4. OUTBREAK CONTROL

This chapter outlines the key activities of outbreak control in an emergency on a step-by-step basis. An epidemic is the occurrence of a number of cases of a disease that is unusually large or unexpected for a given place and time. Outbreaks and epidemics refer to the same thing (although lay persons often regard outbreaks as small localized epidemics). The term outbreak will be used in this manual. Outbreaks can spread very rapidly in emergency situations and lead to high morbidity and mortality rates. The aim is to detect an outbreak as early as possible so as to control the spread of disease among the population at risk.

Control measures specific to different diseases are detailed under individual disease headings in Chapter 5.

It must never be forgotten that an increase in the number of cases of a disease may result from a sudden influx of displaced individuals. While this may not be an outbreak *stricto sensu* (that is to say, an increase in rate above a set value), it may nevertheless present the health services with a task equal to that of responding to an outbreak. Indeed, the task may be greater, since there may be a marked increase in the numbers of cases of several diseases rather than of a single disease and each of these may require a different response. This may not be an outbreak, but it may generate a medical emergency.

4.1 Preparedness

In each emergency situation, the lead agency for health is responsible for preparation for and response to a sharp increase in the numbers of cases of disease. To prepare for such an eventuality, it is essential that:

- a surveillance system is put in place to ensure early warning of an increase in the incidence or numbers of cases of diseases;
- an outbreak response plan is written for the disease – covering the resources, skills and activities required;
- standard treatment protocols for the disease are available to all health facilities and agencies and that clinical workers are trained;
- stockpiles of essential treatment supplies (medication and material) and laboratory sampling kits are available for the priority diseases, such as oral rehydration salts, intravenous fluids, vaccination material, tents, transport media and water purification supplies;
- a competent laboratory is identified for confirmation of cases;
- sources of relevant vaccines are identified in the event that a mass vaccination campaign is required, and that supplies of needles and syringes are adequate;
• sources of additional treatment supplies are identified for non vaccine-preventable diseases in case of expansion of outbreak;
• the availability and security of a cold chain are established.

There are a limited number of diseases with epidemic potential that pose a major threat to the health of a population facing an emergency situation (see Table 4.1). These diseases should be identified during the rapid assessment.

Table 4.1  Major diseases with epidemic potential in emergency situations

- Cholera
- Meningococcal disease
- Measles
- Shigellosis

In certain geographical areas, the following diseases may have to be included:
- Malaria
- Louse-borne typhus
- Yellow fever
- Trypanosomiasis
- Visceral or cutaneous leishmaniasis
- Viral haemorrhagic fevers
- Relapsing fever
- Typhoid
- Hepatitis A and E

In addition, the lead health agency should draw up a list of the main risk factors for outbreaks in the emergency-affected population. Potential risk factors are presented in Table 4.3.

A basic plan for resource requirements in the event of an outbreak should be developed (Table 4.4). For each disease, an outline response plan should be available on site.

Table 4.2  SUMMARY: Steps in the management of a communicable disease outbreak

1. PREPARATION
   • Health coordination meetings.
   • Surveillance system: weekly health reports to Ministry of Health and WHO (during an outbreak, this may be daily rather than weekly)
   • Outbreak response plan for each disease: resources, skills and activities required.
   • Stockpiles: sampling kits, appropriate antimicrobial, intravenous fluids, vaccines
   • Contingency plans for isolation wards in hospitals (see Annex 7 for organization of an isolation centre).
   • Laboratory support.
2. DETECTION

The surveillance system must have an early warning mechanism for epidemic-prone diseases (see Annex 4 for guidelines on use of surveillance system and alert thresholds). If cases of any of the following diseases/syndromes are diagnosed (i.e. alert threshold is passed), inform the health coordinator as soon as possible; the health coordinator should inform the Ministry of Health and WHO:

- acute watery diarrhoea in over 5-year olds,
- bloody diarrhoea,
- suspected cholera,
- measles,
- meningitis,
- acute haemorrhagic fever syndrome,
- acute jaundice syndrome,
- suspected poliomyelitis (acute flaccid paralysis),
- a cluster of deaths of unknown origin,

(diseases/syndromes in list to be modified according to country profile).

Take clinical specimen (e.g. stool, serum, cerebrospinal fluid) for laboratory confirmation. Include case in weekly health report.

3. RESPONSE

Confirmation

- The lead health agency should investigate reported cases or alerts to confirm the outbreak situation – number of cases higher than expected for same period of year and population; clinical specimens will be sent for testing.
- The lead health agency should activate an outbreak control team with membership from relevant organizations: Ministry of Health, WHO and other United Nations organizations, nongovernmental organizations in the fields of health and water and sanitation, veterinary experts.

Investigation

- Confirm diagnosis (laboratory testing of samples).
- Define outbreak case definition.
- Count number of cases and determine size of population (to calculate attack rate).
- Collect/analyse descriptive data to date (e.g. time/date of onset, place/location of cases and individual characteristics such as age/sex).
- Determine the at-risk population.
- Formulate hypothesis for pathogen/source/transmission.
- Follow up cases and contacts.
- Conduct further investigation/epidemiological studies (e.g. to clarify mode of transmission, carrier, infectious dose required, better definition of risk factors for disease and at-risk groups).
- Write an investigation report (investigation results and recommendations for action).

