Module on best practices for measles surveillance

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Contents

Glossary

Measles control: reduction of measles morbidity and mortality in accordance with targets; continued intervention measures are required to maintain the reduction.

Measles elimination: the situation in a large geographical area in which endemic transmission of measles has stopped and sustained transmission does not occur following the occurrence of an imported case; continued intervention measures are required.

Measles eradication: interruption of measles transmission worldwide as a result of deliberate efforts; intervention methods may no longer be needed. Eradication represents the sum of successful elimination efforts in all countries.

Outbreak: the number of cases observed is greater than the number normally expected in a given geographical area during the same period of time. The definition of an "outbreak" will vary according to the country and its phase of control.

Health care facility: a potential reporting site. Examples: hospital, private clinic with a single health care provider, pharmacy, or a public health clinic whose duties are preventive and curative. In health care facilities that provide preventive services the duties may include surveillance activities such as investigating, analysing and responding, in addition to detection and reporting

Introduction

Measles is a highly infectious disease that causes mortality in both developing and industrialized countries. It is estimated that in 1998 about 30 million people contracted measles and that 875 000 of them died. Measles vaccine provides long-term immunity against the disease. Adequately chosen and implemented vaccination strategies not only reduce mortality and morbidity but also interrupt the transmission of indigenous measles virus.

The WHO/UNICEF *Measles Mortality Reduction and Regional Elimination Strategic Plan, 2001-2005* outlines the following strategies for reducing measles mortality:

· providing the first dose of measles vaccine to successive cohorts of infants;

· ensuring that all children have a second opportunity for measles vaccination;

· enhancing measles surveillance with integration of epidemiological and laboratory information;

· improving the management of every measles case.

The objective of this document is to provide guidelines to public health workers at all levels on the best measles surveillance practices.

The organism, the disease and the vaccine

The organism

Measles is an acute illness caused by a virus of the genus *Morbillivirus*, a member of the paramyxovirus family.

Transmission

Measles is one of the most infectious diseases. The virus can be transmitted in the air, in respiratory droplets, or by direct contact with the nasal and throat secretions of infected persons. Individuals with measles are considered to be infectious as from two to four days before the onset of rash until four days after the latter stage.

Clinical features

After an incubation period that usually lasts for 10-12 days but ranges from 7 to 18 days, prodromal symptoms of fever, malaise, cough, coryza (runny nose) and conjunctivitis (pink eye) appear in non-immune persons exposed to the virus. Koplik spots may occur on the buccal mucosa shortly before the onset of rash and for about 1-3 days subsequently. However, the absence of Koplik spots does not rule measles out. Within 2-4 days after the prodromal symptoms begin, a rash of large blotchy red spots, called a maculopapular rash, appears behind the ears and on the face. At this stage a high fever develops, the temperature possibly reaching 40.6 °C (105 °F). The rash spreads to the trunk and extremities, typically lasts for 3-7 days, and may be followed by a fine desquamation. A non-productive cough is present throughout the febrile period, lasting for 1-2 weeks in uncomplicated cases.

Complications from measles include otitis media, pneumonia, diarrhoea, blindness and encephalitis. In developed countries the case-fatality rate for measles tends to be low, between 0.1 and 1.0 per 1000 cases. In developing countries the overall case-fatality rate has been estimated to be between 3% and 6%. The highest case-fatality rate occurs in infants under 12 months of age, among whom it reaches between 20% and 30%. Malnutrition and infection with human immunodeficiency virus are risk factors for complications and mortality.

Immunity

Natural infection produces lifelong immunity. Asymptomatic, IgM-positive persons have not been found to be infectious.

Measles vaccine

Many live, further attenuated measles virus vaccines are in use. Most of them were derived from the Edmonston strain. Measles antibodies develop in approximately 85% of children vaccinated at 9 months of age, 95% of children vaccinated at 12 months of age, and 98% of those vaccinated at 15 months of age. In consideration of the age at infection and the case-fatality ratio, WHO recommends vaccination at 9 months of age in countries at the mortality reduction stage. Measles vaccine provides lifelong immunity in most people. A response is given to a second dose by a high proportion of vaccinated persons who lack detectable antibody.

