 ml
x 50 ml
x 100 ml
x 250 ml
x 500 ml
19. Flask, Erlenmeyer, narrow mouth, heat resistant, x 50 ml
x 100 ml
x 250 ml
x 500 ml
x 1000 ml
20. Flask, volumetric, if reagents are locally prepared, preferably glass stoppered,
x 50 ml
x 100 ml
x 250 ml
x 500 ml
x 1000 ml
21. Forceps, for microscope slide and cover glass
22. Funnel, polypropylene, 65 mm diameter
100 mm diameter
160 mm diameter
23. Jar, Coplin
24. Lancet, disposable, box of 1000
25. Needle holder, 125 mm long
26. Pail, galvanized steel, 12 litre capacity
27. Paper filter, qualitative, diameter, 90 mm
125 mm
185 mm
28. Petri dishes
29. Pipette, serological, 1 ml x 0,01 ml
2 ml x 0,01 ml
5 ml x 0,01 ml
10 ml x 0,01 ml
20 μ l for haemoglobin estimation
30. Pipette, volumetric, 0,2 ml
0,5 ml
1 ml

31. Rack for pipettes
32. Rack, test tube, 12 places, 22 mm holes
14 mm holes
10-11 mm holes
33. Slides, micro, plain, 75 x 25 mm, box of 72
34. Stoppers, different sizes, rubber and cork
35. Support stand for burette and funnels, rectangular base, rod 60 cm high x 12,5 mm diameter with iron supporting ring with screw clamps, diameter of rings 75 and 125 mm
36. Syringe, plastic and glass, 2 ml
5 ml
10 ml
20 ml with appropriate needles
37. Test tube without lip, hard glass, heat resistant, 75 mm x 10 mm
100 mm x 13 mm
150 mm x 16 mm
38. Thermometer, 10-110 °C
39. Tube, centrifuge, conical, ungraduated, 15 ml
40. Tube, microhematocrit, glass, capillary, plain and heparinized
41. Tubing, rubber or PVC
42. Wax pencil
43. Wire, nickel chromium SWG 22

C. Laboratory Reagents

1. Acetic acid, 36% (leukocyte count)
2. Acetic acid, glacial, 99,7% (all purpose)
3. Acetone (Gram stain)
4. Alcohol, ethanol 95% (Ziehl-Neelsen stain)
5. Aluminium hydroxide (nitrate in water)
6. Aminopyrine (occult blood)
7. Ammonium hydroxide, concentrated, ammonia sol., 25% (w/v) (Rothera's test)
8. Ammonium sulfate, granular (Rothera's test)
9. Anti-A grouping sera (blood typing)
10. Anti-B grouping sera (blood typing)
11. Anti-A+B grouping sera (blood typing)
12. Anti-Rhesus grouping sera (blood typing)
13. Ascorbic acid, 2H₂O
14. Barium chloride, crystals (Fouchet's test)

15. Barium hydroxide, $8H_2O$, crystals (DAM test)
16. Benzoic acid, crystals (o-toluidine test and DAM)
17. Bilirubin, powder, artificial standard (Jendrassik Grof test)
18. Blotting paper (bleeding time)
19. Bovine albumin, or other available calibrator (cross-matching, rhesus grouping)
20. Brij-35 solution, 30% (w/v) (bromocresol green method)
21. Brilliant cresyl blue (reticulocyte count)
22. Bromocresol green, biological stain (BCG test)
23. Cadmium sulfate, $8H_2O$ (DAM)
24. Caffeine, powder (Jendrassik Grof test)
25. Calcium chloride, purified
26. Copper sulfate, $5H_2O$, crystals (Benedict's test)
27. Crystal violet (Gram stain)
28. Dextrose (beta-d-dextrose), anhydrous powder (o-toluidine test)
29. Detergent, e.g. Sterox SE or similar
30. Diacetyl monoxime, crystals (DAM)
31. Disodium hydrogen phosphate, anhydrous (buffer solutions)
32. 4-dimethylaminobenzaldehyde (Ehrlich's reagent)
33. EDTA (ethylene diamine tetra acetic acid) (anticoagulant)
34. Ether (enrichment of parasites)
35. Fast green S.F. (for parasites)
36. Formalin (35-40%) (parasite enrichment and antiseptic)
37. Fuchsin, basic, biological stain powder (Gram and Ziehl-Neelsen stain)
38. Gentian violet stain powder (leukocyte count)
39. Glycerol (enrichment of parasites and staining)
40. Hydrochloric acid (all purpose)
41. Hydrogen peroxide (10 v) (blood in urine and stools and nitrate in water)
42. Iodine, resublimed (Lugol's iodine for parasite staining and Gram stain)
43. Iron chloride (Fouchet's reaction)
44. Latex reagent (diagnosis of pregnancy)
45. Light green S.F. (for parasites)

