Chapter 18
Surveillance and Control of Communicable Disease in Conflicts and Disasters

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Abstract

- To describe the principles of health surveillance in conflict and disaster situations
- To assist in organising a health surveillance system in conflict and disaster situations
- To describe the principles of control of communicable diseases in conflict and disaster situations
- To assist in organising a response to outbreaks and epidemics
- To introduce the challenges associated with health surveillance and communicable diseases in conflict and disaster situations

Keywords Health surveillance • Control • Communicable diseases • Conflict and catastrophe • Treatment • Prevention

Objectives

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- To assist in organising a health surveillance system in conflict and disaster situations
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- To assist in organising a response to outbreaks and epidemics
- To introduce the challenges associated with health surveillance and communicable diseases in conflict and disaster situations

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Introduction

Conflicts and Disasters

The number of conflicts recorded throughout the world has declined since the end of the Cold War, but at least eight active conflicts causing more than 1,000 fatalities/year were known to be occurring in the early part of 2012, together with much larger numbers of smaller scale conflicts, terrorist activities, etc. During the same period the numbers of recorded natural disasters and the totals affected increased dramatically from about 100 per year in 1980 to over 400 in 2011. (This may partly be due to improved communications but also is likely to have been a result of the increase in world population forcing larger numbers to live in areas at risk from such disasters.)

Conflicts, Disasters and Disease

Complex emergencies (involving conflict, large-scale population displacement with many persons on the move, in camps or with host families and food shortages) and natural disasters frequently result in damage to or destruction of large parts of the infrastructures of societies (health care, water and sanitation, food supply) that normally contribute to the health of the population.

Communicable disease outbreaks and epidemics are not inevitable in these situations. Serious epidemics are comparatively rare after rapid-onset natural disasters (possibly because of active control measures by health authorities or aid agencies), but there is a greater risk of epidemics during and after complex emergencies because health care is usually severely curtailed. In most wars more people die from illness than trauma. (e.g. it has been estimated that more than 80 % of the ca. 300,000 deaths that occurred in Darfur in the years 2004–2008 were due to disease.)

Conflicts and disasters often lead to population displacement and the displaced are especially at risk from disease. The numbers involved are very large. By the end of 2011, the total population of forcibly displaced persons was estimated by the UNHCR at ca. 43.7 million people including 15.4 million refugees and asylum seekers and 27.5 million IDPs displaced by conflict (IDMC). Displacement due to natural disasters in 2010 was estimated by the Internal Displacement Monitoring Centre (IDMC) to have exceeded 42 million. Amongst the displaced, certain risk groups are especially vulnerable notably:

- Children (especially <5 years and unaccompanied)
- Women (especially pregnant women and nursing mothers)
- Elderly people
- Disabled people

Women and children account for more than 75 % of the refugees and displaced persons at risk from war, famine and natural disaster. Ca25 % of this population are women of reproductive age of whom one in five is likely to be pregnant.

Limiting the numbers of those affected by disasters or conflicts who are affected by disease and preventing disease outbreaks (or at least limiting their effects) fall on those responsible for the health care of the population affected by the emergency. They need to be able to:

- Assess the health status of the population affected and identify the main health priorities.
- Plan and implement programmes based on the assessment, including:
  - Activities designed to prevent disease including provision of basic health care, mother and child health programmes, shelter, food, water and sanitation
  - Managing cases of disease that do occur with prompt and accurate diagnosis and effective treatment
- Monitor the progress of health interventions and their impact and modify them if required.
- Monitor the development and determine the severity of any health emergency that develops (including monitoring the incidence of and case fatality rates from diseases, receiving early warning of epidemics and monitoring responses).
- Identify and take action to prevent or control outbreaks and epidemics.
- Ensure the provision of appropriate aid (and prevent inappropriate aid).
- Provide information for relevant agencies (e.g. national Ministry of Health (MOH), UN, NGOs, donors) for use in planning, funding applications, reporting to international bodies under the provisions of the International Health Regulations, etc.

Rapid assessment has been dealt with elsewhere in this book as have the treatment of cases of infection and of injury and the preventive aspects of disease control (adequate shelter, clean water, sanitation and food together with basic individual health care). This chapter therefore covers surveillance, outbreak/epidemic control and public health aspects of disease prevention and management. The topics are dealt with in general terms. More details can be found in the references.

At first sight undertaking public health activities in emergencies, especially in conflicts, may seem to be difficult or impossible. The destructive nature of warfare may prevent or inhibit the provision of adequate food and shelter, of clean water and sanitation and of vaccination programmes. Natural disasters can cause infrastructure damage that prevents access, damages communications system, contaminates water supplies and damages dwellings. However, despite these difficulties, especially those imposed by warfare, it is generally possible to undertake at least limited public health programmes including disease surveillance and control activities.

In natural disasters, public health activities may be expected to be less affected by the security situation than in a war (aid workers may be at risk if populations are severely deprived of resources such as food, shelter, water or cash), although with limited access and damage to communication systems and other parts of the infrastructure, assessment, surveillance and control activities can be severely restricted. For example, following the Pakistan earthquake late in 2005 access was severely restricted for some time and the urgent need to treat the injured and provide food and shelter meant that the limited transport available was heavily committed.

Health Surveillance

Features

The surveillance and control of communicable disease require data which can be collected in one of three ways:

1. *Surveillance systems* – covering all or at least a significant proportion of the population
2. *Surveys* – in which data are collected from a small sample of the affected population considered to be representative of the whole
3. *Outbreak investigations* – in-depth investigations designed to identify the cause of deaths or diseases and identify control measures

Whilst the latter two can provide valuable information for disease control and form part of the surveillance process, proper control of disease requires regular monitoring of the overall disease situation which in turn requires the establishment of a properly designed health surveillance system.

It is important therefore that responsibility for surveillance activities is defined at the beginning of planning for an aid mission. Generally speaking teams responding to disasters will need a team leader (often an aid agency health co-ordinator), who should ideally have surveillance experience and clinical workers together with the appropriate administrative, logistic, IT and communications support. In addition specialists in other skills such as water, sanitation and hygiene (WASH) or laboratory diagnostics may be needed. As soon as possible after arrival in an area, the team should seek contact with, and if possible include, representatives of the local health services and communities.

The World Health Organisation defines health surveillance as "The ongoing systematic collection, analysis and interpretation of data in order to plan, implement and evaluate public health interventions". Data for surveillance must be accurate, timely, relevant, representative and easily analysed, and the results must be disseminated in a timely manner to all who need to receive them. In addition the data collected, the methods used for collection and the output must be acceptable to those surveyed (health-care professionals and the population).

