THE ROLE OF LABORATORIES AND BLOOD BANKS IN DISASTER SITUATIONS

A practical guide developed at the workshop held in Managua, Nicaragua, on 7 June 2001

Pan American Health Organization
Regional Office of the
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PROGRAM ON EMERGENCY PREPAREDNESS
AND DISASTER RELIEF

&

PROGRAM ON ESSENTIAL DRUGS AND TECHNOLOGY
DIVISION OF HEALTH SYSTEMS AND SERVICES DEVELOPMENT

Washington, D.C. 2002

Cover photos: PAHO/WHO

OPS/HSP/HSE/08-2001

ISBN 92 75 12380 2

This is a joint publication of the Program on Emergency Preparedness and Disaster Relief and the Program on Essential Drugs and Technology, Division of Health Systems and Services Development, Pan American Health Organization/World Health Organization.

This publication was made possible through the financial support of the U.S. Agency for International Development (USAID), the Department for International Development of the United Kingdom (DFID), the Centers for Disease Control and Prevention (CDC) (through Cooperative Grant/Agreement number 318446), the Division of International Humanitarian Assistance of the Canadian International Development Agency (IHA/CIDA), and the U.S. Office of Foreign Disaster Assistance of the U.S. Agency for International Development (OFDA/AID).

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ACKNOWLEDGEMENTS

This publication was prepared through the joint efforts of the institutions and individuals listed below. The technical review was performed at the Workshop on the Role of Laboratories and Blood Banks in Disaster Situations held in Managua, Nicaragua, on 7 June 2001.

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PREFACE

Emergencies and disaster situations require a rapid and timely response by the health services. For several years, the Pan American Health Organization has promoted the development of activities to reduce vulnerability of the health sector to disasters and to strengthen emergency and disaster preparedness plans.

Recent disasters in Central America, such as Hurricanes Mitch and Georges in 1998 and the El Salvador earthquake in 2001, have underscored the importance of including the activities of public health laboratories, clinical laboratories, and blood banks in the health sector's emergency plans. Three areas should be given priority:

- Diagnostic confirmation of communicable diseases with high mortality rates;
- Availability of basic tests used in caring for the injured;
- Timely provision of safe blood.

The purpose of this guide is to sensitize and orient health authorities, laboratory directors, laboratory technicians, and blood bank personnel to the identification of responsibilities and functions of laboratory and blood bank services in disaster situations, taking into account priorities, needs, and the local capacity for immediate response.

The response of health services to disaster situations will be improved when activities to mitigate and reduce vulnerability and to restore and reorganize laboratory and blood bank services are incorporated in emergency plans.

I - INTRODUCTION

One of the principal problems in directing interventions, instituting preventive measures, and managing cases appropriately in disaster situations is the lack of basic information from the affected area. In particular, basic information about the possible emergence of communicable diseases is difficult to obtain in disaster-affected zones.

The following factors influence the emergence and spread of communicable diseases:

- Changes in population density, displacement of population, and/or exposure to the elements;
- A change in the ecological balance that facilitates the proliferation of vectors;
- Displacement of animals, which fosters the development of zoonoses;
- Disruption and contamination of the water supply and sanitation services;
- Emergency provision of food and water and sanitary conditions in shelters, which are potential sources of infectious disease;
- Relative reduction in the response capacity of the health services network due to damage to the health services infrastructure (i.e., hospitals, health centers, and laboratories) or due to increased demand;
- Disorganized public health programs.

The impact of disasters on health infrastructure and services requires specific emergency measures to:

- Ensure basic services to care for the affected population, and
- Reestablish the surveillance system.

In order to guarantee effective intervention by laboratories and blood banks during a period that is characterized by disorganized interventions, inadequate definition of the different actors' roles, and late confirmation of outbreaks, it is necessary to:

- Reduce the vulnerability of laboratories and blood banks;
- Integrate the plans of laboratories and blood banks with the hospital emergency plan and/or national emergency plan;
- Assure speedy diagnosis of the diseases classically found in the wake of disasters;

- Secure the delivery of clinical laboratory services for basic and essential tests;
- Ensure the availability of safe blood supplies in response to immediate demand.

II - PREPAREDNESS AND MITIGATION

Preparedness

Laboratories and blood banks should prepare emergency plans and incorporate them into the health sector's general disaster plans, in coordination with the national disaster program and departments of epidemiology.