Control

- Implement control and prevention measures specific for the disease.
- Prevent exposure (e.g. isolation of cases in cholera outbreak).
- Prevent infection (e.g. vaccination in measles outbreak).
- Treat cases with recommended treatment as in WHO/national guidelines.
4. EVALUATION

- Assess appropriateness and effectiveness of containment measures.
- Assess timeliness of outbreak detection and response.
- Change public health policy if indicated (e.g. preparedness).
- Write and disseminate outbreak report.

Table 4.3  Risk factors for outbreaks in emergency situations

<table>
<thead>
<tr>
<th>Disease</th>
<th>Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute respiratory infections</td>
<td>Inadequate shelter with poor ventilation</td>
</tr>
<tr>
<td></td>
<td>Indoor cooking, poor health care services</td>
</tr>
<tr>
<td></td>
<td>Malnutrition, overcrowding</td>
</tr>
<tr>
<td></td>
<td>Age group under 1 year old</td>
</tr>
<tr>
<td></td>
<td>Large numbers of elderly</td>
</tr>
<tr>
<td></td>
<td>Cold weather</td>
</tr>
<tr>
<td>Diarrhoal diseases</td>
<td>Overcrowding</td>
</tr>
<tr>
<td></td>
<td>Inadequate quantity and/or quality of water</td>
</tr>
<tr>
<td></td>
<td>Poor personal hygiene</td>
</tr>
<tr>
<td></td>
<td>Poor washing facilities</td>
</tr>
<tr>
<td></td>
<td>Poor sanitation</td>
</tr>
<tr>
<td></td>
<td>Insufficient soap</td>
</tr>
<tr>
<td></td>
<td>Inadequate cooking facilities</td>
</tr>
<tr>
<td>Malaria</td>
<td>Movement of people from endemic into malaria-free zones or from areas of low</td>
</tr>
<tr>
<td></td>
<td>endemcity to hyperendemic areas</td>
</tr>
<tr>
<td></td>
<td>Interruption of vector control measures</td>
</tr>
<tr>
<td></td>
<td>Increased population density promoting mosquito bites</td>
</tr>
<tr>
<td></td>
<td>Stagnant water</td>
</tr>
<tr>
<td></td>
<td>Inadequate health care services</td>
</tr>
<tr>
<td></td>
<td>Flooding</td>
</tr>
<tr>
<td></td>
<td>Changes in weather patterns</td>
</tr>
<tr>
<td>Measles</td>
<td>Measles vaccination coverage rates below 80% in country of origin, overcrowding,</td>
</tr>
<tr>
<td></td>
<td>population displacement</td>
</tr>
<tr>
<td>Meningococcal meningitis</td>
<td>Meningitis belt (although the pattern is changing to include eastern, southern and</td>
</tr>
<tr>
<td></td>
<td>central Africa)</td>
</tr>
<tr>
<td></td>
<td>Dry season</td>
</tr>
<tr>
<td></td>
<td>Dust storms</td>
</tr>
<tr>
<td></td>
<td>Overcrowding</td>
</tr>
<tr>
<td></td>
<td>High rates of acute respiratory infections</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>High HIV seroprevalence rates</td>
</tr>
<tr>
<td></td>
<td>Overcrowding</td>
</tr>
<tr>
<td></td>
<td>Malnutrition</td>
</tr>
<tr>
<td>Viral haemorrhagic fever</td>
<td>Contact with ape carcasses (filoviruses)</td>
</tr>
<tr>
<td></td>
<td>Contact with wild-caught rodents (Lassa fever)</td>
</tr>
<tr>
<td></td>
<td>Tick-infested areas (Crimea-Congo haemorrhagic fever)</td>
</tr>
<tr>
<td></td>
<td>Poor infection control in health-care facilities</td>
</tr>
<tr>
<td>Louse-borne typhus</td>
<td>Highland areas</td>
</tr>
<tr>
<td></td>
<td>Poor washing facilities</td>
</tr>
<tr>
<td></td>
<td>Numerous body lice</td>
</tr>
<tr>
<td></td>
<td>Endemic typhus/cases of Brill-Zinsser disease</td>
</tr>
</tbody>
</table>
Table 4.4  Example of resources needed for outbreak response

- Personnel (trained staff)
- Supplies (e.g. oral rehydration salts, intravenous fluids, water containers, water-purifying tablets, drinking cups, vaccines, vitamin A, monitoring forms, vaccination cards, tally sheets)
- Treatment facilities (location, beds available, stocks of basic medical supplies)
- Laboratory facilities (location, capacity, stocks of reagents, etc.)
- Transport (sources of emergency transport and fuel, cold chain)
- Communication links (between health centres; between Ministry of Health, nongovernmental organizations and United Nations agencies)
- Computers for data analysis
- In an outbreak requiring a vaccination campaign:
  - safe injection equipment (e.g. auto-destructible syringes and safety boxes (puncture-resistant boxes)
  - vaccination facilities (location, capacity)
  - cold chain equipment (number and condition of refrigerators, cold boxes, vaccine carriers, ice-packs)

