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Health Laboratory Facilities in Emergency and Disaster Situations

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FOREWORD

Unfortunately, emergencies and disasters are widespread all over the world and many people suffer from famine, pain, injury, and infections Therefore, there is a need for basic care and further support for emergency planning by national and international organizations

The World Association of Societies of Pathology (WASP) appreciates very much the publication of these very important guidelines by the Eastern Mediterranean Regional Office of the World Health Organization. According to these guidelines, the appropriate national organizations should plan, introduce and establish basic administrative and organizational structures to be able to respond immediately and adequately to an emergency or a disaster

The WASP supports all activities which promote the realization of a national contingency plan by local or international specialists in the field of laboratory medicine. These guidelines are an important contribution towards fulfilling the essential requirements of coping with emergencies and disasters. We strongly recommend that all relevant national organizations follow these guidelines.

Prof. Dr. med. H. Reinauer
Vice-President
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(Anatomic and Clinical)

PREFACE

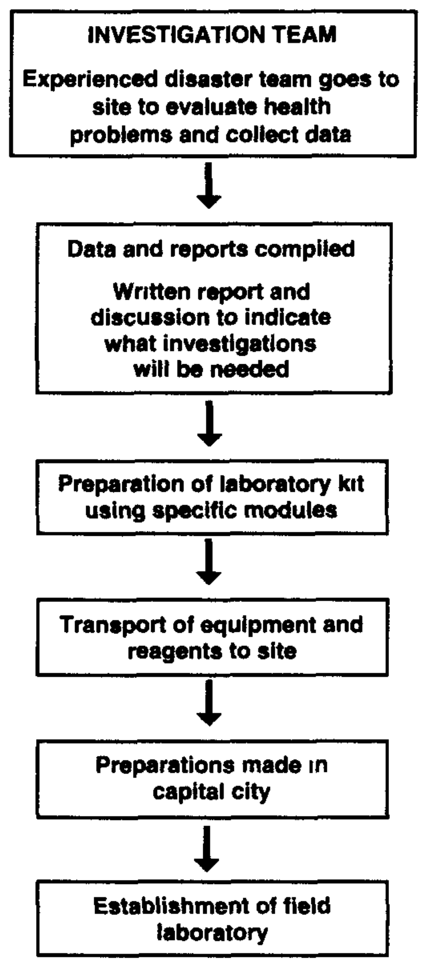
Many countries are vulnerable to disasters and emergency situations and a number of countries in the Eastern Mediterranean Region have suffered from such situations in recent years. The Eastern Mediterranean Regional Office of the World Health Organization has identified the need for guidelines on health laboratory services and problems associated with disasters and emergency situations that fall within the scope of these services.

This publication is intended to provide information on the provision of basic laboratory services in emergency situations. It is aimed at all health professionals, including physicians, nurses, laboratory technicians and other paramedical staff.

The guidelines are also intended to assist international agencies, national authorities and other bodies involved in emergency and disaster relief in drawing up contingency plans for the provision of emergency laboratory services. These plans should enable those involved to respond rapidly and specifically to the needs of the situation. It should be emphasized, however, that the guidelines describe laboratory services that are intended for emergency situations and therefore may not necessarily represent what would be recommended for health laboratory services functioning under normal circumstances. Nevertheless, under any conditions, principles of quality assurance must always be applied and laboratory safety respected.

Throughout the text it has been assumed that the laboratory staff involved are technically competent and well trained in good laboratory practice and quality assurance. For this reason, with a few exceptions, no technical details are given.

This manual could not have appeared without the valuable support and encouragement of Dr Hussein A. Gezairy, Regional Director for the Eastern Mediterranean, and Dr M. H. Khayat, Director, Programme Management, EMRO. Our thanks are also due to A. H. Moody, Hospital for Tropical Diseases, London, UK, Professor Dr H. J. Simon, University of California, San Diego, USA, G. Mortimer, Newcastle-upon-Tyne, UK, Professor Dr J. Okuda, Meijo University, Tempaku-Ku, Nagoya, Japan, and I. Reid, Whangari, New Zealand, for reviewing the draft and for their constructive suggestions



Recommended steps in establishing a laboratory in an emergency

INTRODUCTION

For the purposes of this publication the following definitions of 'emergency' and 'disaster' are those used in the document *WHO Action in Emergencies and Disasters* [1].

emergency
sudden occurrence demanding immediate action that may be due to epidemic, technological catastrophe, strife, or natural and man-made causes;

disaster
any occurrence that causes damage, ecological disruption, loss of human life, or deterioration of health and health services on a scale sufficient to warrant an extraordinary response from outside the affected community or area.

Emergencies and disasters demand prompt and adequate response, and the provision and monitoring of relief will be required until normal services can be resumed. To meet these demands, contingency plans and preparedness are of fundamental importance. In order to be able to respond quickly and adequately to an emergency or a disaster, every country should formulate a national contingency plan and establish mechanisms for emergency preparedness and response in the health sector. The national plan should be based on coordinated multisectoral emergency activities and all aspects, including the plan for emergency health services, should fit into the established administrative structure. The provision of disaster relief may require the support of health laboratory services. Therefore a national programme of emergency health services should include provision for an emergency health laboratory service.

When formulating a national plan for timely and appropriate response to emergencies and disasters a presumptive assessment of needs should be made. The assessment of needs depends upon many factors, some of which relate to the type of disaster (e.g. earthquake, destructive wind, flooding, epidemic, war, famine, refugees) and others which relate to local conditions (e.g. national economic situation; geographic conditions; state of transport and communication; availability of health facilities in the country as a whole and specifically in the affected area; number of people affected; availability of water, food, sanitation facilities, shelter and electricity). Those responsible for a national programme of emergency health services should have readily available a list of external health relief agencies to be contacted should external support be needed (see Annex 1 for a list of agencies providing health relief).

In emergency situations and disasters, basic medical care is essential to limit morbidity and mortality due to infectious diseases and other medical conditions, such as trauma. Morbidity and mortality may result from an increase in the prevalence of existing endemic diseases, such as measles and infantile gastroenteritis, or from epidemic diseases, such as cholera and typhus. Disease surveillance is an essential component of disaster assessment and is also important for monitoring the effectiveness of relief interventions. Some diseases, such as measles, have a typical clinical picture which permits diagnosis without laboratory investigations. However, many infectious diseases require laboratory facilities to make or confirm diagnosis, or to enable valid epidemiological data to be collected.