In acute emergencies the time that can be given to surveillance by medical personnel is likely to be limited and surveillance activities will be far from the minds of most of those involved. Therefore, the methods used need to be rapid, practical and consistent, and whilst the greatest possible accuracy must be achieved, "the best must not be the enemy of the good". It is necessary to strike a balance between collecting large amounts of information ("what we would like to know") and collecting too little which can lead to an ineffective response. Those responsible for establishing surveillance programmes must therefore try to determine what is really needed ("what we need to know"). However, it is better to err on the side of too much than of too little!

Ideally any existing surveillance system should be used. There is no point in establishing a system if one already exists, unless the existing one is inadequate or inappropriate or has broken down irretrievably.

Table 18.1 Criteria for surveillance systems

	Criterion
1	As simple and flexible as possible
2	Appropriate in terms of the information required
3	Capable of providing such information in a timely manner
4	Appropriate in terms of the resources available
5	Sustainable in the long term within local resources
6	Based on standardised sampling methods
7	Based on agreed case definitions
8	Capable of providing regular information from defined sites
9	Capable of covering the whole affected area
10	Compatible with existing systems
11	Use existing systems as far as possible
12	Use existing records as far as possible
13	Involve collaboration between agencies so as to avoid duplication
14	Involve collaboration with local services so as to avoid duplication
15	Acceptable to those surveyed

Surveillance systems for use in conflict and disaster situations should therefore adhere as far as possible to the criteria given in Table 18.1.

Notes on these criteria:

1. *As simple and flexible as possible*.
   Complexity and inflexibility are incompatible with surveillance systems generally and particularly when operating in emergencies where collection of data may be difficult and where situations can change very fast.
2. *Appropriate in terms of the information required*.
   Defining what you "need to know" will allow you to set up the appropriate data collection methods (questionnaires, sites, etc.) to design the system so that it can obtain and handle the information required.
3. *Capable of providing such information in a timely manner*.
   Information that is accurate but out of date is useless for immediate disease control purposes and of little value for immediate forward planning. Effective communications therefore form an integral part of any surveillance system.
4. *Appropriate in terms of the resources available*.
   Do not try to overreach when setting up a system. For example, expatriate staff may best be used to recruit local staff for the system and in supervisory activities rather than in collecting data.
5. *Sustainable in the long term within local resources*.
   This criterion is certainly a goal to aim for as sustainability must be the target for all aid work. However, there may be situations where an emergency system is needed rapidly and where it cannot readily be integrated into existing systems or be developed as a new long-term system.
6. *Based on standardised sampling methods*.
   The sampling system must use the same data collection methods throughout if data are to be comparable. Ideally this should be methods that are internationally

agreed and approved. Agreement should be sought for the methods from the other agencies on the ground to ensure consistency.

7. *Based on agreed case definitions*.
   Without case definitions that are agreed by all parties, the likelihood of success of a surveillance system is very low. This is especially so when laboratory support is minimal or absent since clinical case definitions have to be drawn very tightly if different diseases are not to be confused.
8. *Capable of providing regular information from defined sites*.
   Routine surveillance requires more than material from ad hoc sources. Sites such as medical centres (in towns, villages or camps for displaced persons), hospitals and/or public health units should be recruited.
9. *Capable of covering the whole affected area*.
   The more comprehensive is the coverage of the system, the more likely is it that the data will be accurate and complete and that problems will not be missed. Such coverage can be problematic. The coverage of the different systems that can be used is discussed in the following points.
10. *Compatible with existing systems*.
    The data that is collected and the methods used should ideally fit in with systems that are operating or have previously operated in the area.
11. *Use existing systems as far as possible*.
    Following from criterion 10, if systems are already in existence or in abeyance but revivable, then this should be done (rather than set up an entirely new system) so as to improve the likelihood that local health-care services will be willing to be involved in the system you are proposing and also ensure continuity of data collection and analysis.
12. *Use existing records as far as possible*.
    Existing records are of considerable value for predictive purposes. Knowledge of past problems makes it possible to anticipate future problems and trends and allows for early planning decisions.
13. *Involve collaboration between agencies so as to avoid duplication*.
    If several health agencies are operating, it is essential to ensure collaboration between them in surveillance activities to avoid confusion and duplication of effort.
14. *Involve collaboration with local services so as to avoid duplication*.
    As previously noted, early involvement of local health and surveillance services will reduce workloads and avoid duplication of effort.
15. *Acceptable to those surveyed*.
    If those from whom the data is collected, those who are collecting the data and those who will receive the results are unhappy with the system, the system is unlikely to operate effectively.

These criteria can be used to evaluate a plan for a surveillance system and also, with some additions, to evaluate an existing system. However, failure to fulfil all these criteria need not rule out a system. In many emergencies it can be difficult to meet such a wide range of “best case” criteria and the question that must be

asked is whether the proposed system is capable of fulfilling its purpose – *can it provide sufficiently accurate essential information to those who need it when they need it*?

The emphasis of an emergency surveillance programme may need to be altered as the situation changes especially if a particular item emerges as being of key importance. Those running the surveillance programme should use the data gathered and a continuous assessment of the general running of the system to alter the programme as required (preferably after consultation with relevant stakeholders).

Designing Health Surveillance Systems

When designing health surveillance systems it is essential to:

- Define the population under surveillance
- Determine what type of system can be established
- Set surveillance priorities
- Identify sources of data
- Set up agreed case definitions
- Establish data handling systems
- Establish a protocol for evaluating the surveillance system as a whole

Next, we examine each of these in more detail.

Population Under Surveillance

The population under surveillance may be relatively small and well defined (such as the population of a camp for displaced persons) or in a much less defined group such as mobile groups of refugees or IDPs or the population of a village, town or region, the size of whose population may be unknown or may be fluctuating due to a disaster. In many countries (particularly those that are less developed, where disasters are especially common), population data are very inaccurate. Often censuses have not been held for many years, or if they have their results are suspect. Even camps for the displaced may present a challenge as, whilst the size of the population may appear to be (or actually be) stable, its make-up may vary over time due to movements in and out. If the age or sex make-up of the camp alters, the pattern of disease may also alter. Establishment of denominators may therefore be difficult.

Demography: Numbers vs. Rates

Both the number of cases detected and the rate of factors such as morbidity or mortality per unit of population are important values needed to inform emergency programmes.