4.2 Detection

Figure 4.1  Detection of an outbreak

4.2.1 Surveillance

To ensure early detection of an outbreak in an emergency situation, a basic surveillance system with an early warning mechanism agreed by all operational agencies is essential. Reporting forms, case definitions and reporting mechanisms should be developed by the lead health agency at the beginning of
the emergency and consensus reached with all agencies. Clinical workers at the primary and secondary care levels are the key component of this early warning system. They must be trained to report any suspected case of a disease with epidemic potential immediately to the health coordinator, using direct communication and/or the outbreak alert form (Annex 6).

To ensure rapid detection of an outbreak in an emergency situation, it will be necessary:

- to set up an early warning system within the surveillance system, with immediate reporting of diseases with epidemic potential;
- to train clinical workers to recognize priority diseases/syndromes;
- to train clinical workers to report cases of priority diseases/syndromes immediately to the health coordinator;
- for the health coordinator to report to the lead health agency;
- to arrange for enhanced surveillance during high-risk periods and in high-risk areas, e.g. for meningococcal meningitis during the dry season in the meningitis belt.

The analysis of these reports by the health coordinator will allow for the identification of clusters. It is vital that all suspected cases are followed up and verified. In camps established after large population displacements, an immediate response is necessary because of potentially high case attack rates and high mortality rates. Early detection can have a major impact in reducing the numbers of cases and deaths during an outbreak (see Fig. 4.2).

The surveillance system will ideally have detected an outbreak in the early stages. Once an outbreak occurs, investigation will be required to:

- confirm the outbreak,
- identify all cases and contacts,
- detect patterns of epidemic spread,
- estimate potential for further spread,
- determine whether control measures are working effectively.
Figure 4.2  The impact of early detection and response in reducing the disease burden caused by an outbreak in an emergency situation

OCT: Outbreak control team
While routine surveillance depends on passive methods (i.e. the health workers report data weekly or monthly as part of their overall duties), in an outbreak there may be a need for active surveillance, where a member of the outbreak control team (OCT) specifically goes to the health facilities and reviews the records to detect further cases. This is particularly important for highly infectious diseases, such as viral haemorrhagic fever. Active case-finding may also be necessary where a home visitor goes into the community searching for further cases of the disease and refers to the health facility. Each case is then reported to the OCT.

The amount of data needed for each outbreak varies with the disease and the number of cases. In an explosive outbreak with large numbers of cases there will not be time to collect detailed information, so the priority is to collect numbers of cases and deaths on a line listing form. For outbreaks that are smaller in size or that evolve more slowly (such as a meningitis outbreak), a case investigation form should be completed for each case to obtain information such as contacts (see Annex 6).

4.2.2 Epidemic thresholds

The term epidemic threshold refers to the level of disease above which an urgent response is required. The threshold is specific to each disease and depends on the infectiousness, other determinants of transmission and local endemicity levels. For certain diseases, such as cholera or haemorrhagic fever, one case is sufficient to initiate a response. For other diseases, such as malaria, establishing a threshold ideally requires the collection of incidence data over a period of months or years.

However, most epidemic thresholds have been developed for stable populations, because these thresholds require longitudinal data over a period of years. There are few data on the use of these epidemic thresholds in emergency situations with recently displaced populations. Nevertheless, the establishment of a surveillance system early in an emergency situation will ensure that baseline data on diseases with epidemic potential are available. This will allow an assessment of whether an increase in numbers of cases or deaths requires action or not. At the onset of health activities, the health coordination team should set a threshold for each disease of epidemic potential above which an emergency response must be initiated (see Table 4.5).
Table 4.5 Epidemic thresholds

One suspected case of the following diseases represents a potential outbreak and requires immediate investigation:
- cholera
- measles
- typhus
- plague
- yellow fever
- viral haemorrhagic fever

An increase in the number of cases above a given threshold (or in numbers of cases per 1000 population) of the following diseases indicates a potential outbreak and requires immediate investigation:
- malaria
- shigellosis
- visceral leishmaniasis
- meningococcal meningitis
- human African trypanosomiasis
- others (e.g. typhoid fever, hepatitis A)

For areas of Africa where meningococcal disease is highly endemic, generic thresholds have been defined based on weekly surveillance of meningitis. Two thresholds are recommended to guide different sets of activities, depending on the phase of development of an outbreak.²

✔ The alert threshold is used to: (a) sound an early warning and launch an investigation at the start of an outbreak; (b) check epidemic preparedness; (c) start a vaccination campaign if there is an outbreak in a neighbouring area; and (d) prioritize areas for vaccination campaigns in the course of an outbreak. Sample alert thresholds are given in Annex 4.