Emergency laboratory facilities operating in response to disaster face many constraints, including remoteness of location, lack of reagents, limited equipment and power supplies, and insufficient numbers of trained staff Experience gained from disasters and famine relief areas over the last two decades has provided useful and important information on the optimal use of laboratory services with limited resources

The primary objectives of laboratory services in emergency situations are the prevention or control of infectious diseases and the management of conditions such as anaemia and trauma

> The pages containing descriptions of contents of modules have been printed on separate pages for easy reproduction and inclusion with individual modules in warehouses and in the field.

CHAPTER 1

DISEASES AND MEDICAL CONDITIONS COMMONLY ASSOCIATED WITH DISASTERS

Different health problems are associated with different types of disaster. **Box 1.1** lists various types of disaster. A list of the diseases and medical problems that may be encountered in disasters is shown in **Table 1.1**. Not all of these problems will occur in every disaster. For example some are dependent upon geography; e g a flood or tidal wave in a tropical area may create the conditions for an outbreak of malaria, but this is unlikely to happen in temperate climates. Other problems, such as outbreaks of dysentery and gastroenteritis, can occur anywhere.

The conditions listed in **Table 1.1** are frequently interrelated but may occur independently. Disasters which result in homelessness and population displacement may contribute to the spread of infectious diseases The risk factors for potential outbreaks of disease should be assessed early on by a team of experienced health professionals and risk factors for infectious diseases must be taken into consideration when contingency plans for disasters are drawn up

BOX 1.1 **Types of disasters**

Natural

- **epidemic**
- **earthquakes**
- **volcanic eruption**
- **flood**
- **cyclone**
- **drought**

Man-made

- **war, including chemical and bacteriological warfare**
- **environmental pollution including chemical and nuclear accidents and sewage pollution**

Natural or man-made disasters may result in the following:

- **population displacement and formation of camps for displaced people or refugees**
- **famine**
- **drought**

by national authorities. The relationship between the diseases that may be encountered and their modes of transmission are outlined in **Table 1.2**. Modes of transmission include inhalation, injection, induced trauma, and vectors.

TABLE 1.1 **Diseases and medical conditions encountered in disaster situations**

Disease/medical condition	Population displace-ment	Epidemic	Earthquake /volcanic eruption	Flood/ tidal wave	Drought	War	Environmental pollution
Aids/HIV	1	0	0	0	0	1	0
Anaemia	2	0	0	0	1	0	1
Anthrax	1	1	0	1	0	0	1
Cholera	2	2	0	2	1	1	1
Dehydration	1	0	1	0	1	1	0
Dengue*	1	1	0	1	0	0	0
Diphtheria	1	1	0	0	0	0	0
Dysentery/ gastroenteritis	2	2	0	2	1	1	1
Enteric fevers	2	2	0	1	1	1	1
Haemorrhagic fever*	1	1	0	1	0	1	0
HepatitisA	1	1	2	2	1	1	1*
Intoxication	0	1	0	0	0	0	2
Leptospirosis	1	1	0	1	0	1	2
Leishmaniasis	1	1	0	0	1		
Malaria	2	2	0	1	1	1	0
Malnutrition	2	0	0	0	1	1	0
Measles	2	1	1	1	2	1	0
Meningitis	1	2	0	0	0	1	0
Plague*	2	1	0	0	0	1	0
Poliomyelitis	1	1	0	1	0	0	1
Protozoan dysentery	1	1	0	1	1	1	1
Relapsing fever*	2	2	0	0	0	1	0
Streptococcal disease	0	1	2	0	0	0	0
Tetanus	1	0	2	1	0	2	0
Trauma	1	0	2	2	0	2	0
Tuberculosis	1	1	0	0	0	0	0
Typhus*	1	1	0	0	1	1	0
Viral encephalitis	1	0	0	1	0	0	0
Whooping cough	1	0					

0 = Rare problem
1 = Potential problem (depends on area)
2 = Likely problem (depends on area)
* Particularly in endemic areas

TABLE 1.2 Modes of transmission of diseases encountered in disasters

Disease	MODE OF TRANSMISSION						
	Food contamination	Water/ sanitation	Aerosol droplet	Vector	Sexual contact	Blood/ needles	Trauma/ burns
AIDS/HIV					X	X	
Anthrax	X	X	X				
Bacterial dysentery/ gastroenteritis	X	X					
Cholera	X	X					
Dengue				X			
Diphtheria			X				
Enteric fevers	X	X					
Hepatitis A	X	X					
Intestinal helminths and protozoa	X	X					
Leishmaniasis				X			
Leptospirosis	X	X					
Malaria				X			
Measles			X				
Meningitis			X				
Plague			X	X			
Pneumonia			X				
Poliomyelitis		X					
Protozoan dysentery		X					
Relapsing fever				X			
Streptococcal disease			X				X
Tetanus							X
Trench fever				X			
Tuberculosis			X				
Typhus				X			
Viral encephalitis				X			
Haemorrhagic fever[1]	X	X	X	X		X	X
Whooping cough			X				

[1] The mode of transmission is usually a vector, but other modes occur depending on the particular virus involved

CHAPTER 2

SITUATION ANALYSIS

2.1 Planning and assessment of needs

Poor water and sanitation, crowding and inadequate shelter are known to be risk factors common to most disasters and therefore likely to lead to outbreaks of communicable diseases which will require diagnostic laboratory services. Anticipation of these factors should enable the early establishment of essential laboratory facilities.