Those responsible for all aspects of health care need to know what numbers of cases are involved so as to ensure adequate provision of services (amounts of medicines, numbers of hospital beds, etc.). However, simple numbers are of little value in assessing trends and patterns since increases or decreases in numbers of cases (or numbers of deaths) may reflect changes in population size (e.g. resulting from population displacement) rather than a trend due to, for example, a particular disease. In addition several rates (such as the crude mortality rate) are key indicators in defining health emergencies (discussion to follow).

Knowing the demography of the affected population is therefore important, and all agencies working in an emergency should agree on and use the same population figures.

The essential demographic data needed include:

- Total population size
- Population structure
  - Overall sex ratio and the sex ratio in defined age groups.
  - Population under 5 years old, with age breakdown (0–4 years) – this group has special needs and is usually a key factor in planning the emergency response.
  - Age pyramid.
  - Ethnic composition and place of origin.
  - Number of vulnerable persons (e.g. pregnant and lactating women, members of female-headed households, unaccompanied children, destitute elderly, disabled and wounded persons).
- Average family/household size
- In situations where populations are displaced and extensive population movements may be occurring, it is also necessary to know:
- The number of arrivals and departures per week
- The predicted number of future arrivals at the sampling sites

At the outset it is therefore important to establish methods to obtain demographic data. Often the best that can be managed initially is a rough estimate, but this can usually be refined later. It is helpful to use several methods and crosscheck the figures to obtain the best estimate. Surrogates of the whole population (such as those attending a clinic) may be the best that can be achieved early on.

The ease with which such data can be obtained usually depends on the size and scale of the population under consideration. The demography of a well-run refugee camp is comparatively easy to obtain, but that of a larger area may be much more difficult. A lack of knowledge of the size of a displaced group can be compounded by a lack of knowledge of the size of the resident population. In many countries with poor infrastructures, accurate census data are not available. In some instances tax records may be helpful if these can be obtained. It should be noted that demographic data, especially if it involves refugees and IDPs, can be politically sensitive and interested parties may place undue weight on any figures that are given.

Types of Surveillance System

Comprehensive Systems

Ideally, communicable disease surveillance should be nationwide (or at least "affected area wide"), drawing information from a range of health-care centres that cover a sufficient proportion of the population to ensure that the great majority of cases (ideally all) of the relevant conditions are reported. A surveillance system in a refugee or IDP camp is effectively a miniature comprehensive system as it is (at least theoretically) possible to cover the whole population.

Sentinel Surveillance Systems

There are situations where comprehensive surveillance is not possible and these often arise in disasters. Difficulties of access (due to damage or fighting), damaged or non-existent communications and staff shortages frequently mean that only limited numbers of reporting sites (sentinel sites) can be used. As far as possible these should be chosen to ensure a wide coverage of the area and also to maximise the proportion of the population that is covered. Sentinel surveillance systems are inherently less satisfactory than comprehensive systems largely because they provide a much less complete coverage. The calculation of rates can sometimes be difficult or impossible, such systems can be very labour intensive, and important events may be missed.

Both types of system may rely on notification of cases based solely on clinical evidence (and this is the most likely situation in conflicts and natural disasters at least in the early stages) or may include laboratory verification of some or (preferably) all diagnoses. If there is more than one centre involved in establishing the diagnosis (e.g. a clinical department, a hospital laboratory and a reference laboratory), the channels of reporting must be very carefully set up so as to avoid duplicate reporting.

Setting Surveillance Priorities

Surveillance must provide information on key health indicators which should include:

- Morbidity
- Mortality
- Nutritional status
- Immunisation status
- Vital needs
- Health sector activities including local health services
- Activities in related sectors

The selection of information sought in these categories must be done carefully. It is neither possible nor desirable to monitor everything, especially in the early stages of a disaster response. At that stage (the acute phase), the priority of surveillance is

the detection of factors that can have the greatest and most rapid effect on the population. In terms of communicable disease, this means diseases that affect large numbers of people and have epidemic potential. In most instances this also means diseases for which effective rapid control measures exist. Whilst gathering data on other large-scale disease problems should not be excluded (otherwise outbreaks may be missed), the main surveillance and control efforts should be aimed where they can do the most immediate good.

In the very early stages, only clinical information may be available since laboratory diagnostic services will probably be damaged or simply unavailable. However, this need not be a problem if the medical response is also geared to a syndromic approach. As the situation stabilises, laboratory support becomes available and longer-term control measures can be supported, the surveillance can become more refined and additional diseases (e.g. those which can cause severe morbidity and mortality in the longer term – such as tuberculosis, HIV/AIDS and STIs) can be added to the list.

Mortality

Simple changes in numbers of deaths may reflect changes in population size, and it is important to determine rates because mortality rate is an important surveillance indicator in an emergency. Often the first indication that a problem is developing is an increase in death rate especially in particular vulnerable groups. All deaths occurring in the community must therefore be recorded.

The following indicators can provide the essential information to define the health situation in a population:

- *Crude mortality rate* (*CMR*) is the most important indicator as it indicates the severity of the problem, and changes in CMR show how a medical emergency is developing. CMR is usually expressed as number of deaths per 10,000 persons per day. If the CMR rises above 1/10,000/day (>2/10,000/day for young children), an acute emergency is developing and the emergency phase lasts until the daily CMR falls to 1/10,000/day or below.
- *Age-specific mortality rate* (number of deaths in individuals of a specific age due to a specific cause/defined number of individuals of that age/day). In children this is usually given as the number of deaths in children under and over 5 years old/1,000 children of each age/day. NB: If population data for the under 5 s is not available, an estimate of 17 % of the total population may be used.
- *Maternal mortality rate*. Maternal mortality is a sensitive indicator of the effectiveness of health-care systems. A *maternal death* is usually defined as the death of a woman whilst pregnant or within 42 days of the termination of the pregnancy (for whatever cause) from any cause related to or aggravated by the pregnancy or its management. The 42 days cut-off is recommended by WHO, but some authorities use a time of up to a year.

  Maternal mortality rate = (number of deaths from puerperal causes in a specified area in a year /number of live births in the area during the same year) × 1,000 (or × 100, 000).

- *Cause-specific death rates* (*case fatality rates*). Proportion of cases of a specified condition which are fatal within a specified time. Case fatality rate = (no. of deaths from given disease in a given period/no. of diagnosed cases of that disease in the same period) × 100.

Morbidity

The three main morbidity figures that are routinely sought are:

- *Incidence*. The number of new cases of a particular disease reported over a defined period. (NB: *Incidence rate* is the number of new cases of a particular disease reported over a defined period per unit of population.)
- *Prevalence*. The total number of cases of a particular disease recorded in a population at a given time (also called "point prevalence") (NB: *Prevalence* "*rate*" is the number of cases of a disease at a particular time/population at risk.)
- *Attack rate* (*used in outbreaks*). The cumulative incidence of cases in a group observed over a particular period.