✔ The epidemic threshold is used to confirm the emergence of an outbreak so as to step up control measures, i.e. mass vaccination and appropriate case management. The epidemic threshold depends on the context, and when the risk of an outbreak is high a lower threshold, more effective in this situation, is recommended (see Table 4.6).

Weekly meningitis incidence is calculated at health district level, for a population ranging from 30 000 to about 100 000 inhabitants. Incidence calculated for a large population (such as a city of more than 300 000 inhabitants) might not reach the threshold, even when the threshold is exceeded in some areas. In order to detect localized outbreaks, the region or city should be divided into areas of approximately 100 000 people for the purpose of calculating incidence.

For populations of less than 30 000, an absolute number of cases is used to define the alert and epidemic thresholds. This is to avoid major fluctuations in incidence owing to the small size of the population, and so as not to declare an outbreak too hastily on the basis of a small number of cases.

Table 4.6 Incidence thresholds for detection and control of epidemic meningococcal meningitis in highly endemic countries in Africa

<table>
<thead>
<tr>
<th>Intervention*</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt; 30 000</td>
</tr>
<tr>
<td>Alert threshold</td>
<td>• Five cases per 100 000 inhabitants per week</td>
</tr>
<tr>
<td>• Inform authorities</td>
<td></td>
</tr>
<tr>
<td>• Investigate</td>
<td></td>
</tr>
<tr>
<td>• Confirm</td>
<td></td>
</tr>
<tr>
<td>• Treat cases</td>
<td></td>
</tr>
<tr>
<td>• Strengthen surveillance</td>
<td></td>
</tr>
<tr>
<td>• Prepare</td>
<td></td>
</tr>
<tr>
<td>Epidemic threshold</td>
<td>If (1) no epidemic for 3 years and vaccination coverage &lt; 80% or (2) alert threshold crossed early in the dry season: • 10 cases per 100 000 inhabitants per week In other situations: • 15 cases per 100 000 inhabitants per week</td>
</tr>
<tr>
<td>• Mass vaccination</td>
<td></td>
</tr>
<tr>
<td>• Distribute treatment to health centres</td>
<td></td>
</tr>
<tr>
<td>• Treat according to epidemic protocol</td>
<td></td>
</tr>
<tr>
<td>• Inform the public</td>
<td></td>
</tr>
</tbody>
</table>

* If there is an epidemic in a neighbouring area, the alert threshold becomes the epidemic threshold.

4.2.3 Outbreak control team (OCT)

Once the surveillance system detects an outbreak, or alerts have been received, the lead health agency must set up an OCT to investigate. Membership will essentially be similar to the health coordination team but may have to be expanded depending on the disease suspected and the control measures required. The OCT should include:

• a health coordinator,
• a clinical worker,
• a laboratory technician,
• a water/sanitation specialist,
• a vector control specialist,
• a representative of the local health authority,
• health educators,
• community leaders.

One member of the team should be the team leader; this is usually the health coordinator of the lead health agency. Each agency should be given a clear role for response to an outbreak, such as the establishment of an isolation centre or the implementation of a mass vaccination programme.
In the event of a suspected outbreak, the OCT must:

- meet daily to review the latest data on suspected cases/deaths and follow up any rumours;
- implement the outbreak response plan (see preparedness section) for the disease covering the resources, skills and activities required;
- identify sources of additional human and material resources for managing the outbreak, e.g. treatment sites in a cholera outbreak;
- define the tasks of each member in managing the outbreak, e.g. surveillance, vaccination;
- ensure the use of standard treatment protocols for the disease by all agencies and train clinical workers if necessary;
- coordinate with the local health authorities, nongovernmental organizations and United Nations agencies.

### 4.3 Confirmation

<table>
<thead>
<tr>
<th>OUTBREAK CONFIRMED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate control measures</td>
</tr>
<tr>
<td>Isolation of cases</td>
</tr>
<tr>
<td>Case management</td>
</tr>
<tr>
<td>Vaccination</td>
</tr>
<tr>
<td>Vector control</td>
</tr>
<tr>
<td>Severe cases with deaths</td>
</tr>
<tr>
<td>Cases still occurring</td>
</tr>
<tr>
<td>Source unknown</td>
</tr>
<tr>
<td>Mode of transmission unknown</td>
</tr>
</tbody>
</table>

**Figure 4.3**  Confirmation of an outbreak
4.3.1 Verification of an outbreak and laboratory confirmation

Reports and alerts of outbreaks are frequent in emergency situations and must always be followed up. It is important to aware that in some languages one word may be used for more than one disease (e.g. in Serbo-Croat and its variants the same word is used for typhus and typhoid). Diagnosis must be confirmed either on a clinical basis by senior clinical workers (e.g. for measles) or by laboratory tests, in which case specimens (e.g. blood, serum, faeces or cerebrospinal fluid) must be sent to a laboratory for testing. Material required for an outbreak investigation is listed in Annex 6.