Preliminary assessment of the overall health situation and needs should be made by an experienced health team, using check lists and other means of collecting data. When medical services are required, an experienced laboratory technician should be part of the operational team. Where risk factors are not apparent or the situation is more complex, for example where trauma is involved, such data may be used to determine laboratory needs

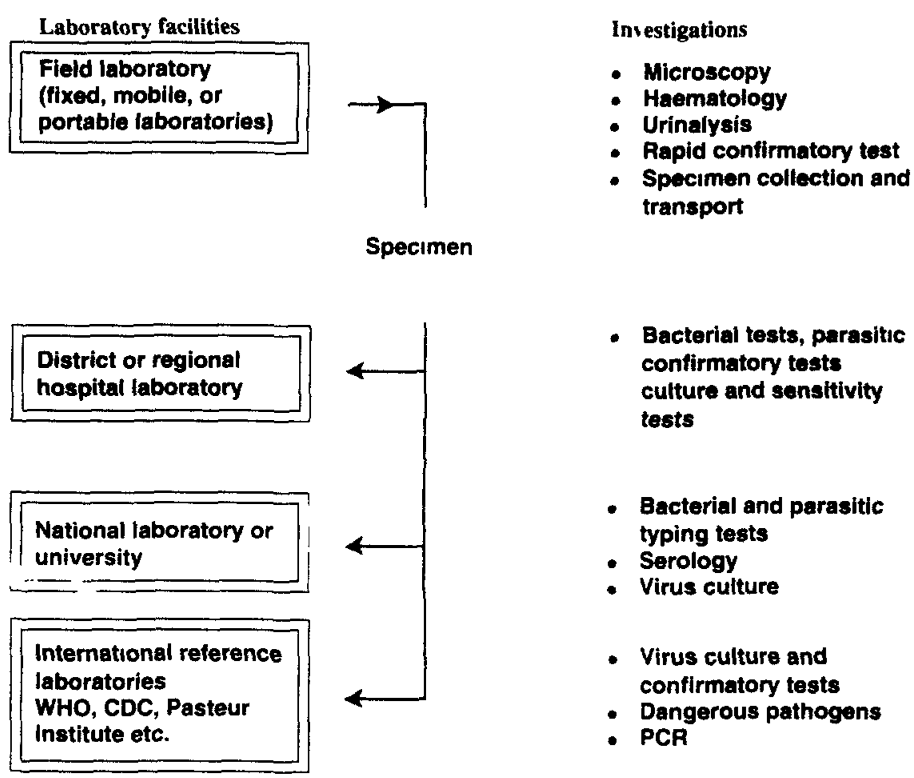


Figure 2.1 Laboratory referral/support hierarchy

During the early stages of a disaster, laboratory services are more useful for identifying the major health problems than for diagnosing individual patients. This information, when combined with the available data on prevalent causes of morbidity and mortality (such as measles, diarrhoea and dysentery, respiratory infections and malaria), can provide a useful basis for planning and evaluation of control measure efficiency Laboratory results, together with data on disease prevalence enable ongoing surveillance to determine changes in disease patterns and to give early warning of epidemics During epidemiological investigations, laboratory services can provide a definitive confirmation of a suspected disease.

For a population dispersed over a large area or several locations, one laboratory may serve all or part of the affected population In such situations it is more appropriate to collect and transport samples to a central field laboratory than to set up a laboratory in each location.

The field laboratory will not always be able to undertake all the necessary investigations such as the proper testing for viral infections or the culture of mycobacteria. Therefore, it is important that the laboratory be part of a laboratory network as illustrated in **Figure 2.1.**

Support to district and regional laboratories in the form of materials, equipment, or personnel may be an important component of disaster response. National and international reference laboratories should be involved in supporting field laboratories (a list of international reference laboratories is given in Annex 2).

2.2 Assessment of existing services

2.2.1 General

Central and local laboratory services, where they exist, should be assessed by the laboratory technician during the first visit of the assessment and/or operational team(s). Capabilities should be recorded. Strengths and weakness of available health laboratory services should be reported.

2.2.2 Supplies

The laboratory technician should also visit a number of local suppliers of laboratory equipment, chemicals and reagents. A telephone call is not sufficient A personal visit enables the technician to check:

- availability of equipment and supplies;
- storerooms for stock levels;
- the possibilities for local purchase of basic items such as microscope slides, methanol. Field's stain and Giemsa's stain, together with their prices.

2.2.3 Reference laboratories

The laboratory technician should also visit local reference laboratories and check the following:

- standard of work, professional capability and willingness of laboratory staff to test referred samples;
- availability and quality of media and other consumables such as Cary-Blair, Amies transport medium, alkaline peptone water, TCBS medium, and Group O1 polyvalent antiserum;
- expiration dates of materials;
- source of supplies.

2.2.4 Blood transfusion services

Finally the technician should visit the local blood transfusion services to check the following:

- adequacy of blood stocks;
- contingency plans for provision of extra blood supplies from other centres and other countries;
- stocks of in-date grouping antisera;
- availability and routine use of HIV and HBV testing kits;
- cold chain equipment and vehicles for blood transport.

2.2.5 Logistics of sample referral and transport of blood

The laboratory team should check the following:

- state of all transportation (road, rail, river, sea and air);
- timetables for buses, trains, ships, river ferries and aircraft flights;
- other agencies, e.g. United Nations or Red Cross/Red Crescent, to determine if specimens can be sent on chartered aircraft.

2.2.6 Contacts with existing laboratory services and suppliers

The team should also register the following:

- names, addresses and telephone numbers (work and private) of contact persons and store-room key holders;
- opening hours of services;
- availability and call-up signs of high frequency radio, for base office of UN, Red Cross/Red Crescent, Médecins sans Frontières, and other organizations;
- fax and telex numbers of services, including the above organizations.

2.3 Selection of laboratory staff

Staff for emergency laboratories may be locally trained or expatriate. Criteria for selection should include the following:

a) *Essential*

- internationally or nationally recognized qualification in medical laboratory technology. The laboratory technologist must be familiar with:
  - microscopical techniques for the identification of parasites and bacteria;
  - basic haematological investigations;
  - water testing for thermotolerant (faecal) coliforms;
  - blood grouping, crossmatching, and HIV, HBV, and syphilis testing, using rapid or simple tests;
  - use of other rapid or simple diagnostic tests;
- flexible approach to tasks and problems encountered in field and emergency laboratories;
- willingness to work long, unsocial hours;
- ability to work and take decisions without direct supervision.

b) *Desirable*

- experience in logistics and purchase of equipment;
- experience in general laboratory management;
- experience of working overseas (if expatriate);
- working knowledge of language of the country (if expatriate), whenever possible. The employment of bilingual local staff or an interpreter may also help.