There are a number of ways of estimating morbidity. Health information systems based on health centre attendance are the most common but are passive and rely on who presents to the services. Other ways of gathering morbidity data include:

- *Surveys* – in which data are collected from a small sample of the emergency-affected population deemed to be representative of the whole (or from a particular group for a specific purpose)
- *Outbreak investigations* – which entail in-depth investigations designed to identify the cause of deaths or diseases and identify control measures

Nutritional Status

The following indicators must be measured:

- Prevalence of global acute malnutrition (includes moderate and severe malnutrition) in children 6–59 months of age (or 60–110 cm in height) (% of children with weight for height under two standard deviations below the median value in a reference population and/or oedema)
- Prevalence of severe acute malnutrition in children 6–59 months of age (or 60–110 cm in height) (% of children with weight for height under three standard deviations below the median value in a reference population and/or oedema)
- Prevalence of micronutrient deficiencies
- Estimate number of children needing to be cared for in selective feeding programmes (SFP)
- Estimate number of additional calories per day provided by SFP

Immunisation

Immunisation programmes are a vital part of the public health measures undertaken following disasters. For example, measles vaccination is one of the most important health activities in such situations. The need for campaigns may be assessed on the basis of national vaccination records if they exist. In the absence of such records, questioning of mothers may provide the information required, or children or their parents may have written vaccination histories with them (rare). If in doubt, children should be vaccinated, especially against measles.

The effectiveness of the programmes undertaken can be assessed in defined populations by recording the percentage of children vaccinated. In less well-defined populations, an assessment of coverage may be made using the numbers of children attending clinics as a surrogate for the population as a whole.

Health Service Activities

Indicators such as numbers of consultations/day, numbers of vaccinations, number of admissions to hospitals and numbers of children in feeding programmes are typically reported. Other factors such as effectiveness of the supply chain, maintenance of the cold chain and laboratory activities may also be surveyed.

Activities in Related Sectors

Depending on the circumstances, it may be necessary to monitor activities in related sectors such as water and sanitation; food, shelter and security may also be included as they are essential to maintain a healthy population and prevent communicable diseases.

Sources of Data

The major sources of health data will be hospitals and clinics (both national and those established by aid agencies), individual medical practitioners and other health-care workers. Specialised agencies should be able to provide data on particular needs (e.g. food, water, sanitation and shelter).

Case Definitions

Case definitions are an essential part of surveillance. If the diseases (or syndromes) that are to be covered by the system are not clearly defined, or if the definitions are not adhered to, the results become meaningless – changes from week to week are as likely to be due to changes of definition as to real changes in numbers of cases. This

Table 18.2 Types of cases

Type of case	Criteria
Suspected case	Clinical signs and symptoms compatible with the disease in question, but no laboratory evidence of infection (not available, negative or pending)
Probable case	Clinical signs and symptoms compatible with the disease in question and also epidemiological evidence (e.g. contact with a known case) or some laboratory evidence (e.g. the results of a screening test) for the relevant disease
Confirmed case	Definite laboratory evidence of current or recent infection, *whether or not* clinical signs or symptoms are or have been present

is especially important when laboratory confirmation is not possible. It is therefore important that all agencies working in an emergency agree to and use the same case definitions so that there is consistency in reporting.

Case definitions must be prepared for each health event/disease/syndrome. If available, the case definitions used by the host country's MOH should be used to ensure continuity of data. Several different sets of case definitions already exist, either in generalised form (e.g. those produced by the Centers for Disease Control in Atlanta) or sets prepared for specific emergencies (e.g. WHO usually prepares a "toolkit" for different crises covering the disease situation in the country(s) affected). Standard case definitions may have to be adapted according to the local situation. It should be noted that such case definitions are designed for the purposes of surveillance, not for use in the management of patients, nor are they an indication of intention to treat the patients.

When case definitions based purely on clinical observations are used, each case can only be reported as suspected, not confirmed (Table 18.2).

Although lacking precision, such definitions can make it possible to establish the occurrence of an outbreak. Samples can subsequently be sent to a referral laboratory for confirmation. Once samples have been examined and the causative organism identified, a more specific case definition can be developed to detect further cases.

Establish Data Handling Systems

The following issues should be considered:

- Methods of recording and transferring data
- Methods of verifying data
- Frequency of reporting
- Who will analyse the data and how often
- Methods for disseminating results

Recording and Transferring Data

Visits to surveillance sites and discussions with staff involved will help define the recording and data transmission systems required. The advances in information

technology (IT) that have been made in recent years have greatly facilitated the collection, recording, transmission and analysis of surveillance data, but care must be taken that the systems put in place are workable. In areas where electricity supplies are problematical and communications poor, it may be better to use a paper recording system and verbal data transmission by radio than a computerised system (or at least maintain a paper based backup).

Verification

Data verification is essential for the credibility of a surveillance system. Those responsible for surveillance systems must ensure good adherence to case definitions if a symptom-based system is in operation and that laboratory quality control systems operate where appropriate. Regular assessments of record keeping and the accuracy of data transfer are required. Triangulation of results from several sources can sometimes help to detect anomalies.

Frequency of Reporting

Frequency of reporting will usually depend on the severity of the health situation. In general daily reporting during the acute phase of an emergency will be needed, although in an acute medical emergency (such as a severe cholera outbreak) even more frequent reporting may be necessary, especially if the situation is fluctuating rapidly. The frequency may reduce to (say) weekly as the situation resolves.

Data Analysis

Who is to analyse the data and how it is to be analysed must be established at the outset. In a relatively defined area such as a camp, a data analysis session may be the last of the daily activities of the person responsible for surveillance. If record keeping and analysis protocols have been carefully worked out initially, this task need not be a large additional burden. Surveillance systems that cover larger areas and bigger and more diffuse populations usually rely on a central data collection point where designated staff analyse the data. Use of such a system requires good data transmission systems.

Output of Surveillance Systems

Output is as important as input. Collecting data without dissemination of results is a sterile exercise and tends rapidly to demotivate those involved. There are some important points to consider:

- The results of surveillance must be presented in a readily comprehensible form.
- Surveillance reports should be produced regularly and widely distributed to aid agencies and to national and international governments and organisations. This will help those involved to understand the overall picture, rather than just that in the area where they are working, and will allow them to take informed decisions about future actions.
- Translators may be needed if different languages are involved.