46. Mercuric chloride (for parasites)
47. Methanol (Ziehl-Neelsen stain)
48. Methylene blue powder (Ziehl-Neelsen stain)
49. 1-Naphthylamine (nitrite test)
50. Orthophosphoric acid, 85% (w/v) (DAM)
51. Ortho-toluidine test papers (blood in urine)
52. Ortho toluidine (chlorine in water)
53. Ortho-toluidine (glucose)
54. Petroleum jelly (sealing of cover-slips)
55. Phenol, crystals (Pandy test and nitrate in water)
56. Potassium dihydrogen phosphate, anhydrous, crystals (KH_2PO_4) (buffer solutions)
57. Phenylmercuric acetate (PMA) (DAM)
58. Potassium cyanide, granular (hemiglobincyanide)
59. Potassium ferricyanide, crystals
60. Potassium iodide (starch-iodine method and Gram stain)
61. Potassium nitrate (nitrate in water)
62. Resin (for mounting slides)
63. Romanowsky stains
64. Silver nitrate, crystal powder (phenoldisulfonic acid method)
65. Sodium acetate (Jendrassik Grof test)
66. Sodium arsenite, powder (chlorine in water)
67. Sodium azide (preservation of serum)
68. Sodium benzoate, powder (Jendrassik Grof test)
69. Sodium carbonate, anhydrous crystals (Benedict's and Jendrassik Grof tests)
70. Sodium chloride, recrystallised (saline solution)
71. Sodium dichromate, crystals (cleaning solution)
72. Sodium hydroxide, pellets (all purpose)
73. Sodium nitrate, crystals (Jendrassik Grof test)
74. Sodium nitroprusside, $2\text{H}_2\text{O}$, crystals (Rothera's test)
75. Sodium phosphate, dibasic, crystals (buffer solution)
76. Sodium phosphotungstic acid (for protein precipitation)
77. Sodium potassium tartrate, $4\text{H}_2\text{O}$ (Jendrassik Grof test)

78. Sodium sulfate, $3H_2O$ (nitrate in water)
79. Starch, soluble, pharmaceutical grade (starch-iodine method)
80. Succinic acid, crystals (Bromcreosol green method)
81. Sulfanilic acid, crystals (Jendrassik Grof test)
82. Sulfo-5-salicylic acid, solution 6% (urine protein)
83. Sulfuric acid, concentrated 95-97% (w/v) (all purpose)
84. Thiourea, crystals (o-toluidine test)
85. Thiosemicarbazide (TSC), crystals (DAM)
86. Thymol, crystals (specimen preservation)
87. Tincture of merthiolate, 1% (general preservation)
88. Trichoroacetic acid, crystals (o-toluidine test, DAM, Fouchet's reagent)
89. Trisodium citrate, $2H_2O$ (Benedict's test and Westergren method)
90. Universal indicative paper: pH 1-10, 100 strips
91. Urea, pure (DAM)
92. Xylene (cleaning solution)

ANNEX I

Cost of laboratory tests at the primary health care level

It is recognized that resources for establishing and maintaining laboratories will be very limited. Considerable attention, therefore, has been given to the cost of such laboratories as this relates to their effectiveness, and how it compares to similar costs in central and regional laboratories. Analysis of the results of field studies carried out over the past four years in several countries has shown, in fact, that peripheral laboratories can be cost-effective.

For example, in one country, the average cost per test for all tests performed in the regional laboratory was only 78% of the same figure for the central laboratory, and the peripheral laboratory cost per test was only 83% of the cost in the central laboratory. This comparison of all tests obscures even more dramatic differences between individual tests that are common to both laboratories, e.g. the average cost per test for those tests performed in the emergency laboratory of the central facility was five times higher than the cost per test in the peripheral laboratories of that country. This is a more valid comparison since, inasmuch as the emergency laboratory cannot use automated equipment or batch its tests, it operates more closely to a peripheral laboratory. Comparisons of specific tests done in all three levels show similar economies at the peripheral and regional laboratories, e.g. the cost for microscopic examination of sputum smears for acid-fast bacilli in the regional laboratory was 44% of the central laboratory cost, and the cost for the same test in a peripheral laboratory was only 33% of the cost for that test in the central laboratory. In another country studied, the average cost per test in a health centre was 41% of the cost per test in the rural hospital.