In preparing emergency plans it is necessary to:

- Consider the risk of disaster from natural, technological, social, or biological causes to the country or to a particular region, and identify possible health and needs scenarios based on previous experiences;
- Evaluate vulnerability to epidemics based on the epidemiologic profiles of each country or specific region;
- Determine the physical and organizational vulnerability of the services;
- Assess the vulnerability of the life lines that guarantee the operation of services, that is, water and electricity supply, communications, and transportation;
- Evaluate the organizational and institutional response capacity, and identify the roles and duties of the key staff members;
- Establish mechanisms for coordination between the network of laboratories and other related institutions such as health services, military hospitals, ministry of agriculture, universities, social security institutions, and customs houses;
- Disseminate the emergency plan widely and train the staff that play an important role in its execution;
- Conduct periodic simulations to test the viability of the plans;
- Develop a budget for disaster preparedness and response activities;
- Institutionalize, through ministerial resolutions or directives, emergency plans for laboratories in the event of disasters.

The specific preparedness considerations for laboratories and blood banks are described in chapters III and V.

Mitigation

Disaster mitigation begins by conducting a vulnerability analysis to identify the critical points in the system that may be subject to risk.

The following factors should be taken into account during vulnerability analysis:

- Structural elements that support the weight of the building (e.g., beams, columns, and load-bearing walls);
- Nonstructural elements, including architectural features (such as exterior walls, windows, ceilings, etc.); critical systems (including water, electricity, and communications); and a building's contents (supplies, equipment, and furniture);
- Functional elements, including aspects of interior design (use of space, access to and relationship of different critical areas of a facility); and exterior design (for example, access routes to the facility). Administrative and organizational elements must also be considered and include the presence of signs, emergency doors and exits, and fire extinguishers. Personnel training and awareness of disaster preparedness are critical administrative elements. Coordination with other institutions, such as the fire department, during simulation exercises, is another of the functional elements to consider as part of disaster mitigation.

The following are aspects of *structural vulnerability* studies:

- Performing a visual inspection of the facilities and/or requesting an expert assessment in order to determine which areas might be affected by different types of hazards, and
- Assigning competent professionals to study a facility's vulnerability to natural disaster.

Based on these analyses, responsible authorities should conduct a cost/benefit analysis of recommended structural and nonstructural interventions, taking into account the benefits expected in terms of financial and social losses.

Following are steps to reduce the vulnerability of *nonstructural elements*:

- Identify and classify the nonstructural elements that represent risk to human life, property loss, or loss of the facility's ability to function in the event of disaster (see Annex 1);
- Store hazardous materials in a safe, remote location. Remove vulnerable architectural elements such as false ceiling made of tiles or plaster;
- Secure gas tanks, oxygen tanks, and generators to the floor or walls;
- Attach diagnostic equipment and centrifuges to counters, walls, or panels;
- Anchor heavy equipment with bolts or cables;
- Secure filing cabinets and shelving to the floors and walls;
- Store laboratory glassware in containers and keep a reasonable amount of space between them;
- Cover glass or fragile materials with plastic;
- Choose safe places for chemical and biological reagents and cultures to minimize the risk of contamination and fire in a disaster;
- Guarantee the provision of basic services such as water, electricity, and communications during and immediately after the disaster;
- Determine the minimum amount of water the facility should have in reserve in order to function in a disaster situation;
- Ensure that the installation has sufficient water storage capacity (such as a cistern) to operate for at least two days independently of external supply;
- Identify the areas where a supply of water is vital for operation in order to determine necessary rationing;
- Procure an electric generator capable of providing power in case of emergency;
- Identify the areas and equipment that should be connected to the emergency electric power plant and inventory the equipment that needs special protection in connection with essential laboratory functions (see Annex 2);
- Ensure that laboratory and blood bank cold storage are connected to the emergency energy supply;

- Store supplies and tools in accessible, safe places that allow for their rapid retrieval in emergencies;
- Clean and continually maintain the drainage and sewer channels;
- Ensure climate control where needed.

In order to reduce *organizational and administrative vulnerability*, these actions should be taken:

- Establish appropriate layout and connections between areas in the facility, and determine administrative processes and routines to guarantee adequate operation under both normal and emergency conditions;
- Identify evacuation routes, emergency exits, danger zones, areas where there is a risk of exposure to toxic substances, and the location of alarms and fire extinguishers, and mark them with signs.