Evaluation of Surveillance Systems

Surveillance systems should be evaluated constantly to ensure that they are working properly, that the data are representative, that analyses are appropriate and accurate and that results are being disseminated to where they are needed.

Control of Communicable Disease

Introduction

The public health aspects of communicable disease control can be broadly divided into preventive activities (such as vector control and vaccination programmes) and the investigation and control of outbreaks and epidemics. (Treatment strategies are needed both to serve the individual patient and also to reduce the risks of transmission of disease. These are dealt with elsewhere in this book.)

Experience from many emergencies and disasters has made it possible to identify a number of syndromes or diseases that are most likely to occur in such situations (Table 18.3). This makes it possible to plan activities and interventions on the basis of likely occurrences, even before those involved are present at the scene of the disaster, and to make initial purchases and establish stockpiles of appropriate medicines and equipment.

Table 18.3 Syndromes or diseases that occur commonly in disasters

Bloody diarrhoea	Suspected meningitis
Acute watery diarrhoea	Acute jaundice syndrome
Suspected cholera	Acute haemorrhagic fever syndrome
Lower respiratory tract infection	Trauma/injury
Measles	Malnutrition
Acute flaccid paralysis (AFP)	

A few others, such as malaria and other vector-borne diseases (e.g. typhus, plague and Leishmaniasis), are also likely to occur but are region specific. TB and HIV/AIDS can also cause major problems in the longer term

Prevention

"Prevention is better than cure", and proper attention to preventive measures from the earliest stage of the response to the disaster will greatly reduce the risks to the health of the population from infectious disease.

Public Health Education

Public health education and information activities play a vital role in disease prevention. For example, vaccination programmes will not work unless there is acceptance by the public of the necessity for such programmes. Individuals must be informed as to why these programmes are necessary and also where and when they need to take their children for vaccination.

Such activities are also essential to inform people about particular health programmes (e.g. feeding programmes or vector control programmes) and about the steps they can take to protect their health and that of their families (e.g. good hygiene). Information can be propagated in numbers of ways:

- Posters
- Radio/TV/film
- Lectures
- Songs/poems/drama, etc.
- Leaflets

Staff who are trained in this type of activity therefore play a key role in disease prevention. Social anthropologists and social communicators can help ensure that the messages are appropriate and acceptable to the target population.

Heath education also requires transport and equipment (such as video or film projectors, screens, generators, blackboards).

Provision of Appropriate Physical Conditions

Key activities for preventing the transmission of communicable disease and helping people to resist infection include the provision of shelter, adequate amounts of clean water, sufficient safe food and proper sanitation (latrines and facilities for personal hygiene, clothes washing and drying).

Control of Disease Vectors and Pests

Arthropod vectors of disease (mosquitoes, ticks, flies, etc.) can be controlled by appropriate spraying programmes and also by habitat management (e.g. the removal of places where water can accumulate and mosquitoes breed) and the proper disposal of waste. Provision of bed nets, particularly nets impregnated with insecticide, is effective for reducing infection with agents such as malaria and *Leishmania*.

In areas where mosquitoes are important vectors of disease, individuals need to be made aware of the need to cover themselves properly, especially in the evenings and at night, so as to reduce the risks of being bitten, and also of the value of insect repellents.

Control of rodents by proper control of rubbish, by rodent-proofing food stores, by attention to domestic hygiene and by use of rodenticides will reduce the risks of transmission of rodent-borne diseases such as plague and Lassa fever.

Cutting down vegetation around buildings will also help to reduce rodent infestation (they do not like to move around without cover) and will also reduce the risk of snakes entering dwellings.

Disposal of Rubbish

Accumulations of domestic rubbish should be cleared from around buildings and either burned or buried. If rubbish is buried, it needs to be covered with at least 0.5 m of earth to prevent it being dug up by scavengers and to prevent certain types of insect from reaching it for use as a breeding site. Any middens for rubbish disposal should be sited well away from dwelling areas.

Disposal of Contaminated Materials

Medical waste includes laboratory samples, needles and syringes, body tissues and materials stained with body fluids. This requires careful handling, especially the sharps, as infectious agents such as those causing hepatitis B and C, HIV/AIDS and viral haemorrhagic fevers can be transmitted by these materials. Used sharps should be disposed of into suitable containers. (Proper sharps boxes are ideal, but old metal containers such as coffee or milk powder tins are adequate.)

Medical waste (including sharps) should ideally be burned in an incinerator. This should be close to the clinic or hospital but downwind of the prevailing wind. A 200 l oil drum can be used for this purpose with a metal grate halfway up and a hole at the bottom to allow in air and for the removal of ash. Larger scale and more permanent incinerators can be constructed if necessary. Burning pits can be used in emergency. If burning is not possible, items should be buried at least 1.5 m deep. This is more suitable than burning for large items of human tissue such as amputated legs. Ensure there is no risk of groundwater contamination.

Dealing with the Dead

This is a complex process involving not just considerations of infection risk but also legal, sociocultural and psychosocial factors. There are a number of specialist publications which can be of help.

Health Aspects

After almost every natural disaster, fear of disease has encouraged authorities rapidly to dispose of the bodies of the dead, often without identifying them, and this sometimes seems almost to take precedence over dealing with the living. However, in sudden impact disasters (such as the Haitian earthquake in 2010), the pattern and incidence of disease found in the dead will generally reflect that in the living. The situation is much the same in wars and other long drawn out disasters, although these may affect disease patterns and create vulnerable groups.

In fact dead bodies pose little risk to health (with some exceptions listed next) since few pathogenic microorganisms survive long after the death of their host. The diseased living are far more dangerous as organisms can multiply in them and be transmitted to others. The decay of cadavers is due mainly to organisms they already contain and these are not pathogenic.

Those most at risk are those handling the deceased, not the community. The most likely risks to them are:

- Blood-borne viruses (hepatitis B and C, HIV)
- Some enteric pathogens (especially cholera)
- Respiratory pathogens (e.g. TB)
- Spore-forming bacteria (anthrax, tetanus)
- Some vector-borne diseases (plague, typhus) because the vectors may be present on the cadaver
- Acute haemorrhagic fevers (Ebola, Marburg, Lassa)

Those handling cadavers should:

- Observe universal precautions for blood and body fluids
- Dispose of or disinfect used gloves
- Avoid contamination of personal items
- Wash hands after handling bodies and before eating
- Have hepatitis B vaccination
- Ensure disinfection of vehicles and equipment

Mortuary facilities may need to be provided where the dead can be preserved until they are identified and appropriate legal proceedings have been undertaken and where relatives may easily attend to identify and claim the deceased. Cold stores and refrigerated vehicles can be employed as temporary mass mortuary facilities. Alternatively such facilities can be provided in buildings, huts or tented structures, but refrigeration will be needed.