Goals and strategies for global measles mortality reduction and regional elimination

In 1989 the World Health Assembly defined a specific goal for measles control: "reduction in measles incidence of 90% from preimmunization levels by 1995". In 1990 the World Summit for Children endorsed the following goal: "reduction by 95% in measles deaths and reduction by 90% of measles cases compared to preimmunization levels by 1995, as a major step to global eradication of measles in the longer run". The World Summit for Children also set a target of 90% coverage with measles vaccine and other vaccines used in the Expanded Programme on Immunization by 2000. Furthermore, targets for the regional elimination of measles have been established in the Region of the Americas, the European Region and the Eastern Mediterranean Region by 2000, 2007 and 2010 respectively.

The 2001-2005 global strategic plan seeks to reduce measles mortality worldwide. Its goals are:

· to halve the annual number of deaths by 2005 relative to 1999 estimates;

· to achieve and maintain the interruption of indigenous transmission in large geographical areas with established elimination goals (including elimination in the Region of the Americas by 2000 and progress towards elimination in the European Region by 2007 and the Eastern Mediterranean Region by 2010);

· to convene a global consultation in 2005, in collaboration with other major partners, in order to review progress and assess the feasibility of global eradication.

As mentioned in the Introduction, four strategies are recommended for reducing mortality attributable to measles and achieving the elimination of the disease:

· providing the first dose of measles vaccine to successive cohorts of infants;

· ensuring that all children have a second opportunity for measles vaccination;

· enhancing measles surveillance with integration of epidemiological and laboratory information;

· improving the management of every measles case.

In addition, with a view to reducing overall childhood mortality, vitamin A supplementation should be provided through immunization services.

Measles surveillance objectives

Surveillance objectives

Surveillance is ongoing systematic collection, analysis, and interpretation of outcome-specific data for use in planning, implementation, and evaluation of public health practice. Disease surveillance is a critical component of measles control and elimination efforts and is used in the assessment of progress and in making adjustments to programmes as required.

Surveillance data are essential for:

- describing the characteristics of measles cases in order to understand the reasons for the occurrence of the disease and develop appropriate control measures;

- predicting potential outbreaks and implementing vaccination strategies in order to prevent outbreaks;

- monitoring progress towards achieving disease control and elimination goals;

- providing evidence that, in countries with low measles incidence, the absence of reported cases is attributable to the absence of disease rather than to inadequate detection and reporting.

Surveillance and its objectives should evolve according to the stage of measles control.

The principal uses of data for decision-making are as follows.

At the mortality reduction stage:

- monitoring incidence and coverage in order to assess progress (i.e. decreasing incidence and increasing coverage);

- identifying areas at high risk or with poor programme performance;

- describing the changing epidemiology of measles in terms of age, immunization status and the intervals between epidemics.

At the low incidence or elimination stage:

· identifying high-risk populations;

· determining when the next outbreak may occur because of a build-up of susceptible persons, and accelerating activities beforehand;

· determining where measles virus is circulating or may circulate (i.e. high-risk areas);

· assessing the performance of the surveillance system (e.g. reaction time for notification, specimen collection) in the detection of virus circulation or potential importation;

· using performance indicators to identify areas where it is necessary to strengthen surveillance.

At both stages:

· detecting and investigating outbreaks so as to ensure proper case management, and determining why outbreaks have occurred (e.g. failure to vaccinate, vaccine failure, accumulation of susceptible persons).

In general, surveillance lags behind vaccination efforts in most programmes for the control of vaccine-preventable diseases. Effective vaccination strategies can quickly reduce disease incidence, whereas establishing a surveillance system takes time and changing surveillance practices is difficult. Countries should therefore develop and follow long-term measles control strategies providing a surveillance system that can respond to changes in the incidence of the disease.

In the interest of improving vaccination systems that aim to control and eliminate measles it is also vital to monitor the cold chain and immunization safety, including injection safety and adverse events following immunization. However, the present document deals exclusively with disease surveillance.

Monitoring the accumulation of susceptible persons

The aim of a vaccination programme is to reduce the number of susceptibles and to ensure that low levels of susceptibility are maintained thereafter. The susceptibility profile describes the distribution of susceptibility to measles within a population. It will vary by age and by population sub-group (e.g., ethnic or social group). Before a new vaccination programme is launched the age specific susceptibility profile should be established. In particular, vaccination campaigns can only be targeted effectively if the distribution of susceptible individuals in the population is known.