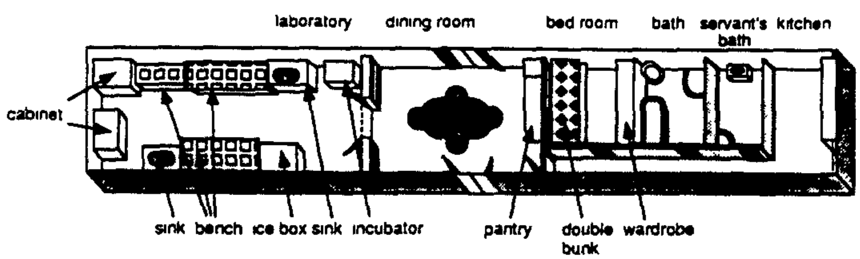
CHAPTER 3

TYPES OF LABORATORY FACILITY

3.1 General

There are five types of laboratory facility:

- existing laboratory facilities
- temporary stationary laboratory facilities
- mobile laboratories
- portable laboratories
- reference laboratories.



Laboratory Railroad Car

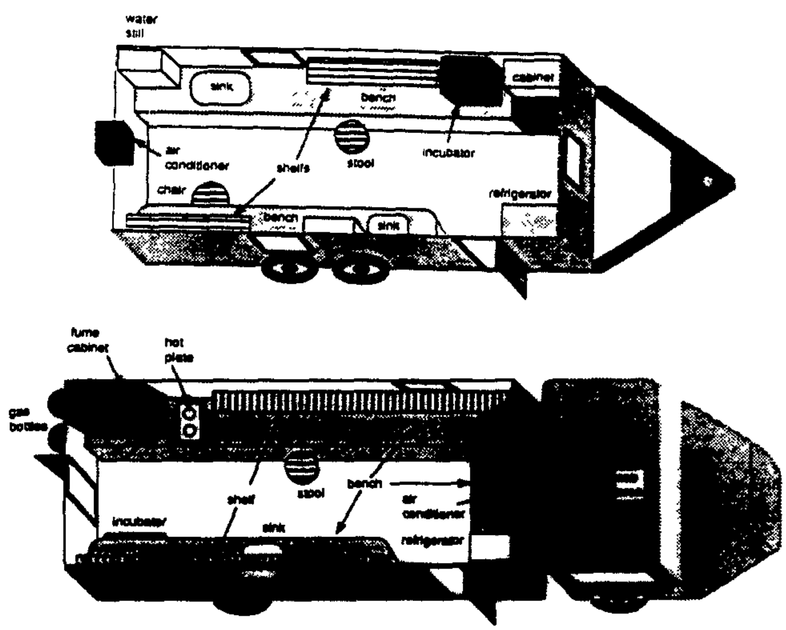


Figure 3.1 Transportable rigid structures

3.2 Existing laboratory facilities

Existing laboratory facilities should be prepared to provide emergency services wherever possible, particularly in situations such as epidemics not associated with disaster. Review of central and local laboratory facilities must be included in the preliminary assessment of the situation. It may be necessary to provide supplementary support to local laboratories in the management of specific diseases.

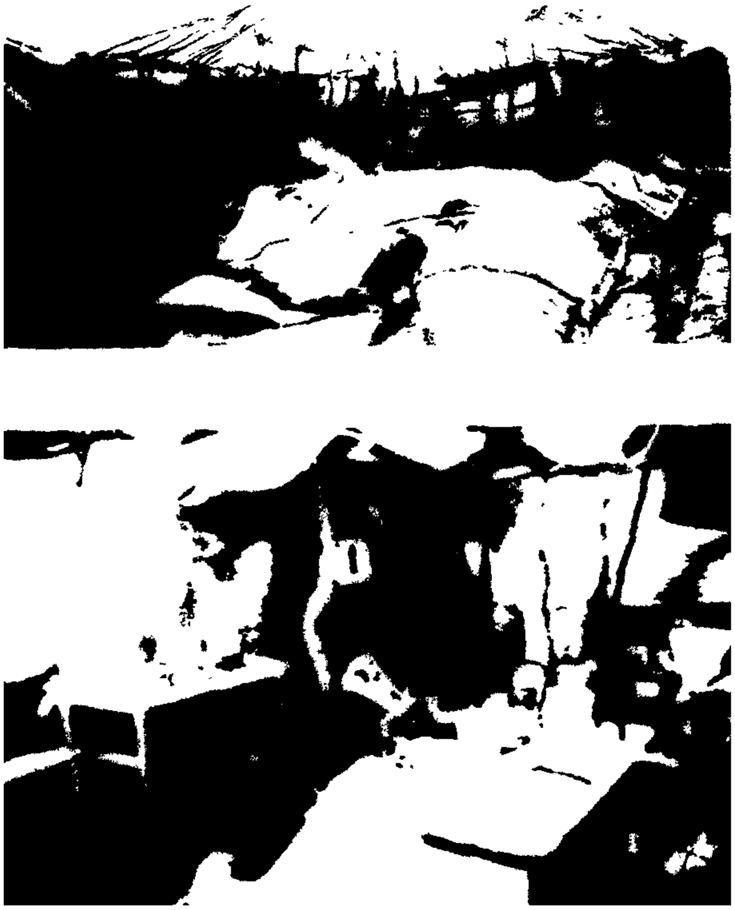


***Figure 3.2** A temporary laboratory*

3.3 Temporary stationary laboratory facilities

Where there are no existing laboratory services, laboratories may be established in temporary facilities. There are three types of temporary laboratory:

a) existing building;
b) transportable rigid structure, e.g. caravan, truck (**Figure 3.1**);
c) tent or shelter constructed with available material, e.g. bamboo, straw mats, plastic, poles and canvas (**Figure 3.2**).

A temporary laboratory can be set up in an existing room, a tent, or a specially constructed shelter using locally available materials. The long axis of the laboratory should run from east to west so that the laboratory faces south and obtains maximum sunlight (for microscope use). It should be near the health centre. A storeroom should be situated on the cooler, shady side of the laboratory (see **Figure 3.3**). A system for safe disposal of specimens should be prepared (see Chapter 6). If possible, there should be a separate room for collecting samples. Basic items of furniture and equipment that may be purchased locally are listed in **Table 3.1**.