The dead must always be treated with dignity and respect. As far as possible the appropriate customs of the local population or the group to which the deceased belonged should be observed. This may not be possible. For example, in a situation where cremation is the normal disposal method, shortages of fuel may prevent the use of this method.

If the dead have to be buried in mass graves, then the layout of the cemetery must be carefully mapped to facilitate exhumation if needed. When an individual may

have died of a particularly dangerous infection, then a body bag should be used (and also for damaged cadavers). In general bodies should be buried rather than cremated as exhumation for purposes of identification, for other forensic reasons or for repatriation may have to be undertaken at a later date. Bodies should be buried at least 1.5 m deep or, if more shallowly, should have earth piled at least 1 m above the ground level and 0.5 m to each side of the grave (to prevent access by scavengers and burrowing insects). New burial sites should be at least 250 m from drinking water sources and at least 0.7 m above the saturated zone.

Chloride of lime is frequently used as a disinfectant when dealing with the dead, especially when dealing with extensive numbers of cadavers trapped under rubble. This should be avoided. It is of little use (except possibly partially to mask odours) and is dangerous to those using it.

Vaccination Programmes

Vaccination programmes are an essential part of disease prevention. Information about existing vaccination programmes must be obtained during the assessment process, and this should include information from external assessors (e.g. WHO, UNICEF, NGOs) as to the effectiveness of the vaccination programmes that have been undertaken in the past. It cannot be assumed that simply because children have received vaccines that these vaccines were effective. Information about vaccine supplies and the existing cold chain should also be obtained.

Vaccination Priorities in Emergencies

Measles kills large numbers of children in developing countries and is one of the greatest causes of morbidity and mortality in children in refugee and IDP camps. Mass vaccination of children between the ages of 6 months and 15 years should be an absolute priority during the first week of activity in humanitarian situations and should be accompanied by the distribution of vitamin A. Either monovalent measles vaccine or MMR vaccine can be used.

If there is good evidence that the children involved have received a full course of vaccination against this disease, then vaccination may not be necessary, but if there is any doubt, a vaccination programme should be undertaken.

A system for maintaining measles immunisation must be established once the target population has been covered adequately in the initial campaign. This is necessary to ensure that children who may have been missed in the original campaign, children reaching the age of 6 months and children first vaccinated at the age of 6–9 months who must receive a second dose at 9 months of age are all covered.

Some of the children vaccinated during such a mass campaign may have been vaccinated before. This does not matter and a second dose will have no adverse effect. It is essential to ensure full coverage against measles in the population. Other EPI vaccinations for children are not generally included in the emergency phase

because they can only prevent a minor proportion of the overall morbidity and mortality at that stage. However, should specific outbreaks occur then the appropriate vaccine should be considered as a control measure. For example, polio has caused outbreaks in refugee settings.

Vaccination programmes require:

- Appropriate types of vaccines.
- Appropriate amounts of these vaccines.
- Equipment (needles, syringes, sterilisation equipment, sharps disposal). Emergency immunisation kits, including cold chain equipment, are available from a number of sources including UNICEF and some NGOs (e.g. MSF).
- Logistics (transport, cold chain).
- Staff: a vaccination team may be quite large. It will need to include:

A supervisor.
Logistics staff.
Staff to prepare and administer vaccines.
Record keepers.
Security staff (to maintain order and control crowds) may also be needed.

The Cold Chain

Maintenance of the cold chain is particularly important. This is the system of transporting and storing vaccines within a suitable temperature range from the point of manufacture to the point of administration. The effectiveness of vaccines can be reduced or lost if they are allowed to get too cold, too hot or are exposed to direct sunlight or fluorescent light. Careful note should be taken of the conditions needed to transport different vaccines because these can vary.

The essential cold chain equipment needed to transport and store vaccines within a consistent safe temperature range includes:

- Dedicated refrigerators for storing vaccines and freezers for ice packs at the correct temperatures. (Domestic fridges and freezers are not generally suitable for this purpose.) Note that fridges and freezers powered by gas or kerosene are available as alternatives to electric machines, and solar-powered fridge/freezer combinations specially designed for vaccine storage are also available.
- A suitable thermometer and a chart for recording daily temperature readings.
- Cold boxes for transporting and storing vaccines.
- Cold packs to keep vaccines cool.
- Insulating material to separate cold packs from the vaccines when in the cold boxes (e.g. bubble wrap or expanded polystyrene foam).

If possible, vaccines should be stored in their original packaging because removing the packaging exposes them to room temperature and light. Check the temperature to ensure the vaccines have not been exposed to temperatures outside the normal storage ranges for those vaccines (Table 18.4).

Table 18.4 WHO recommended storage conditions for different vaccines

Vaccine	Primary	Region	District/health centre
OPV	−15 to −25 °C	−15 to −25 °C	+2 to +8 °C
Freeze-dried vaccines (BCG, measles, MMR,MR, yellow fever, Hib freeze dried, meningococcal A and C)	+2 to +8 °C	+2 to +8 °C	+2 to +8 °C
Other vaccines (HepB, DTP-HepB, Hib liquid, DTP, DT, TT, Td/IPV)	+2 to +8 °C	+2 to +8 °C	+2 to +8 °C

Max storage time at the different levels
Primary 6 months, *region* 3 months, *district* 1 month, *health centre* 1 month, *health post* daily use – max 1 month
Diluents must never be frozen. Freeze-dried vaccines supplied packed with diluent must be stored at +2 to +8 °C. Diluents supplied separately should be kept at +2 to +8 °C

Vaccine Storage

Vaccines must be kept at the correct temperature since all are sensitive to heat and cold to some extent. All freeze-dried vaccines become much more heat-sensitive after they have been reconstituted. Vaccines sensitive to cold will lose potency if exposed to temperatures lower than optimal for their storage, particularly if they are frozen. Some vaccines (BCG, measles, MR, MMR and rubella vaccines) are also sensitive to strong light and must always be protected against sunlight or fluorescent (neon) light. These vaccines are usually supplied in dark brown glass vials, which give them some protection against light damage, but they must still be covered and protected from strong light at all times.

Only vaccine stocks which are fit for use should be kept in the vaccine cold chain. Expired or heat/cold damaged vials should be removed from cold storage. If unusable vaccines need to be kept for a period before disposal (e.g. until completion of accounting or auditing procedures), they should be kept outside the cold chain, separated from all usable stocks and carefully labelled to avoid mistaken use.