There are 3 methods to assess the susceptibility profile of a population, availability of surveillance data is important for the last two methods:

· **Serological surveys.** The most direct way to estimate the susceptibility profile is through an age stratified serological survey, interpreting samples negative for measles IgG antibody as susceptible to measles.

- **Alternative methods using vaccine coverage and incidence data.** For a healthcare system with limited resources other methods of estimating the susceptibility profile can be used. These rely upon routine vaccine coverage and case notification data. In populations with little exposure to natural infection, the proportion susceptible can be estimated from age-specific data on vaccination status (proportions who have received no dose, one dose only, and two doses) and vaccination effectiveness.

- **Mathematical models.** Mathematical models simulate measles transmission in a population and those simulations can be used to determine the susceptibility profile.

Further information is given in the WHO document "Measles reduction and regional elimination. Principles for measles control and elimination" (in press).

Operationalizing surveillance

The functions of measles surveillance are:

· detecting and reporting cases and outbreaks;

· collecting, consolidating and interpreting data;

· investigating and confirming cases and outbreaks;

· analysing, producing routine reports and interpreting data;

· feeding data forward to more central levels;

· providing feedback to more peripheral levels.

In these guidelines the enhanced surveillance that is needed and recommended only in countries at the elimination stage is provided in a separate section at the end of this chapter.

Figure 1: Measles surveillance flow-chart
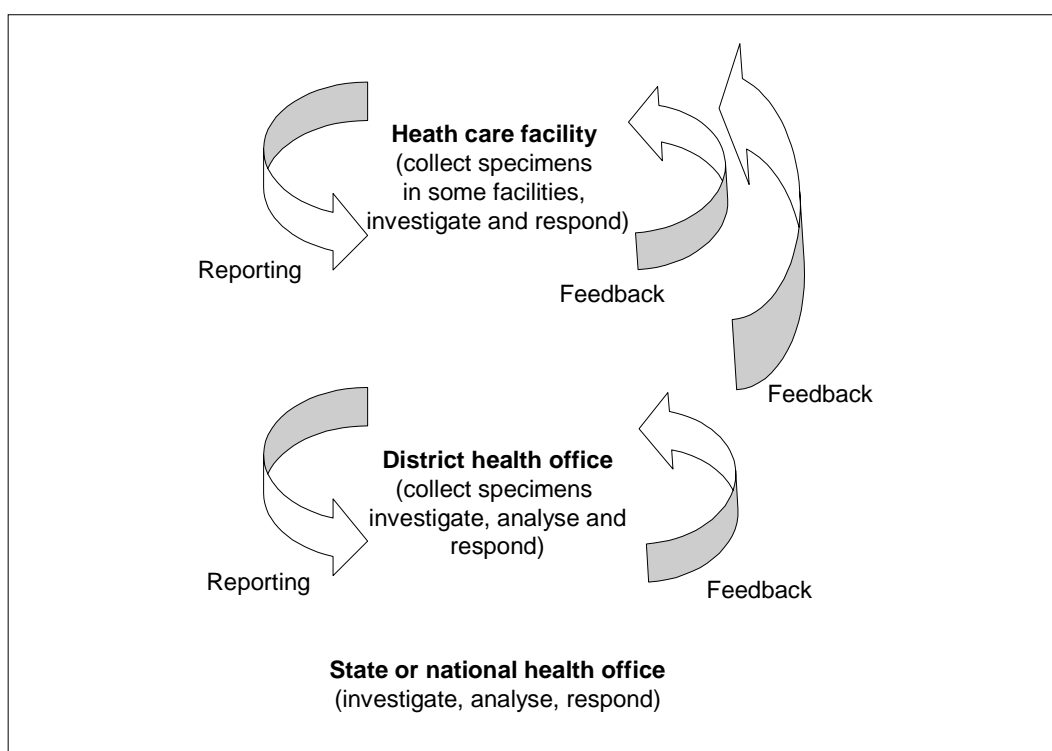
Measles surveillance systems should:

- provide the information needed to direct the vaccination system;
- avoid collecting unnecessary information;
- be sustainable;
- allow decisions and responses to be made at the most peripheral level;
- be part of an integrated disease surveillance system.