An assessment of current clinical and epidemiological information is the starting point for dealing with the problem of an outbreak of unknown origin. The historical knowledge of regional endemic and epidemic diseases, as well as their seasonality, further defines the possible causes. Since a variety of infectious agents can cause a similar clinical picture, the initial steps of the outbreak investigation (case definitions, questionnaires, etc.) should generally elaborate on known syndromes (e.g. fever of unknown origin, acute neurological syndrome, acute jaundice) rather than on any preconceived diagnosis. One or more specimen types may be required to define the cause of the outbreak.

Laboratory confirmation of initial cases is necessary for most diseases when an outbreak is suspected. There must be an efficient mechanism for getting the correct samples in good condition from the patient to the laboratory and getting the result back to the OCT and clinical workers. At the onset of health care activities in a camp, the lead health agency must set out the method for sampling, the type of samples to be taken and the tests to be undertaken, and identify the relevant laboratories with complete addresses. The agency must assess the diagnostic capability of the local laboratory, including the availability of rapid diagnostic kits. A reference laboratory must also be identified at regional or international level to test, for example, for the antimicrobial sensitivity of Shigella spp. Table 4.7 outlines the steps in laboratory confirmation.

<table>
<thead>
<tr>
<th>Table 4.7</th>
<th>Steps in laboratory confirmation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection of samples</td>
<td>Sampling equipment, specimen containers, training of clinical workers in sampling techniques</td>
</tr>
<tr>
<td>Transport of samples</td>
<td>On-site/referral laboratory</td>
</tr>
<tr>
<td>Safe packaging</td>
<td>Appropriate leak-proof transport containers</td>
</tr>
<tr>
<td>Testing samples</td>
<td>Quality assurance in laboratory</td>
</tr>
<tr>
<td>Reporting result</td>
<td>When, to whom</td>
</tr>
<tr>
<td>Interpreting result</td>
<td>Implications for control measures</td>
</tr>
</tbody>
</table>
If a certain pathogen, source or mode of transmission is suspected, **control measures should not be delayed** if laboratory confirmation is not yet available. In the absence of laboratory confirmation, epidemiological information should continue to be collected, as this will facilitate the initial control measures.

### Table 4.8 Laboratory specimens required for tests for specific causative agents

<table>
<thead>
<tr>
<th>Suspected disease</th>
<th>Specimen</th>
<th>Diagnostic test</th>
<th>Additional information needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cholera</td>
<td>Fresh stool/rectal swab in transport medium</td>
<td>Culture</td>
<td>Antimicrobial sensitivity testing</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>Serum (+ 4 °C)</td>
<td>Antigen detection</td>
<td></td>
</tr>
<tr>
<td>Malaria</td>
<td>Blood (thick and thin smears)</td>
<td>Staining</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rapid diagnostic tests (for P. falciparum and P. vivax)</td>
<td></td>
</tr>
<tr>
<td>Meningococcal meningitis</td>
<td>CSF&lt;sup&gt;a&lt;/sup&gt;, Blood</td>
<td>Gram stain</td>
<td>Serogrouping</td>
</tr>
<tr>
<td>Shigellosis</td>
<td>Fresh stool/rectal swab in transport medium</td>
<td>Culture</td>
<td>Serogrouping</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rapid diagnostic test</td>
<td>Antimicrobial sensitivity testing</td>
</tr>
<tr>
<td>Typhoid fever</td>
<td>Blood in culture bottles</td>
<td>Culture</td>
<td></td>
</tr>
<tr>
<td>Typhus</td>
<td>Serum (+ 4 °C)</td>
<td>Serology</td>
<td></td>
</tr>
<tr>
<td>Viral haemorrhagic fevers</td>
<td>Blood</td>
<td>Antigen detection</td>
<td></td>
</tr>
</tbody>
</table>

Note: Measles is diagnosed clinically and does not require laboratory confirmation.

<sup>a</sup> CSF: cerebrospinal fluid

#### 4.3.2 Planning for specimen collection

After the clinical syndrome and suspect pathogen(s) have been defined, the clinical specimens for collection and appropriate laboratory diagnosis should be determined (Table 4.8).

In the event of an outbreak, one agency should coordinate the transport of specimens and follow up on the results of laboratory tests. Laboratories with the capacity to test (a) stool samples for Shigella, Salmonella and cholera and (b) CSF samples for meningococci should be identified rapidly. WHO maintains an updated database of international reference laboratories for testing of stool samples for poliovirus, or serum samples for dengue fever, Japanese encephalitis and agents of viral haemorrhagic fevers.
4.3.3 Specimen collection and processing

Specimens obtained in the acute phase of the disease, preferably before administration of antimicrobial drugs, are more likely to yield laboratory identification of the cause. Before specimen collection begins, the procedure should be explained to the patient and his/her relatives. The appropriate precautions for safety during collection and processing of samples must be followed.

Procedures for collection of specific specimens are detailed in Annex 8.

Labelling and identification of specimens

In an outbreak investigation, the information contained in the case investigation and laboratory request forms is collected along with the specimen. Each patient should be assigned a unique identification number by the collection team. It is the link between the laboratory results on the line listing form, the specimens and the patient, which guides further investigation and response to the outbreak. This unique identification number should be present and used as a common reference together with the patient’s name on all specimens, epidemiological databases, and forms for case investigation or laboratory request.