Diluents

Diluents for vaccines are less sensitive to storage temperatures than the vaccines with which they are used (although they must be kept cool), but may be kept in the cold chain between +2 and +8 °C if space permits. However, diluent vials must never be frozen (kept in a freezer or in contact with any frozen surface) as the vial may crack and become contaminated.

When vaccines are reconstituted, the diluent should be at same temperature as the vaccine, so sufficient diluent for daily needs should be kept in the cold chain at the point of vaccine use (health centre or vaccination post). At other levels of the cold chain (central, provincial or district stores), it is only necessary to keep any diluent in the cold chain if it is planned to use it within the next 24 h.

Freeze-dried vaccines and their diluents should always be distributed together in matching quantities. Whilst the diluents do not need to be kept in the cold chain (unless needed for reconstituting vaccines within the next 24 h), they must travel with the vaccine at all times and must always be of the correct type and from the same manufacturer as the vaccine which they are accompanying. Each vaccine requires a specific diluent and therefore diluents are not interchangeable (e.g. diluent made for measles vaccine must not be used for reconstituting BCG, yellow fever or any other type of vaccine). Likewise, diluent made by one manufacturer for use with a certain vaccine cannot be used for reconstituting the same type of vaccine produced by another manufacturer.

Some combination vaccines comprise a freeze-dried component (such as Hib) which is designed to be reconstituted by a liquid vaccine (such as DTP or DTP-HepB liquid vaccine) instead of a normal diluent. For such combination vaccines, it is again vital that only vaccines manufactured and licenced for this purpose are combined. Note also that for combination vaccines where the diluent is itself a vaccine, all components must now be kept in the cold chain between +2 and +8 °C at all times. As for all other freeze-dried vaccines, it is also essential that the "diluent" travels with the vaccine at all times.

Effectiveness of Vaccination Programmes

The effectiveness of a vaccination programme will need to be assessed. The programme can be evaluated both by routinely collected data and, if necessary, by a survey of vaccination coverage.

Routine data on coverage is obtained by comparing the numbers vaccinated with the estimated size of the target population (and clearly depends on accurate assessment of the latter). A coverage survey requires the use of a statistical technique called a two-stage cluster survey details of which can be found in the appropriate WHO/EPI documents.

Information about the effectiveness of the campaign should be obtained from routine surveillance of communicable disease. If, for example, large numbers of measles cases continue to occur, or there is an outbreak, then data on coverage should be re-examined. If this is shown to be good (over 90 %) then the efficacy of the vaccine must be suspected. If the field efficacy is below the theoretical value 85 % (for measles vaccine – data on efficacy of other vaccines can be obtained on line), then possible causes of a breakdown in the vaccination programme must be investigated (failure of the cold chain, poorly respected vaccination schedule). Methods for measuring vaccine efficacy can be found in the WHO/EPI literature.

Chemoprophylaxis

Mass chemoprophylaxis for bacterial infections such as cholera and meningitis is not usually recommended except on a small scale (e.g. the use of rifampicin may be

considered to prevent the spread of meningococcal meningitis amongst immediate contacts of a case), but the difficulties of overseeing such activities and the risks of the development of antibiotic resistance generally outweigh any benefits that might be gained. The use of chemoprophylaxis for malaria must be undertaken with care. It may be indicated for vulnerable groups of refugees/IDPs (e.g. children and pregnant women) arriving in an endemic area particularly if they come from a non-malarious area, but care must be taken to provide drugs to which the local strains of malaria are sensitive. The spread of resistance means that many of the standard drugs are ineffective and the replacements are both costly and may have unwanted side effects.

Treatment

Details of the treatment of individuals for various infectious diseases and the facilities needed are covered elsewhere in this book and in many textbooks covering disasters and disease response. In terms of the population aspects of the treatment of disease, important requirements are to ensure that there are:

- Adequate supplies of appropriate antimicrobial agents available and the facilities to transport these, store and distribute them under appropriate conditions (e.g. controlled temperature) together with relevant instruction for use
- Appropriate laboratories (microbiological, parasitological, haematological, biochemical) available to confirm diagnoses and monitor treatment

(Details of the use of laboratories and the storage and transport of specimens are given elsewhere in this book.)

Antimicrobials

Treatment of disease requires good supplies of appropriate antimicrobial agents. It is important to ensure that the agents chosen are suitable for use in the area and are licenced for use in the country(s) involved. It is common for doctors in affected areas to ask for the latest therapeutic agents. However, these agents, whilst effective, are often expensive and not part of the normal treatment programmes in the region. The local doctors may not therefore be familiar with the use of these agents nor may laboratories be capable of monitoring their use. It is better to use funds, which are often limited, to supply larger amounts of older (generic) agents. One caveat is the possibility that regular use may have allowed resistance to certain agents to develop in a country. Data on this may be available from local surveillance records. Antimicrobials should always be supplied with relevant guidelines in a language that can be understood locally. If local laboratories are unable to test microbes for resistance to antimicrobials, isolates or specimens should be sent as soon as possible to appropriate national or international reference laboratories for testing.

Response to Outbreaks and Epidemics

Features

Outbreaks of communicable disease may occur before preventive measures can take effect or because the measures are in some way inadequate or fail. An epidemic is generally defined as the occurrence in a population or region of a number of cases of a given disease in excess of normal expectancy. An outbreak is an epidemic limited to a small area (a town, village or camp).

The term *alert threshold* is used to define the point at which the possibility of an epidemic or outbreak needs to be considered and preparedness checked. The areas where vaccination campaigns are a priority need to be identified and campaigns started.

The term *epidemic* (*outbreak*) *threshold* is used to define the point at which an urgent response is required. This will vary depending upon the disease involved (infectiousness, local endemicity, transmission mechanisms) and can be as low as a single case.

Infections where a single case represents a potential outbreak include:

- Cholera
- Some viral haemorrhagic fevers (Ebola, Marburg)
- Yellow fever
- Measles
- Plague
- Typhus

Infections where the threshold is set higher, usually based on long-term collection of data, and will vary from location to location, include:

- Shigellosis
- Typhoid
- Hepatitis A
- Malaria
- Meningococcal meningitis
- Human African trypanosomiasis
- Visceral Leishmaniasis

A surveillance system that is functioning well should pick up the signs that an outbreak or epidemic is developing and should therefore allow time for measures to be introduced that will prevent or limit the scale of the event. However, this may not always work and it is essential therefore that plans are made to combat outbreaks or epidemics. This planning process can be aided by reference to any available information about prevalent diseases that have epidemic potential that are known to occur in the area in question. Equally, there is a great deal of literature about the types of epidemics and outbreaks that have accompanied disasters in the past and which are therefore potential causes of problems.