Detecting and reporting

Who detects and reports?

Suggested reporting sites are:

1. Hospitals: inpatient and outpatient clinics.
2. Health centres/units/clinics.

It is important that **private medical practitioners and private hospitals** be included in the system, as they may be the first to see suspected measles cases.

As the incidence of measles decreases, community sources play an important role in the detection and reporting of cases because the small number of persons affected may not seek health care. These community sources may include pharmacists, traditional healers, village leaders, school personnel, and so on. In countries where laboratory testing is common, laboratories can be important reporting sites.

Every health facility should designate one person and one or two stand-ins to monitor suspected measles cases and report on them. The mechanisms for reporting should be simple and efficient; if they are not, busy clinicians may not submit reports.

Where to report?

Reports should be submitted to district or provincial surveillance coordinators. In return, district or provincial staff should promptly report to the state or national surveillance staff.

What to report?

The use of a sensitive and specific measles case definition is recommended at every level so as to standardize reporting and avoid underreporting or reporting non-measles cases as measles cases. WHO recommends the following clinical and laboratory case definitions of measles.

Clinical case definition

Any person in whom a clinician suspects measles infection **or**

any person with fever **and** maculopapular rash (i.e. non-vesicular) **and** cough, coryza (i.e. runny nose) or conjunctivitis (i.e. red eyes).

Laboratory criteria for diagnosis

Presence of measles-specific IgM antibodies.

Case classification:

Countries are advised to use the clinical classification until their programme meets the following two criteria:

· low levels of measles incidence has been achieved, and

· there is access to a proficient measles laboratory.

Laboratory and epidemiological confirmation are the best criteria for those countries in the low incidence or elimination phase.

Clinical classification:

Clinically confirmed:	A case that meets the clinical case definition.
Discarded:	A suspect case that does not meet the clinical case definition.

*Laboratory classification**

Laboratory confirmed:	A case that meets the clinical case definition and is laboratory confirmed.
Epidemiologically confirmed:	A case that meets the clinical case definition and is linked epidemiologically to a laboratory confirmed case.
Clinically confirmed:	A case that meets the clinical case definition and for which no adequate blood specimen was taken.
Discarded	A suspect case that does not meet the clinical or laboratory definition.

* Laboratory classification may also be used for outbreak investigations.

Figure 2: Laboratory classification of measles cases using the laboratory scheme

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*   While IgM ELISA tests are more sensitive between days 4 and 28 after the onset of rash, a single serum sample obtained at the first contact with the health care system within 28 days after onset is considered adequate for measles surveillance.

** If the case has been vaccinated within 6 weeks prior to serum collection, refer to the *Manual for the laboratory diagnosis of measles virus infection, December 1999* (WHO/V&B/00.16). If an active search in the community does not find evidence of measles transmission and there is no history of travelling to areas where measles virus is known to be circulating then the case should be discarded.

The following data are essential for understanding the causes of cases and the effectiveness of the vaccination system:

· date of occurrence of cases;

· place of occurrence of cases;

· age and vaccination status of cases.

In addition it is useful to collect information on the vital status of cases.

How to report?

Case-based reporting may overburden the system and is unnecessary for decision-making in countries where measles is endemic. In these countries the reporting of aggregate data from cases detected during a defined period, e.g. a month, is recommended. Annex 1 is a sample report form for countries where measles is endemic. Copies of this form should be readily available at reporting sites. The reports can be communicated by mail, fax, courier service or email.

In countries where measles is endemic or where elimination is targeted it is recommended that measles surveillance be part of an integrated disease surveillance system.

When to report?

Monthly reporting of cases is recommended where measles is endemic. If, however, there is a sudden increase in the detected number of cases the health authorities at the more central level should be notified immediately.

If monthly reports are provided as part of an integrated disease surveillance system, zero measles cases should also be indicated on the forms used for this purpose.

Collecting, consolidating and interpreting data

District-level staff should combine and evaluate the data collected from all reporting sites on a monthly basis. The form used for reports from health facilities (Annex 1) can also be used to aggregate data at the district level. After the compilation of district-specific data the form should be sent to the state or national level every month. If possible, data should be entered into a computer at the district or provincial level and forwarded to the state or national level for the purpose of analysis.