Label specimen container/slide

Labels (at least five) should be used whenever possible. The label should be permanently affixed to the specimen container. It should contain:

• the patient’s name,
• the unique identification number,
• the specimen type and date and place of collection,
• the name or initials of the specimen collector.

Case investigation and laboratory forms

A case investigation form should be completed for each patient at the time of collection. The originals remain with the investigation team, and should be kept together for analysis and later reference. A laboratory form must also be completed for each specimen. The epidemiological and clinical data gathered in the investigation can then easily be tied to the laboratory results for analysis later. The form includes:

• patient information: age (or date of birth), sex, complete address,
• clinical information: date of onset of symptoms, clinical and vaccination history, risk factors, antimicrobials taken before collection of specimens,
• laboratory information: acute or convalescent specimen, other specimens from the same patient.

The form must also record the date and time when the specimen was taken and when it was received by the laboratory, and the name of the person collecting the specimen.
4.3.4 Storage of specimens

To preserve bacterial or viral viability in specimens for microbiological culture or inoculation, specimens should be placed in appropriate media and stored at recommended temperatures. These conditions must be preserved throughout transport to the laboratory and will vary according to transportation time. They will differ for different specimens and pathogens, depending on their sensitivity to desiccation, temperature, nutrient and pH.

Many specimens taken for viral isolation are viable for 2 days if maintained in type-specific media at 4-8 °C. These specimens must be frozen only as directed by expert advice, as infectivity may be altered.

Specimens for bacterial culture should be kept in appropriate transport media at the recommended temperature. This ensures bacterial viability while minimizing overgrowth of other microorganisms. With the exception of cerebrospinal fluid, urine and sputum, most specimens may be kept at ambient temperature if they will be processed within 24 hours. For periods > 24 hours, storage at 4-8 °C is advisable except for particularly cold-sensitive organisms such as *Shigella* spp., meningococcus and pneumococcus. These exceptions must be kept at ambient temperature. Longer delays are not advisable, as the yield of bacteria may fall significantly.

Specimens for antigen or antibody detection may be stored at 4-8 °C for 24-48 hours, or at −20 °C for longer periods. Sera for antibody detection may be stored at 4-8 °C for up to 10 days. Although not ideal, room temperature may still be useful for storing serum samples for antibody testing, even for prolonged periods (weeks). Thus samples that have been collected should not be discarded simply because there are no refrigeration facilities available.

Transport of specimens requires appropriate safety boxes, cold boxes and coolant blocks and may require a suitable cold chain.

4.4 Response

4.4.1 Investigation of source and modes of transmission

The OCT should:

- meet daily to update the team on outbreak developments;
- review the human, logistic (stores, stocks, etc.) and financial resources available to manage the outbreak;
- oversee the investigation of reported cases to assess pathogen, source and transmission;
- ensure that clinical workers report suspected cases to the team immediately;
- ensure that clinical workers are using standard treatment protocols;
• ensure that cases are quantified by time and place;
• produce spot maps and epidemic curves;
• oversee the implementation of control measures.

Collection and analysis of descriptive data and development of hypotheses

The systematic recording of data on cases and deaths (time, place and person) in an outbreak is essential to ensure accurate reporting. These data are necessary to form a hypothesis of the pathogen involved and its source and route of transmission, and to measure the effectiveness of control measures. This process is summarized in the six key questions: Who? What? When? Where? Why? How?

A simple, clear, easily understood case definition must be used consistently from the beginning of an outbreak and must be placed conspicuously at the top of each case reporting form. This case definition, the outbreak case definition, may have to be adapted from the surveillance case definition. The syndromic definitions often used by the surveillance system for early detection may not be sufficiently specific in the event of an outbreak and could lead to an overestimation of cases. In most outbreaks, basic epidemiological data on time, place, person and basic laboratory confirmation are sufficient for the design and implementation of effective control measures.

Cases may be placed in two categories: suspected or confirmed. A suspected case is one in which the clinical signs and symptoms are compatible with the disease in question but laboratory confirmation of infection is lacking (negative or pending). A confirmed case is one in which there is definite laboratory evidence of current or recent infection, whether or not clinical signs or symptoms are or have been present. Once laboratory investigations have confirmed the diagnosis in the initial cases, the use of a clinical/epidemiological case definition may be sufficient and there may be no need to continue to collect laboratory specimens from new cases for the purposes of notification.

During an epidemic, data should be analysed rapidly to determine the extent of the outbreak and the impact of actions taken to date (Fig. 4.4).
The following steps should be taken by members of the outbreak control team in charge of the epidemiological investigation.

- Define the extent of the outbreak in time, place and person:
  - when did the cases occur – dates of onset (e.g. epidemic curve)?
  - where do cases live (e.g. spot map)?
  - who are they (e.g. tables of age, vaccination status)?