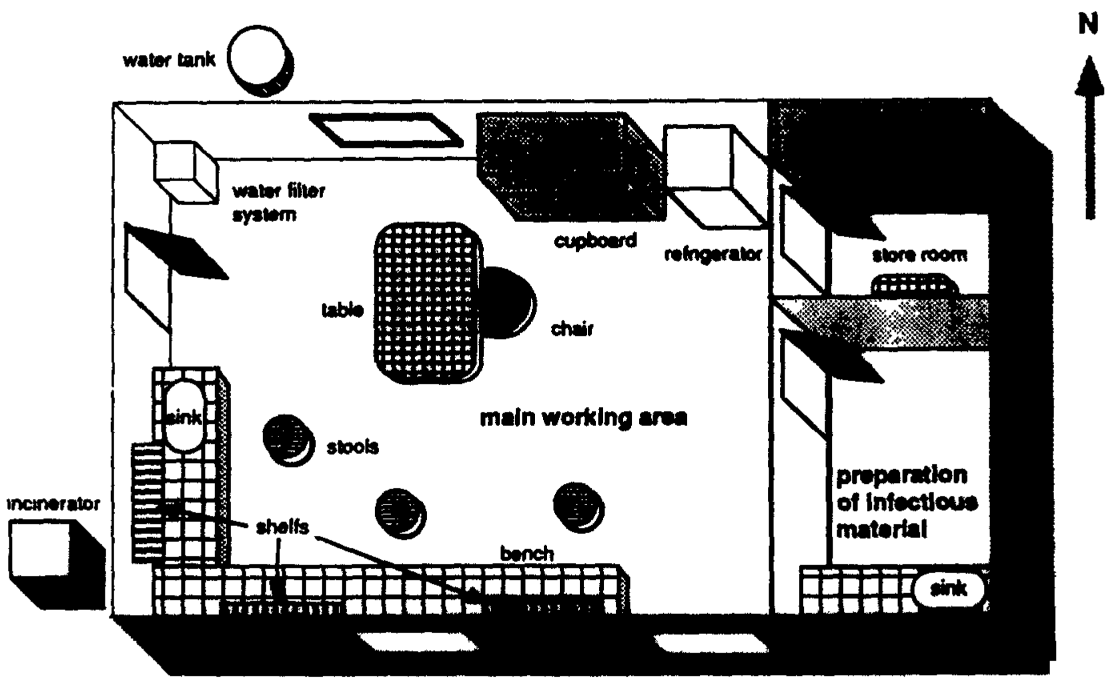


Figure 3.3 Plan for a temporary laboratory

TABLE 3.1 **Items to be purchased or prepared locally**

Item	Quantity[1]
Tables [2]	2
Chairs [2]	4
Matches	1 packet of six boxes
Soap powder, medium sized	1 packet/bag
Hand-washing soap	1 cake
Adhesive tape	1 roll
Cupboard, wood or metal, length150 cm, width 40 cm, height 120 cm, fitted with shelves (for storage of laboratory equipment and chemicals)	1
Padlocks and keys, for cupboard and laboratory doors	3 sets
Padlock catch for cupboard and doors	3
Basic first aid kit (for cuts and burns)	1
Bucket for use in case of fire (12 L)	1
Strong glue	1 tube
Quicklime (for burial of waste material)	1 sack

Quantities required may vary according to the situation
Alternatively, sufficient wood, nails and screws The following tools should be available
- pair of long nose pliers
- small hacksaw and spare blades
- screwdriver with interchangeable pieces
- adjustable 20 cm spanner wrench
- file
- set of vicegrip pliers
- saw
- hammer
- small spirit-level
- ruler
- tape measure (8 metres)

3.4 Mobile laboratories

A mobile laboratory is a laboratory mounted on or built into some form of transport. The transport might be a truck or van, a trailer, a railway carriage, a boat, or a large self-supporting container-like unit that can be conveyed by truck, boat, plane, or helicopter. All of these formats exist and have been used very successfully. Planning authorities should give serious consideration to including mobile laboratories in their emergency contingency plans.

A mobile laboratory has three advantages:

It can go almost anywhere, depending on the type of laboratory and the location of the disaster.

- It is self-contained, usually with its own sources of electrical power and utilities, such as water and gas.
- It is designed to be operable immediately upon arrival.

The disadvantages are·

- cost; and
- the fact that it may not be able to reach the emergency areas in some situations.

Mobile laboratories can be configured for almost any type of investigation, including, for example. medical diagnostic tests and environmental investigations. Mobile laboratories should be chosen according to the anticipated conditions e.g. ship, boat or canoe-transported systems for rivers and seas (**Figure 3.4**); vehicle or rail-mounted systems on land.

Preplanning is necessary to take advantage of the capabilities of mobile laboratories. They must be procured before the emergency situation has happened. This requires planning to decide and, perhaps, design what is needed for the area projected as a target. A list of manufacturers of mobile laboratories is given in Annex 3. Once the laboratory has been obtained, the personnel that are to use it should receive periodic hands-on training, working together so that they have the opportunity to form an efficiently functioning team. Actual work in the field is essential for solving potential problems in the system.

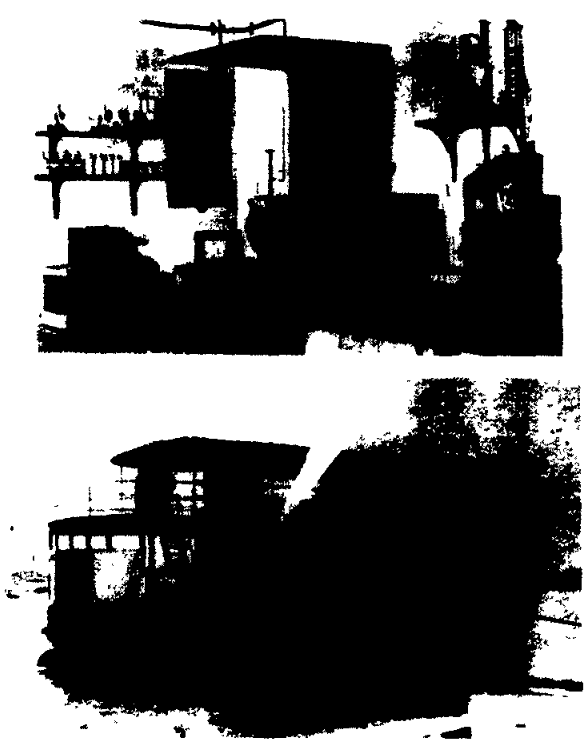


Figure 3.4 A boat- mounted laboratory

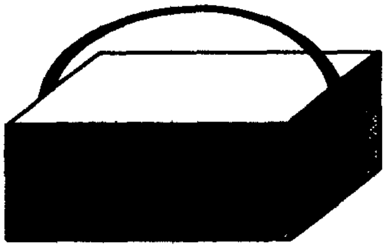
3.5 Portable laboratories

Portable laboratories are self-contained diagnostic systems that can be carried by hand. They are compact and relatively lightweight. Portable cases or plastic boxes containing laboratory materials may be used in combination with existing temporary or mobile laboratory facilities. They are particularly useful for epidemiological surveys in the field. However, there should be a critical evaluation of portable systems available, as some are extremely expensive and not well compiled. A list of manufacturers of portable systems is provided in Annex 3