It is important to keep track of and evaluate measles data at the **district level** (i.e. the most peripheral level). District staff are thus able to assess whether a measles outbreak is imminent and how it can be prevented, or whether such an outbreak is continuing and how the spread of the disease can be limited.

Will there be an outbreak in the current year?

Outbreaks can be predicted and prevented by monitoring the number of susceptible individuals and the changing epidemiology of the disease and by vaccinating before an outbreak occurs. Estimates of the current number of susceptible individuals can be calculated on the basis of:

·   information about vaccination:

  –   the time elapsed since the introduction of measles vaccine;
  –   measles vaccine coverage[1] since the introduction of the vaccine;
  –   the timing of and coverage achieved during supplementary measures such as campaigns;

·   information about the disease:

  –   age-specific incidence;

·   change in population dynamics:

  –   large migration of unvaccinated individuals into the area in question.

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[1]   Vaccine coverage calculation: it is important to evaluate coverage for all recommended doses of measles vaccination (one-dose and two-dose coverage, depending on the recommended schedule in the country concerned). For example, using administrative method to calculate first-dose coverage recommended at 9 months of age, the numerator should be the number of doses administered to children at 9-11 months of age and denominator should be the birth cohort corresponding to the same year as the numerator data. If a second dose is recommended at 4 years of age the numerator should be the number of doses administered to children aged 48-59 months and the denominator should be the total number of children corresponding to the same birth cohort.

Although model-based calculations can be performed in order to estimate when the next measles epidemic is likely to happen, outbreaks can also be predicted in a simple way. In the absence of any major interventions or events (e.g. mass vaccination campaigns, substantial increases in routine vaccination coverage, recent influxes of refugees), reviewing the trend of reported cases over time reveals sufficient information. The interval between epidemics increases with the level of immunity in the population. For example, in an area that experiences measles epidemics every three to four years the timing of the next epidemic can be predicted. To allow for intervention before an outbreak occurs it is recommended that a low estimate is made of the interval between epidemics.

If an intervention is planned with a view to preventing an outbreak it should be effected before the measles epidemic season begins.

What is an outbreak?

The term "outbreak" is used when the number of cases observed in a given geographical area is greater than that normally expected in the area during a given period of time. For this reason it is useful to evaluate trends in recent years (i.e. average numbers of cases or the average incidence rate for a defined geographical area during a defined period of time in non-epidemic years).

If previous surveillance data are not available, conversations with local health care workers can provide reliable information about an unusual increase in the occurrence of measles in the past month.

An increase in the number of cases may reflect an increase in reporting. For instance, a new doctor assigned to a hospital may be more diligent than a predecessor in reporting cases. During the investigation of an outbreak it is possible to discover whether the observed increase is real or an artefact. An increase may also reflect other diseases, e.g. rubella. If the initial 5-10 samples are negative for measles it is important to test them for rubella.

Investigating and confirming cases and outbreaks

1. During the endemic period it is not recommended that every suspected case of measles be investigated and confirmed. However, there may be exceptions to this in countries where there is a strong surveillance infrastructure and integrated case-based disease surveillance.

2. If a measles epidemic affects a wide geographical area or is nationwide, it is recommended that outbreaks be investigated in a few locations, e.g. a rural area and an urban area, rather than every outbreak in every town.

3. When an outbreak is suspected (see "Collecting, consolidating and interpreting data" above) it is recommended that:

    – district surveillance staff immediately notify other health facilities in their area and make sure that blood specimens are collected from 5-10 cases for the purpose of confirmation (Annex 2a);

    – urine or nasopharyngeal specimens are collected from 5-10 cases, which may be the same ones as those from which blood specimens are collected, for viral isolation and genetic sequencing. (Annex 2a);

- a laboratory form is filled in, sent to the laboratory, and copied to the district health office (Annex 2b);
- laboratory results are obtained within seven days of submitting the specimens.

4. When the outbreak is confirmed it is important that:
- the state or national level is notified immediately;
- the collection and analysis of data continue so that the outbreak is monitored and its causes determined (see "Analysing, producing routine reports, and interpreting data" below);
- appropriate outbreak response takes place (see "Analysing, producing routine reports, and interpreting data" below).

Analysing, producing routine reports and interpreting data

Surveillance data should be analysed:

· at each level (i.e. health facility, district, state or national) on a monthly basis.