In addition to the establishment of surveillance, outbreak preparation involves:

- Preparing an epidemic/outbreak response plan for different diseases covering the resources needed and the types of staff and their skills that may be needed and defining specific control measures.
- Ensuring that standard treatment protocols are available to all health facilities and health workers and that staff are properly trained.
- Stockpiling essential supplies. This includes supplies for treatment, for taking and shipping samples, other items to restock existing health facilities and the means to provide emergency health facilities if required.
- Identifying appropriate laboratories to confirm cases and support patient management, make arrangements for these laboratories to accept and test specimens in an emergency and set up a system to ship specimens to the laboratory.
- Identifying emergency sources of vaccines for vaccine preventable diseases and make arrangements for emergency purchase and shipment. Ensure that vaccination supplies (needles, syringes, etc.) are adequate. Make sure the cold chain can be maintained.
- Identifying sources for other supplies including antimicrobials and make arrangements for emergency purchase and shipment.

Confirmation of the Outbreak

If the number of reported cases is rising, is this in excess of the expected number? Ideally work with rates rather than numbers (see earlier discussion) because, for example, the numbers of cases in a refugee camp could increase if the number of people in the camp increases, without an outbreak occurring. Verify the diagnosis (laboratory confirmation) and search for links between cases (time person and place). Laboratory confirmation requires the collection of appropriate specimens and their transport to an appropriate laboratory.

Outbreak Control Team

In the case of a limited outbreak a local control team should be set up. This is frequently done by the lead agency, generally in consultation with the MOH and with membership from other relevant organisations including WHO, other UN organisations and NGOs. In the case of an epidemic, the MOH will probably take the lead or may ask WHO or another UN agency to do so. The team will need to include a co-ordinator, and specialists from the various disciplines needed to control the outbreak. This may include clinical and other health workers, laboratory staff, water and sanitation, vector control and health education specialists, representatives of the MOH or other local health authorities, representatives of local utilities (e.g. water supply), representatives of the police and/or military and representatives of the local community.

This team should meet at least once a day to review the situation and define the necessary responses. It has additional responsibilities including implementing the response plan, overseeing the daily activities of the responders, ensuring that treatment protocols are followed, identifying resources (both material and human) to manage the outbreak and obtaining these as necessary and co-ordinating with local, national and international authorities as required. The team should also act as the point of contact for the media. A media liaison officer should be appointed and all media contact should be through this individual. This will allow team members to refer media representatives to a central point and reduce interference with their activities. It will also ensure that a consistent message based on the most complete data is given to the media.

Information

The appropriate national authorities should be informed of the outbreak. In addition to their responsibilities to their own population and to any refugees within their borders, they have a responsibility under the Revised International Health Regulations (2005) to report outbreaks of certain diseases. These include four diseases regarded as public health emergencies of international concern:

- Smallpox
- Polio (wild type)
- New strains of human influenza
- Severe acute respiratory syndrome (SARS)

In some cases, Member States must report outbreaks of additional diseases: cholera, pneumonic plague, yellow fever, viral haemorrhagic fever, West Nile fever and other diseases that are of special national or regional concern (e.g. dengue fever, Rift Valley fever and meningococcal disease).

Investigation

Once the diagnosis has been confirmed and the causative organism identified, then there are a number of steps that must be taken in addition to continuing to treat those affected:

- Produce a case definition for the outbreak. This is primarily a surveillance tool that will reduce the inclusion of cases that are not part of the outbreak and prevent dilution of the focus and activities of the main control effort.
- Collect and analyse descriptive data by time, person and place (time and date of onset, individual characteristics of those affected – age, sex, occupation, etc., location of cases). Plot maps of case distribution (can locate source(s) of an outbreak and determine spread) and plot outbreak curves (which will help estimate of how the outbreak is evolving).

- Determine the population that is at risk.
- Determine the number of cases and the size of the affected population. Calculate the attack rate.
- Formulate hypotheses for the pathogen about the possible source and routes of transmission.
- Conduct detailed epidemiological investigations to identify modes of transmission, vectors/carriers and risk factors.
- Analyse data, report results and make recommendations for action.

Outbreak Investigations

The two main statistical tools used to investigate outbreaks are:

- *Case–control studies* in which the frequency of an attribute of the disease in individuals with the disease is compared to the same attribute in individuals without the disease who are matched to the cases in terms of age, sex and location (the control group)
- *Cohort studies* in which the frequency of attributes of a disease is compared in members of a group (e.g. those using a particular feeding centre) who do or do not show symptoms

However, the design and methods involved in such studies are often too complex and demanding of staff and of time for the environment of conflict and disaster.

Control Activities

- Implement prevention and control measures specific to the disease organism (e.g. clean water, personal hygiene for diarrhoeal disease).
- Prevent infection (e.g. by vaccination programmes).
- Prevent exposure (e.g. isolate cases or at the least provide a special treatment ward or wards).
- Treat cases.

Evaluation

- Evaluate the outbreak detection and response – were they appropriate, timely and effective?
- Change/modify policies and preparedness to deal with future outbreaks if required.
- What activities are needed to prevent similar outbreaks in the future (e.g. improved vaccination programmes, new water treatment facilities, public health education)?

- Produce and disseminate an outbreak report. The report should include details of the outbreak including:
  - Cause
  - Duration, location and persons involved
  - Cumulative attack rate (number of cases/exposed population)
  - Incidence rate
  - Case fatality rate
  - Vaccine efficacy (if relevant) (number of unvaccinated ill – number of vaccinated ill/number of unvaccinated ill)
  - Proportion of vaccine preventable cases (no. of vaccine preventable cases/no of cases)
  - Recommendations

Epi Info™ 7

This is an easy-to-use tool, available for Microsoft Windows, which is of great value for handling epidemiological data and for organising study designs and results, which can be downloaded free of charge from the Internet. It is produced by the Centers for Disease Control (Atlanta) and is a series of computer programmes which can be used both for surveillance and for outbreak investigation . The statistical tests available include t-tests, ANOVA, nonparametric statistics, cross tabulations and stratification with estimates of odds ratios, risk ratios, and risk differences, logistic regression (conditional and unconditional) and survival analysis (Kaplan Meier and Cox proportional hazard). The software is in the public domain and can be downloaded free from http://www.cdc.gov/epiinfo. (Earlier versions of the software, suitable for older computers, are also available on line.)

Further Reading

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