- Measure the severity of the outbreak:
  - how many cases were hospitalized?
  - how many cases suffered complications?
  - how many cases died as a proportion of all cases (case-fatality ratio)?

- Draw an epidemic curve, i.e. a graph showing cases by date of onset. This helps to demonstrate where and how an outbreak began, how quickly the disease is spreading, the stage of the outbreak (start, middle or end phase) and whether control efforts are having an impact (Fig. 4.4).

- Draw a graph or table of age distribution and vaccination status of cases; this should be constructed from the line listing of cases. This information is used for identifying cases that were not preventable (e.g. those developing measles before the scheduled age of vaccination). If population data are available, calculate age-specific attack rates.

- If appropriate, estimate the vaccine efficacy. In the case of a vaccine-preventable disease such as measles, vaccine efficacy and the proportion of cases that were vaccine-preventable should be calculated. Using vaccination history data it is possible to tabulate those immunized but not protected (vaccine failures) and those who failed to be immunized.
• Draw a spot map. A map of the camp or community should be marked with the location of all cases and deaths. The outbreak control team can use this map to identify areas with clusters of disease. Further investigation of these areas may reveal the source of infection or modes of transmission. Even when a camp is involved, it is essential that the effect on the local community outside the camp is documented (this may be the source) and the local health authorities assisted in controlling the outbreak if it has spread.

• Provide summary data of the outbreak, by calculating the basic epidemiological indices set out in Table 4.9.

<table>
<thead>
<tr>
<th>Table 4.9 Basic epidemiological indices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The case-fatality ratio (CFR)</strong> is the percentage of cases that result in death</td>
</tr>
<tr>
<td>• Count the number of cases who died of the disease</td>
</tr>
<tr>
<td>• Divide by the total number of cases of the disease</td>
</tr>
<tr>
<td>• Multiply the result by 100</td>
</tr>
<tr>
<td><strong>The weekly attack rate is the number of cases per 10 000 people per week</strong></td>
</tr>
<tr>
<td>• Divide 10 000 by the total emergency-affected population</td>
</tr>
<tr>
<td>• Multiply the result by the number of cases that occurred in a given week</td>
</tr>
<tr>
<td><strong>The age-specific weekly attack rate is the number of cases per 10 000 people in one age group (e.g. &gt; 5 years)</strong></td>
</tr>
<tr>
<td>• Calculate the number of persons in that age group in the camp</td>
</tr>
<tr>
<td>• Count the number of cases in the age group for the chosen week</td>
</tr>
<tr>
<td>• Divide 10 000 by the number of persons</td>
</tr>
<tr>
<td>• Multiply the result by the number of cases in that group</td>
</tr>
</tbody>
</table>

**Follow-up of cases and contacts**

For each case, information should be collected on name, age, location, date of onset and outcome; for some diseases, additional information on vaccination status, water source and duration of disease may be collected.

An alert registry must be established to record alerts of cases systematically. One site should be dedicated to this activity. The registry must have close links to home visitors and the local community and its existence must be widely advertised. It should be carefully maintained and used to provide material for the team.

Active case-finding may be required, depending on the infectiousness of the disease and the risk to the population. Contact-tracing may also be required, particularly in the case of outbreaks of viral haemorrhagic fever. The OCT must define what constitutes a contact, specify the period of risk and agree on the method of follow-up, e.g. active contact-tracing.
Further investigation/epidemiological studies

In some outbreaks, routine data do not give sufficient information about items such as the source of the outbreak, risk factors, local characteristics of the causative agent (e.g. resistance, serotype) or mode of transmission. Further investigation, such as case control studies or environmental assessments (e.g. vector breeding sites), may be required to identify the source of this outbreak, risk factors in respect of severity, or modes of transmission. This may need the participation of external agencies with skills in epidemiological investigation or in specific diseases.

4.4.2 Control

The data gathered in the course of these investigations should reveal why the outbreak occurred and the mechanisms by which it spread. These in turn, together with what is known about the epidemiology and biology of the organism involved, will make it possible to define the measures needed to control the outbreak and prevent further problems.

An outbreak may be controlled by eliminating or reducing the source of infection, interrupting transmission and protecting persons at risk. In the initial stage of an outbreak in an emergency situation, the exact nature of the causative agent may not be known and general control measures may have to be taken for a suspected cause. Once the cause is confirmed, specific measures such as vaccination can be undertaken. These disease-specific measures are detailed in Chapter 5.

Control strategies fall into four major categories of activity.

1. Prevention of exposure: the source of infection is reduced to prevent the disease spreading to other members of the community. Depending on the disease, this may involve prompt diagnosis and treatment of cases using standard protocols (e.g. cholera), isolation and barrier nursing of cases (e.g. viral haemorrhagic fevers), health education, improvements in environmental and personal hygiene (e.g. cholera, typhoid fever, shigellosis, hepatitis A and hepatitis E), control of the animal vector or reservoir (e.g. malaria, dengue, yellow fever, Lassa fever) and proper disposal of sharp instruments (e.g., hepatitis B).