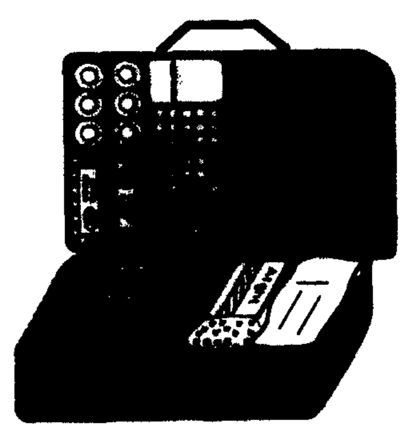
A heavy duty plastic box 60 cm x 40 cm x 30 cm can be used to transport laboratory materials (**Figure 3.5**). Plywood may be used for hinges and carrying straps. Diagnostic equipment and supplies can be put into another box or case for taking to the field. However, it is advisable to use a well-sealed case that will withstand environmental conditions such as rain, immersion in water, and dust. The case should also be sturdy enough to withstand the rigours of transport. Conditions in the field will not be known prior to the emergency situation, therefore a carrying case appropriate to any eventuality must be chosen.

The inside of the case should be designed so that the equipment and supplies are arranged for ease of use. Provision should be made to protect delicate equipment, either by securing it in position or by using shock-protective padding.

A portable laboratory should be modular, so that users can pick and choose the components needed for the particular emergency situation being addressed. At the same time, a portable laboratory should also be able to meet unexpected diagnostic requirements. Most of the diagnostic tests described in Chapter 6 can be carried in a portable laboratory. The amounts of reagents available for some tests will be limited by space, but a portable laboratory can carry sufficient supplies to obtain a good picture of disease prevalence in an emergency situation. By using micro-methods, a portable laboratory can provide a large number of certain diagnostic tests. Technical instructions must be included in a portable laboratory system, and the parts should be identified by name, illustration, and function.



a) Plastic box



B) Portable laboratory system

Figure 3.5 Portable laboratories in rural health care

An important component of a portable laboratory is specimen collection and transport. A sampling of appropriate specimens can be returned with the investigation team to their base for analysis. Test results from these specimens and from on-site tests, especially in the event of high endemicity or even an epidemic of disease, will help significantly in identifying the appropriate modules for a laboratory kit (described in Chaper 7).

After its use in the preliminary investigation, a portable laboratory can remain on site to provide continuing support until a more comprehensive laboratory system can be set up and to expand investigations into satellite areas. A portable laboratory is shown in **Figure 3.6.**

Military casualties resulting from war or armed conflict are usually the responsibility of military medical services, but there may also be civilian causalities and mobile or portable laboratories may be particularly useful in such circumstances.

The modules of a portable laboratory should include equipment and reagents to perform:

- specimen collection and transport
- basic haematology
- urinalysis
- blood and urine chemistry tests
- microscopic microbiology
- rapid serodiagnostic tests.

3.6 Referral of samples to reference laboratories

Where it is not possible or feasible to establish any kind of laboratory or where investigations are required that are beyond the scope of the local laboratory, samples may be collected and transported to reference laboratories.

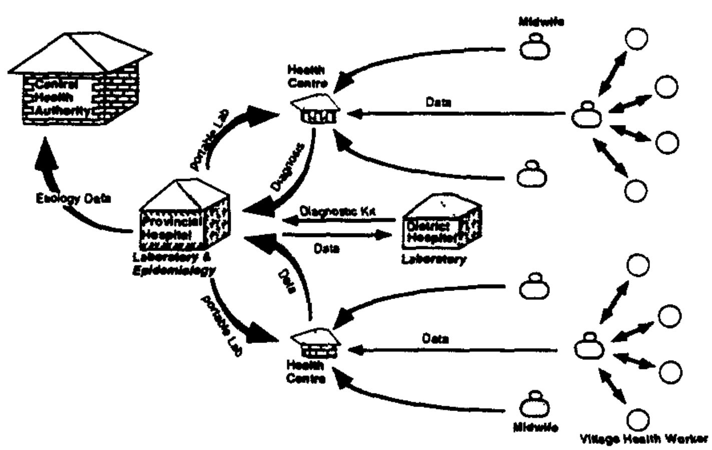


Figure 3.6 Applications of portable medical laboratories in rural health care and epidemic investigations

CHAPTER 4

SELECTION OF APPROPRIATE LABORATORY TESTS

4.1 General

Many medical laboratory diagnostic tests are suitable for use in the emergency laboratory. Most of these are the same as those used in conventional established laboratories, but some tests have to be modified for use in the field. Diagnostic laboratory tests can be classified as either direct or indirect. Direct tests are intended to specify the exact cause of the disease. Indirect tests examine the host's reaction to the infection or medical condition, as in haematology or urinalysis tests.

Both types of diagnostic tests are appropriate for emergency laboratories. Since infectious diseases are the primary concern in most disaster situations, direct tests are often the most important.

4.2 Direct diagnostic tests

4.2.1 Rapid diagnostic tests for infectious diseases

Rapid diagnostic tests are defined as laboratory tests that can yield a specific diagnosis within 24 hours, preferably within 10 minutes. Rapid diagnostic tests that are appropriate for use in emergency situations must be simple, easy to read, and clear to interpret.

Standard brightfield light microscopy provides direct, rapid diagnosis for many diseases, for example, malaria, bacterial meningitis, and intestinal parasites. Since microscopic examinations provide rapid diagnosis for many other infections, microscopy is considered a first-line rapid diagnostic technique.

Rapid diagnosis can also be made by serodiagnostic or immunodiagnostic tests. Serodiagnostic tests can be done rapidly by a variety of methods. Since these tests are very specific, pre-existing knowledge of potential disease problems in any geographical area is required to choose appropriate serodiagnostic reagents

The most suitable serodiagnostic tests for field diagnostic testing in disasters are.