III - PUBLIC HEALTH LABORATORIES

The main responsibility of the public health laboratory network is to establish early diagnosis of diseases with high mortality rates (see Annex 3) and to notify the department of epidemiology. Diseases typically associated with disaster situations include:

- Water-borne and foodborne diseases;
- Acute respiratory infections and reemergence of subacute infections;
- Bacterial meningitis;
- Vector-borne diseases;
- Zoonoses;
- Vaccine-preventable diseases.

Disaster Preparedness Stage

The central reference laboratory is the institution designated to organize the emergency plan and coordinate actions to be taken by the laboratory network. As part of disaster preparedness, the following steps should be taken:

1. Confirm that the central reference laboratory is the coordinating institution for the laboratory network in emergencies;
2. Provide for an alternate laboratory with technical-managerial capacity similar to that of the reference laboratory in the event that the reference laboratory does not maintain optimum capacity;
3. Establish a functional network of strategically located laboratories appropriate to geopolitical conditions in the country, access routes, and communication;
4. Define the response capacity by laboratory level;
5. Maintain a current list of laboratory personnel in order to define their roles in an emergency;
6. Train laboratory staff for integration into the multidisciplinary teams or rapid intervention brigades that investigate outbreaks;
7. Establish a flow chart and protocols for shipping specimens within the laboratory network in keeping with international biosafety standards (see Annex 4);

8. Standardize, update, and distribute manuals of procedures for diagnosing diseases;
9. Provide the central laboratory and certain strategically located laboratories with a stock of rapid diagnostic tests;
10. Equip the central and alternate laboratories with portable laboratories for field testing, to include identification of etiological agents of outbreaks and inspection of water and food in keeping with the institutional capacities of each country;
11. Establish official outside support channels for the diagnosis of unusual infectious agents.

Emergency Stage: Immediate Response

Actions immediately following event

Immediately after the event, the following steps should be taken:

1. Assess the damage in order to restore, reactivate, and reorganize the laboratory network (see Chapter II).
2. Incorporate the trained laboratory staff into rapid intervention brigades.
3. Provide brigades with portable laboratories and/or supplies for field testing and sampling.
4. Coordinate activities closely with the national disaster and epidemiology programs.

Reactivating the laboratory network

Actions necessary to reactivate and reorganize the laboratory network following a disaster, in priority order, are:

1. Reestablish the basic operations of the affected local laboratories;
2. Prioritize the provision of transportation, sampling supplies, and laboratory reagents to the affected areas in accordance with the first estimates of cases;
3. Ensure efficient receipt and processing of specimens;
4. Issue an early, accurate diagnosis of the diseases;
5. Establish flexible communication channels in the network to ensure information dissemination and feedback;

6. Determine the causes, sources, and means of transmission of the diseases;
7. Update the knowledge of local technical personnel;
8. Maintain records and data.

Local actions: presumptive diagnosis

In emergencies, it is unrealistic to expect the use of diagnostic techniques that are not generally found at the local level. However, rapid, accurate diagnosis of many infectious disease can be accomplished through microscopic examination. Basic tests for certain infectious diseases include:

- Cholera—motility and Gram stain
- Meningitis—Gram stain
- Pneumonia due to pneumococcus—Gram stain
- Malaria—thick blood film
- Tuberculosis—microscopic examination

The use of rapid diagnostic tests is an alternative for early diagnosis at the local level; however, a test to confirm the first positive cases detected should be performed systematically at the central level. Tests available on the market are as follows (this is not an exhaustive list):

- Cholera (immunoenzyme test)
- Rotavirus (agglutination)
- Bacterial meningitis (soluble antigens)
- Malaria (immunochromatography)
- Dengue (IgM)
- Leptospirosis (IgM)

Actions at the central level: case confirmation

For cultures and serological tests, it is recommended that the specimens be sent directly to the higher level laboratory in accordance with the system established in the disaster preparedness stage.

Post-Emergency Stage

The post-emergency stage involves strengthening surveillance and disease control in accordance with the organizational systems present in the country. This requires a focus on tracer diseases, especially with respect to outbreak characteristics (for example, circulating microbial serotypes, antimicrobial resistance profiles, virulence factors, sources, vectors, risk factors) and trend analysis. Other diseases under surveillance in the country should not be neglected.

At this stage, a thorough evaluation of the actions taken in connection with all operational aspects of the emergency plan should be conducted, and appropriate corrective measures established.

IV - CLINICAL LABORATORIES

Immediately after the event, a damage assessment should be made in order to restore, reactivate, and reorganize the laboratories.

In the vast majority of cases, the diseases reported in an emergency and the leading causes of death can be clinically identified. Treatment can be presumptive and symptomatic.