One observation needs to be made regarding cost comparisons between peripheral and central laboratories. The tendency has been to expect the cost of tests done in the peripheral laboratories to be higher because of the expense of sending them supplies, materials and equipment. However, it is often forgotten that the cost of doing a test in the central laboratory also includes the cost of transporting the patient or sample to the laboratory. When this is included, it will be found that the cost of doing a test in the central laboratory is usually higher than the cost of doing the same test in the peripheral laboratory. Additional benefits to the patient of doing preliminary testing in the peripheral laboratory include a reduction in days of hospitalization and of time lost from work.

These costs were reported during the initial phase of the field study, and are expected to markedly decrease as the physician and other users of the peripheral laboratory become more aware of the support which is available to them. The cost of peripheral laboratories can also be reduced by two additional activities: (1) efforts to integrate these general purpose laboratories with those of the vertical programmes, to permit greater utilization of the facilities and reduce the costs for both, and (2) by the local preparation of reagents and availability of supplies.

Once the laboratory is established, and the fixed costs have been incurred, the workload can be increased with only modest additional cost. It appears from these field studies that the costs of peripheral laboratories have been held down by the small investment in simple, manual equipment which in some cases should be no more than US \$3200 (Morocco experience), and by the fact that the peripheral laboratory workers can be more productive. Such laboratories have other additional important cost-saving advantages: the health centres and primary health care personnel have more rapid access to the results of the examinations that can be used for immediate decisions regarding the patients. This will save resources by permitting more rapid treatment, thereby reducing the number of days lost from work, and number of days spent in the hospital, or by preventing unnecessary admission to a hospital in the first place. In addition, the availability of a network of peripheral laboratories provides an invaluable source of information for the surveillance and control of communicable diseases.

Annex I

In summary, it appears from the studies carried out and the experience available up to now, that tests done at the peripheral level can be inexpensive and cost-effective. However, this is valid only if the tests performed are as accurate and reliable as those done at higher levels. Adequate supervision of peripheral laboratories and quality control programmes will ensure that they maintain their cost-effectiveness.

ANNEX II

List of supplementary tests, equipment and reagents

A. HEALTH CENTRE

I. Supplementary tests

<u>TESTS</u>	<u>METHOD</u>
Leishmania parasites	Formol gel test on serum
Monilia in vaginal discharge	Gram stained smear
Occult blood in stools	Aminopyrine
Sickling of red cells	Sodium metabisulfite

II. Supplementary equipment

1. Burner, kerosene, vertical pressure type
2. Distilled water unit (if reagents are prepared)
3. Oven, hot air, small

III. Supplementary reagents

1. Aminopyrine (occult blood in stools)
10. Formalin (35-40%)
11. Hydrogen peroxide (10v) (occult blood in stools)
12. Paraffin wax (sealing cover-slips in sickling test)
13. Petroleum jelly (sealing cover-slips)
14. Sodium metabisulfite, anhydrous (sickling test)

B. PRIMARY LEVEL HOSPITAL

I. Supplementary tests

<u>TESTS</u>	<u>METHOD</u>
<u>Blood</u>	
Borreliae	Romanowsky stained smear
Electrolytes ¹	Flame emission spectrometer
Leishmania parasites	Formol gel test on serum
Platelets	Counting chamber
Sickling of red cells	Sodium metabisulfite
VDRL or similar test	Slide or tube method
Widal ²	Agglutination test

¹ For this determination, more reagents and costly equipment are required.

² In many countries, the Widal test is no longer used due to its doubtful value.

Lymphnodes

Trypanosomes

Direct wet preparation

II. Supplementary equipment

1. Autoclave
2. Flame emission spectrometer (flame photometer)
3. Incinerator (if a central incinerator is not available)
4. pH meter
5. Slides (special) for VDRL
6. Stirrer, electrical, for maintaining uniform temperature in waterbath
7. VDRL shaker
8. Waterbath, serological

III. Supplementary reagents

1. Aqueous standards (electrolytes)
2. Antigens and control sera (VDRL)
3. Bacterial antigens and control sera (Widal test)
4. Paraffin wax (sealing cover-slips in sickling test)
5. Petroleum jelly (sealing cover-slips)
6. Propane gas (electrolytes)
7. Sodium metabisulfite, anhydrous (sickling test)

NOTE: When bacterial culture is performed, culture media and other reagents, particularly biochemical, are necessary.

- = =