2. Prevention of infection: susceptible groups are protected by vaccination (e.g. meningitis, yellow fever and measles), safe water, adequate shelter and good sanitation.

3. Prevention of disease: high-risk groups are offered chemoprophylaxis (e.g. malaria prophylaxis may be suggested for pregnant women in outbreaks) and better nutrition.

4. Prevention of death: through prompt diagnosis and management of cases, effective health care services (e.g. acute respiratory infections, malaria, bacterial dysentery, cholera, measles, meningitis).
Selection of control measures depends on:
• feasibility (technical/operational),
• availability (stockpiles),
• acceptability,
• safety (of operators and population),
• cost.

**Patient isolation**

The degree of isolation required depends on the infectiousness of the disease. Strict barrier isolation is rarely indicated in health facilities, except for outbreaks of highly infectious diseases such as viral haemorrhagic fevers. The isolation room must be in a building separate from other patient areas and access must be strictly limited. Good ventilation with screened doors is ideal, but fans should be avoided as they raise dust and droplets and can spread aerosols. Biohazard warning notices must be placed at the entrances to patients’ rooms. Patients must remain isolated until they have fully recovered.

During outbreaks, isolation of patients or of those suspected of having the disease can reinforce stigmatization and hostile behaviour of the public toward ill persons. The establishment of isolation rules in a community or in a health facility is not a decision to be taken lightly, and should always be accompanied by careful information and education of all members of the involved community. Every isolated patient should be allowed to be attended by at least one family member. Provided that enough supplies are available, designated family attendants should receive barrier nursing equipment, and be instructed on how to protect themselves when in contact with the patient.

Every outbreak requires a response specific to the disease. Control measures for the main communicable diseases encountered by displaced populations are described under disease-specific sections in Chapter 5.

**Biohazardous materials**

Safe disposal of body fluids and excreta is essential, especially in the case of highly contagious diseases. This may be achieved by disinfecting with bleach or by incineration. If contaminated material has to be transported, it should be placed in a double bag.

The threat of infection from body fluids of patients with diseases such as cholera, shigellosis or viral haemorrhagic fevers is serious, and strict procedures for disposal of hazardous waste must be maintained. Laboratory specimens and contaminated equipment should also be carefully sterilized or disposed of. When possible, heating methods such as autoclaving, incineration or boiling can be used to disinfect. Proper disposal of sharp objects such as needles is essential.

Table 3.10 outlines the general precautions to be taken in relation to isolation of cases. See Section 2.3.6 for procedures for the disposal of the dead.
### Table 3.10 General precautions to be taken for isolation of cases in outbreaks

<table>
<thead>
<tr>
<th>Isolation measure</th>
<th>Contagiousness of cases</th>
<th>Route of transmission</th>
<th>Type of protective measure</th>
<th>Diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard precautions</td>
<td>Moderate</td>
<td>Direct or indirect contact with faeces, urine, blood, body fluids and contaminated articles</td>
<td>Hand-washing, safe disposal of contaminated articles</td>
<td>Most infectious diseases except those mentioned below</td>
</tr>
<tr>
<td>Enteric isolation</td>
<td>High</td>
<td>Direct contact with patients and with faeces and oral secretions</td>
<td>Contact precautions</td>
<td>Cholera, shigellosis, typhoid fever, Gastroenteritis caused by rotavirus, E. coli, hepatitis A</td>
</tr>
<tr>
<td>Respiratory isolation</td>
<td>High</td>
<td>Direct contact with patients or oral secretions and droplets</td>
<td>Separate room, masks, contact precautions</td>
<td>Meningococcal meningitis, diphtheria, measles</td>
</tr>
<tr>
<td>Strict isolation</td>
<td>Very high</td>
<td>Airborne Direct contact with infected bloods, secretions, organs or semen</td>
<td>Separate room, biohazard notification</td>
<td>Viral haemorrhagic fevers</td>
</tr>
</tbody>
</table>

### Prompt diagnosis and effective case management

There are two steps in this process: timely presentation to the health facility and effective diagnosis and treatment by the clinical workers. Home visitors and health educators can play an important role in ensuring that the community is aware of the symptoms and signs of a disease, and that they know that effective treatment is available at the health facility. The second step is the use of standard treatment protocols by clinical workers well trained in their use. The early diagnosis of a disease is important, not only to avoid serious sequelae and death in the patient but also to prevent further transmission.
4.5 Evaluation

After an outbreak, the outbreak control team must carry out a thorough evaluation of the following:

- cause of the outbreak,
- surveillance and detection of the outbreak,
- preparedness for the outbreak,
- management of the outbreak,
- control measures.

The specific issues under each heading that should be evaluated include:

- timeliness of detection and response,
- effectiveness,
- cost,
- lost opportunities,
- new/revised policies.

The findings of this evaluation should be documented in a written report containing clear recommendations on:

- the epidemiological characteristics of the epidemic,
- surveillance,
- preparedness,
- control measures carried out.

Evaluation should feed back into preparedness activities for future outbreaks.
4.5.1. Further reading