- serological immobilization
- inert particle aggregation (passive agglutination)
- enzyme-linked immunosorbent assay
- fluorescent antibody (immunofluorescence).

Serological immobilization is the interruption of bacterial mobility by treatment of the specimen with specific antiserum It is most commonly used for rapid diagnosis of cholera This test can often be done directly on liquid stool specimens.

Inert particle aggregation tests are very simple and useful. The two most commonly used are latex agglutination (LA) and coagglutination (COAG). Latex reagents are tiny styrene spheres covered with latex to which a specific antibody or antigen has been attached. COAG reagents are made from killed and stabilized cells of certain strains of *Staphylococcus aureus* that are rich in a substance called 'protein A'. Specific antibodies are attached to these cells through a natural affinity of the immunoglobulin-G of certain species for protein A. The resulting antibody-coated staphylococcal cells, tiny spheres themselves, are COAG reagents. When either LA or COAG reagents react with a homologous antigen such as bacteria in the spinal fluid of meningitis patients, a serological reaction occurs that causes clumping of the LA or COAG particles. This reaction can be observed easily with the naked eye, providing a very rapid andpecific diagnosis.

LA and COAG reagents are about equal in sensitivity Some of the important infectious diseases that can be diagnosed rapidly with these reagents are:

- cholera
- bacterial meningitis
- bacterial pneumonia
- salmonella gastroenteritis
- typhoid and paratyphoid fevers.

The difference between LA and COAG reagents lies in the ease of reagent preparation. The latex particles must be purchased. The COAG reagents can be easily prepared in almost any laboratory Commercially available LA and COAG reagents are listed in Annex 4

Enzyme-linked immunosorbent assay (ELISA) is becoming widely used for rapid diagnosis of infectious diseases, autoimmune diseases and normal conditions such as pregnancy. It can identify both antigens (microorganisms or their by-products) and antibodies ELISA tests are very sensitive and easy to use. Many are commercially available (see Annex 2).

Fluorescent antibody (FA) tests are used to detect and identify both antigens and antibodies The reagents are antibodies to which a fluorescent dye, a 'conjugate', has been attached chemically There are two types of FA test, direct and indirect. In direct FA test the specific fluorescent reagent is made to react with a specimen that may contain the target microorganism. If the target microorganism is present, for example, the meningococcus in spinal fluid, the individual (meningococcus) cells will glow brightly against a dark background when viewed with a fluorescence microscope. For indirect FA tests, an antibody is first made to react with the specimen, and then a fluorescent antibody specific for the protein of that antibody or species serum is made to react with it. The latter process yields great versatility to the indirect method. Only one fluorescent conjugate is needed, and many antisera (polyclonal and monoclonal) are available for detecting a wide variety of infectious disease agents

The primary disadvantage of performing FA tests in the field is the need for a fluorescence microscope. Recent technical developments in fluorescence microscopy equipment, however, have made it quite practical to do FA tests and fluorescent acid-fast stains in the emergency laboratory. This technological advance is due to the development of fluorescence objectives which can turn any standard microscope into a fluorescence microscope, at very reasonable cost

4.2.2 Communicable diseases: bacteria, parasites, rickettsia and viruses

General

The principal tests required for diagnosis of communicable diseases that may occur in disasters are listed in **Table 4.1**. The tests are divided into those that give presumptive diagnoses and those that are confirmatory.

Presumptive tests for some diseases are sufficiently sensitive and/or specific that further confirmatory tests are not appropriate or needed. Presumptive tests for other diseases are only a guide, having low sensitivity and/or specificity, and confirmatory tests should be done if at all possible.

TABLE 4.1 **Diagnosis of communicable diseases in disasters**

Disease	Specimen examined	Presumptive diagnostic test	Done on site	Confirmatory test	Done on site
AIDS/HIV	Serum	ELISA Fluorescent antibody Latex agglutination	Yes Yes Yes	Serology	No
Anthrax	Lesion Sputum	Gram stain	Yes	Culture Serology	No No
Bacterial dysentery/ gastro-enteritis	Faeces	Culture/ coagglutination Microscopy, polymorphic and red cells	Yes Yes	Culture	Yes[1]
Cholera	Faeces	Serum immobilization Coagglutination Latex agglutination	Yes Yes Yes	Culture	Yes[1]
Dengue	Serum	None	No	Serology	No
Diphtheria	Throat swab	Microscopy, Gram stain	Yes	Culture	No

TABLE 4.1 Diagnosis of communicable diseases in disasters (continued)

Disease	Specimen examined	Presumptive diagnostic test	Done on site	Confirmatory test	Done on site
Enteric fevers	Blood Faeces Urine	Culture/ coagglutination	Yes	Culture	Yes[1]
Hepatitis	Urine	Test strip	Yes	Serology	No
Intestinal helminths and protozoae	Faeces	Microscopy	Yes	NA	No
Leishmaniasis	Serum	DAT ELISA Fluorescent antibody	Yes No Yes	Culture Serology	No No
Leptospirosis	Blood Serum	Culture Darkfield	No Yes	Culture Serology	No No
Malaria	Blood	Microscopy	Yes	NA	
Measles	Serum	ELISA	Yes	NA	
Meningitis	Cerebrospinal fluid	Coagglutination ELISA Latex agglutination Microscopy	Yes Yes Yes Yes	Culture	No
Plague	Bubo aspirate Sputum	Gram stain	Yes	Culture	No
Pneumonia	Serum Sputum	Coagglutination ELISA Fluorescent antibody Latex agglutination	Yes Yes Yes Yes	Culture	No
Poliomyelitis	Serum	None	No	Culture, Serology	No
Protozoan dysentery	Faeces	Microscopy	Yes	NA	No
Relapsing fever	Blood	Field's stain/ Giemsa's stain Microscopy Wet mount (brightfield or darkfield)	Yes Yes Yes	Animal inoculation	No
Streptococcal disease	Throat swab	Coagglutination Latex agglutination Microscopy, Gram stain	Yes Yes Yes	Culture	No
Tetanus	None	None	No	NA	No
Trench fever	None	None	No	Serology	No

TABLE 4.1 Diagnosis of communicable diseases in disasters (continued)