Surveillance staff at district health offices should review any areas that do not report cases for extended periods. If there are such areas it is important to identify at least one reporting site, e.g. a hospital or large clinic, and include it in training programmes and prompt reporting procedures.

Analyses should be aimed at understanding the reasons for the occurrence of measles, obtaining guidance for control strategies, predicting potential outbreaks in order to implement vaccination strategies for the prevention of outbreaks, and planning measles elimination strategies. A few simple graphs can provide the essential data (i.e. time, place and person):

· number of cases by month of report comparing two consecutive years (Annex 3a);

· number of cases reported by health facility (spot map) (Annex 3b);

· number of cases by age group and vaccination status (cumulative for the year) (Annex 3c);

In addition and where information on vital status/deaths are available, analysis of number of deaths by age group and vaccination status (cumulative for the year) is recommended (Annex 3d).

Despite complete reporting from all sites it is likely that some measles-related cases or deaths will be undetected by the surveillance system. Some measles deaths may occur at home without health care having been sought, and some cases may recover in the same circumstances. Furthermore, because of the long-term effects of measles and delayed measles mortality, some measles deaths may be misclassified as attributable to other factors and may not be reported as measles deaths. Finally, cases in which measles is the underlying cause of death rather than the primary cause (e.g. in secondary bacterial pneumonia) may not be reported as attributable to measles. However, these biases do not preclude the need to collect data on measles

deaths and their characteristics. Such data are essential for the measurement of progress towards measles mortality reduction and for targeting appropriate control measures.

In order to monitor the impact of the vaccination system over time, surveillance staff should compare data from previous years with current data:

· number of cases and deaths by year (Annex 4a and 4b);

· proportion of cases in each age group (Annex 4c);

· proportion of vaccinated cases (Annex 4d);

· proportion of fatal cases (i.e. case-fatality ratio = number of measles deaths divided by the total number of cases) (Annex 4e).

The calculation of incidence rates, i.e. the number of measles cases divided by the population at risk, is especially useful at the state or national level for comparing the occurrence of disease at different places and times (Annex 5). In order to calculate rates accurately it is important to obtain accurate population figures. Population data can be obtained from the census bureau or can be assessed by special surveys performed by various institutions or by health facilities. However, even if population figures are obtained it may be difficult to determine the area served by reference hospitals. Moreover, it should be borne in mind that variations in measles incidence rates may reflect variations in reporting.

If population data are available, age-specific attack rates, i.e. the number of cases in a specific age group divided by the total number of persons in it, can be calculated to see which age group is at highest risk for measles (Annex 6).

During an outbreak

In areas with a routine surveillance system, aggregate data routinely collected may reveal sufficient information about the cause of an outbreak, i.e. whether the outbreak occurred because of vaccine failure, failure to vaccinate, accumulation of susceptible individuals or migration of such individuals, and about how it might have been prevented. However, if routine surveillance is poor or lacking it is important that data on cases (e.g. time, place and person) be collected and that analyses be performed as indicated above. (For further information, see *WHO guidelines for epidemic preparedness and response to measles outbreaks.*[2])

Examples of data trends and interpretation

· High proportion of unvaccinated cases: poor vaccination coverage.

· High proportion of vaccinated cases: high vaccination coverage. Because one dose of measles vaccine does not provide 100% immunity it can be expected that cases will occur among individuals who have received only a single dose. If the number of vaccinated cases is more than expected, or very high, the effectiveness of the vaccine should be evaluated (see below).

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[2] *WHO guidelines for epidemic preparedness and response to measles outbreaks* (WHO/CDS/CSR/ISR/99.01).

- High proportion of cases among children aged 1-4 years: poor vaccination coverage.

- High proportion of cases among children aged 5-9 years: moderate to high one-dose vaccination coverage, increased risk of exposure, e.g. in schools. As vaccination coverage increases, overall incidence decreases and the occurrence of measles cases shifts towards older age groups.

- High proportion of adult cases: measles contracted by susceptible persons who have never been exposed to measles virus or vaccine, e.g. workers from isolated rural areas who have recently migrated to urban areas.

- High incidence in certain areas: vaccination coverage is poor or surveillance is better than elsewhere in these areas.