The health authorities should ensure the availability of personnel, supplies, and equipment at the local level. Equipment must be available to conduct the following essential tests:

- Hemogram with white cell, red cell, and platelet counts; and hemoglobin and hematocrit determinations;
- Electrolytes, glucose, urea, transaminases;
- Blood group and Rh factor;
- Arterial gases (in accordance with capacity).

V - BLOOD BANKS

The National Blood Commission or Council will, within the framework of the national emergency plan, provide intervention guidelines as outlined below.

Disaster Preparedness Stage at the National Level

- Establish a national reference blood bank to coordinate operations and designate centers that are strategically located in accordance with geopolitical conditions in the country, type of emergency, access routes, and communications;
- Provide for a blood bank or alternate health service with technical-managerial capacity similar to that of the reference blood bank, in the event that the reference bank fails to function following the disaster;
- Maintain an inventory of blood bank personnel;
- Organize the communications systems of the blood banks, transfusion services, and the reference bank;
- Ensure that information is transmitted about the need for and inventory of immediately available blood and components;
- Organize the transportation of the blood and components to the affected areas as necessary, taking advantage of the cold chain established for supplies such as drugs and vaccines;
- Define mechanisms for blood reception, pre-transfusion tests, and transfusion in the disaster-affected areas;
- Plan blood collection in accordance with needs;
- Organize simulation exercises.

At each blood bank, define and establish functions for the different work areas, taking into account higher demand, reduced capacity to provide services, and the need for alternate local sites to absorb demand. These functions will include:

- Donor reception and orientation, including telephone assistance, donor selection, blood collection, and post-donation donor care;

- Screening tests;
- Blood grouping;
- Component separation;
- Release of products for transfusion;
- Shipments of blood and components, including the receipt of requests for blood and components and coordination with land and air transport;
- Administrative/logistical support (delivery of material, establish shifts for personnel, role of volunteer personnel, statistical information, information to the communications media).

Emergency Stage: Immediate Response

- Assess the need for blood;
- Confirm the number of units available for immediate release to the affected areas;
- Evaluate the contribution of unprocessed units of blood available in the blood banks;
- Determine the ability to meet the demand before beginning to make appeals to the community and causing more panic than an emergency already entails;
- Proceed with appeals to the community if absolutely necessary;
- Concentrate volunteer donation centers in areas that are not congested;
- Collect blood in accordance with the standards in the country, including implementation of all screening tests (HIV, HBV, HCV, syphilis, Chagas'), ABO and Rh grouping, component separation, release of approved products for transfusion;
- Accept donors who have previously donated blood, when possible;
- Process the units of blood in accordance with the standards in the country;
- As necessary, mobilize skilled health workers who are trained to collect blood.

Post-Emergency Stage

- Assess compliance with the existing emergency plan and take the appropriate corrective action;
- Evaluate coverage of the demand and, at a minimum, determine:
  - Number of units dispatched versus units requested;
  - Number of units dispatched versus units transfused;
  - Number of discarded units and reasons for discard (this should include all the units collected in response to the event);
- Replace stock (including supplies, reagents, and budget affected by the increase in demand);
- Check the inventory and use of the supplies of blood and components;
- Notify the responsible authorities of the actions taken;
- Report to and thank the community for the blood donations.

ANNEXES

Annex 1
Analysis of nonstructural vulnerability, consequences, probable damage, and types of risk

Nonstructural elements	Consequences and damage *	Type of risk**
Architectural • Dividers and partitions • Interiors • Façades • False ceilings • Coverings • Cornices • Terraces • Facings • Windows • Appendages (signs, etc.) • Ceilings • Antennas		
Equipment and furniture • Medical/laboratory equipment • Industrial equipment • Office equipment • Furniture • Contents • Supplies • Files • Shelving • Cold chain		
Basic installations • Electricity • Medical/laboratory gases • Industrial gas • Telecommunications • Drinking water • Industrial water • Air conditioning/heating • Steam • Pipes in general		

*The probable consequences and damage due to inadequate protection or installation can be: collapse of the equipment, breakage, displacement, operating defects, decalibration, loss of data, etc.