Disease	Specimen examined	Presumptive diagnostic test	Done on site	Confirmatory test	Done on site
Trypanosomiasis	Serum or plasma	CATT	Yes	ELISA Giemsa's stain	No
Tuberculosis	Sputum	Microscopy, acid-fast stain Fluorescent acid-fast stain	Yes Yes	Culture and sensitivity	No
Typhus	Serum	Indirect fluorescent antibody Weil Felix stained antigens	Yes[1] Yes	Serology	No
Viral diarrhoeas	Faeces	Latex agglutination	Yes	Culture	No
Viral encephalitis	Serum	None	No	Culture, serology	No
Viral haemorrhagic fever	Serum	None	No	Culture, serology	No
Whooping cough	Naso-pharyngeal swab	Fluorescent antibody	Yes	Culture	No

[1] Dependent on the level of sophistication of the emergency laboratory
For example, many mobile laboratories can do this

CATT Card agglutination test
DAT Direct serum agglutination test
NA Not applicable

Notes to Table 4.1

1 A presumptive test involving bacterial immobilization with anti-*V cholerae* Ol antiserum solution can be used in the field If Ol antiserum containing preservatives is used, it must be diluted 1 10 with saline solution Interpretation of the test is subjective, and prior experience is important COAG and LA agglutination tests have been developed, and these have been field tested but not in disaster situations

2 If shigellosis is suspected, stool specimens should be transported in Cary-Blair medium or on filter paper for culture and susceptibility testing at a regional bacteriology laboratory

3 Experience with COAG and LA tests on selective enrichment broth cultures is limited, and confirmatory culture tests may be helpful

4 LA and COAG tests on clinical specimens have been used under field conditions, particularly in endemic meningitis areas They may be considered an acceptable alternative to microscopy with comparable sensitivity

5 The CATT is a useful screening test for trypanosomiasis DAT is a useful screening test for visceral leishmaniasis Representative serum samples should be sent to a reference laboratory for more sensitive and specific serology Marrow or splenic aspirates should only be done by suitably experienced medical personnel

6 Where specific viral fevers are endemic, and may become epidemic in disasters, on site serological tests should be considered (e g dengue)

Cholera

Diagnosis of cholera is, in most cases, essentially clinical. Presumptive laboratory diagnosis is important for epidemiological and outbreak investigations. Culture confirmation is essential for public health notification and to determine antimicrobial susceptibility. *V. cholerae* isolates or stool specimens should be sent to a reference laboratory for biotyping and serotyping. Stools may be tested directly on site with simple COAG or LA slide agglutination tests. Use of alkaline peptone water for enrichment culture incubation followed by LA or COAG tests gives more sensitive diagnostic results.

Enteric fever/salmonellosis

Typhoid/paratyphoid fever outbreaks are relatively uncommon in disasters, but all types of *Salmonella* infection are increasingly common in HIV endemic areas. No satisfactory non-culture diagnosis test for salmonellae exists for field use, with the possible exception of FA. Widal serological tests are of no value in tropical areas. Rapid COAG tests on stool and blood selective enrichment broth cultures have been reported. Confirmatory tests require culture of blood or faeces followed by biochemical and serological identification of suspect isolates.

Shigellosis

A presumptive diagnosis of shigellosis can be made by the presence of blood and polymorphonuclear leucocyte cells demonstrated by direct microscopy of the stool specimen. However, in the absence of amoebic trophozoites, this is rarely necessary and is of low specificity for epidemiological purposes. Culture confirmation and serotyping is necessary for epidemic investigation. Antibiotic susceptibility testing should be done in an extensive outbreak.

Amoebic dysentery (amoebiasis)

Stool microscopy demonstration of amoebic trophozoites is sufficiently sensitive and specific for diagnosis. Faecal specimens for this test must be very fresh.

Other diarrhoeal diseases

Investigations additional to those for shigellosis and amoebic dysentery are rarely indicated in disasters. In a diarrhoeal disease outbreak in which the above investigations are negative, a sampling of faecal specimens can be sent to a reference centre.

Stool microscopy for other enteric pathogens

Intestinal helminths and protozoan infections are common in communities where water and sanitation facilities are deficient. Their diagnosis may be important in individual patient management, but they are rarely implicated in disease outbreaks. Therefore, examinations for intestinal helminths should take low priority. Although they are easy to do and hold interest for those inclined towards parasitology, these examinations will have little impact on the health of the community at risk.

Bacterial meningitis

In an outbreak of suspected meningitis, lumbar puncture should be performed on a representative number of cases using aseptic technique. It should only be done by an experienced health worker. Stained cerebrospinal fluid (CSF) specimens should be examined with a microscope. Antigen detection, using COAG or LA tests has proved to be a useful field diagnostic technique. Culture confirmation will define the causative agent and allow serotyping and antimicrobial susceptibilities to be determined.

Tuberculosis

Presumptive diagnosis of tuberculosis can be made by microscopic examination of sputum smears stained by either the Ziehl Neelsen or Kinyoun methods. Fluorescent acid-fast staining provides very sensitive diagnosis. Mycobacterial culture facilities are often limited at regional or national levels. If tuberculosis is a major health problem, dispatch of a limited number of sputum specimens to a reference centre for culture and antimicrobial susceptibility testing may be considered. Microscopy is an essential component of tuberculosis control programmes. The idea is to detect active cases so that they can be treated and immediate contacts can be immunized with BCG vaccine.

Blood parasites

Microscopic examination of Giemsa-stained, Wright-Giemsa-stained, or Field-stained blood films for malaria, relapsing fever, and trypanosomiasis should be done. A card agglutination test (CATT) is available for serological screening, but microscopy remains the first line of diagnosis.

Rickettsial and viral fevers

For investigation of presumed viral or rickettsial fevers, filter paper blood specimens should be sent to an appropriate reference centre. Such specimens should be taken by a special investigation team, and adequate safety precautions must be taken for shipment (see the special shipping precautions described in Chapter 11).

Leishmaniasis

The direct serum agglutination test (DAT) can be used in the field as a screening test for visceral leishmaniasis. Serum specimens should also be sent to a reference centre for more specific serological tests.

Viral diseases

Increasingly, rapid diagnostic tests for viral diseases are becoming commercially available (see Annex 4). They are designed for detection and identification of either antigens or antibodies, but the most rapid and specific serodiagnostic tests detect and identify virus antigens. These simple rapid diagnostic tests are particularly significant because conventional tests for detecting and identifying viruses are time-consuming, difficult, cumbersome and expensive.