**Risks can be classified as:

- ■ Risk to human life
- ▼ Risk of loss of function
- ● Risk of property loss

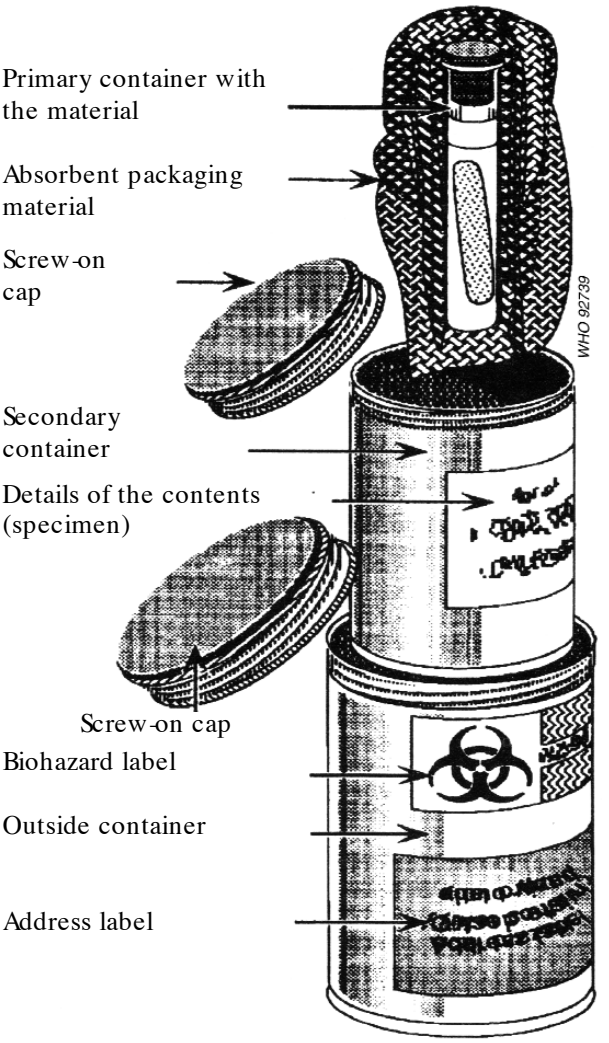
Annex 2
Basic list of laboratory equipment requiring special protection

- Microscope
- Refrigerator
- Freezer
- Incubator
- Centrifuge
- Autoclave
- Laminar flow systems
- Precision scale
- ELISA equipment
- Automated analytical equipment
- Spectrophotometer
- Computer equipment

Annex 3
Specimen, rapid diagnosis, reference methodology, and turnaround time by groups of diseases

Group of diseases	Specimen	Transport medium	Rapid presumptive diagnosis	Reference methodology	Turnaround times
Food- and waterborne diseases					
Acute diarrheal diseases	Stool	Cary Blair	---	Culture	2-3 days
Cholera	Stool	Cary Blair	Motility Rapid text	Culture	Immediate to 1 day
Viral diarrheal diseases	Stool	< 4 hours	Latex agglutination	ELISA	Immediate to 1 week
Hepatitis A	Blood	Serum	(Transaminases)	ELISA	2 days to 1 week
Typhoid	Blood	Blood	No	Blood culture	3 days to 1 week
Acute respiratory infections					
Pneumonia	Sputum	< 4 hours	Gram stain	Culture	2 days
Whooping cough	Nasopharyng.	Bordet Gengou Regan-Lowe	No	Culture	1 week
Diphtheria	Nasopharyng.	Loefler	Microscopy	Culture	2 days
Tuberculosis	Sputum	Flask	Microscopy	Culture	1-3 days 3 week culture
Bacterial meningitis	CSF	< 2 hours Room temp.	Soluble antigens	Culture	Immediate to 2 days
Vector-borne diseases					
Malaria	Blood	Blood	Thick blood film/ Giemsa	Thick blood film/ Giemsa	1/2 hour
Dengue	Blood	Serum	Rapid test	ELISA/culture	3 days to 1 week
Other hemorrhagic diseases	Blood	Serum	No	ELISA/culture	3 days to 1 week
Zoonoses					
Rabies	Blood	Serum	No	ELISA IgM	3 days to 1 week
Leptospirosis	Blood	Serum	Rapid test	Agglutination	1 day
Plague	Bubo or blood	Serum	Wayson stain Immunofluorescence	Blood culture Passive hemagglutination	2 days to 1 week
Hantavirus	Blood	Serum		ELISA IgM	3 days to 1 week
Vaccine-preventable diseases					
Measles	Blood	Serum		ELISA IgM	2 days to 1 week
Polio	Blood	Serum		ELISA IgM	2 days to 1 week

Annex 4
Triple packing system for the transportation of diagnostic specimens and infectious substances



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