Vaccine effectiveness (VE) can be estimated by plotting the percentage of measles cases in vaccinated individuals (PCV) and the percentage of the population vaccinated (PPV) on a graph showing the relationship between PPV, PCV and VE (Figure 3). For instance, if 60% of measles cases are in individuals vaccinated against measles and if vaccination coverage is 95%, vaccine effectiveness is close to 95%; if 30% of measles cases are in individuals vaccinated against measles and if vaccination coverage is 60%, vaccine effectiveness is about 70%. (See Orenstein et al. for further information on calculating vaccine effectiveness.)

Figure 3: Percentage of cases immunized (PCV) per percentage of population immunization (PPV), for 7 values of vaccine efficacy (VE)
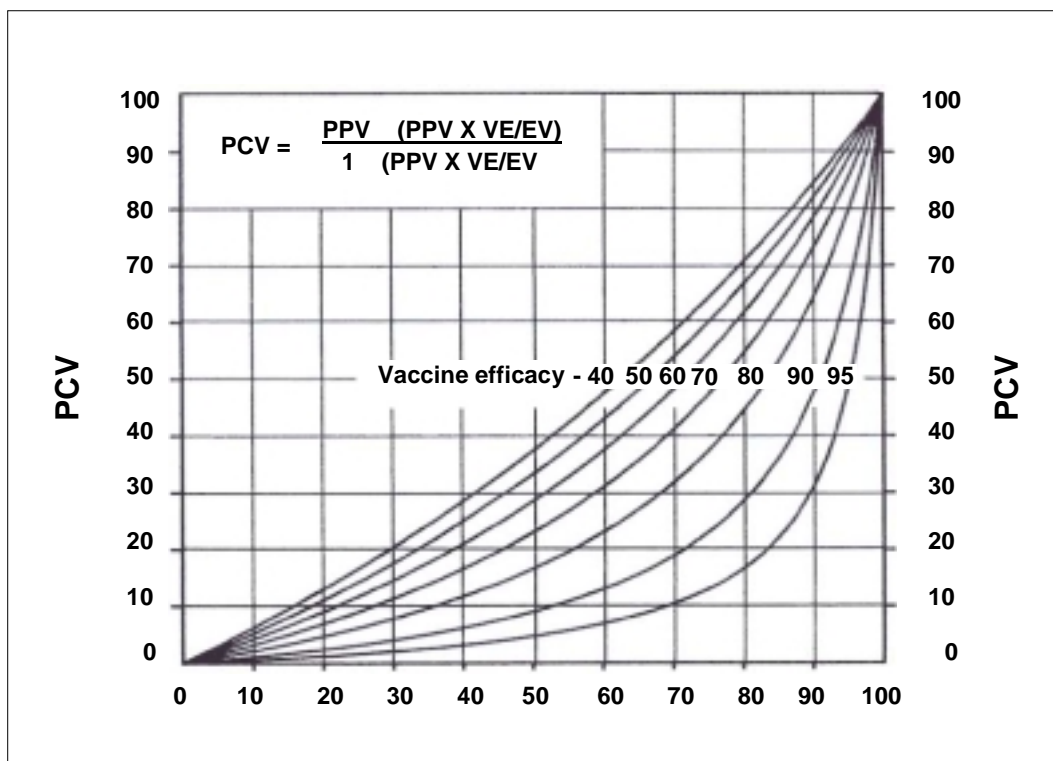
Response

Surveillance and vaccination coverage data make it possible to decide where vaccination coverage should be improved. The response should take place before an outbreak occurs. Once an outbreak has begun in an area with low vaccination coverage, vaccination efforts are not usually sufficiently rapid and extensive to control it. Consequently, it is critical that outbreaks be predicted and prevented. This means reducing susceptibility by increasing vaccination among populations with low immunity. Outbreak prevention requires not only one-dose coverage to be increased, but also coverage with a second dose provided by a routine vaccination system or by supplemental activities.

The following measures should be adopted once an outbreak is confirmed.

- In the immediate area:
    - health care workers and the community should be informed at once and continued feedback should be provided;
    - in all measles outbreaks, the activities of strengthening routine immunization, raising awareness of vaccination and effective case management should be a priority. It is critical to recognize that supplementary immunization activities may not have a substantial impact on the course of a measles outbreak; and that even when they are successful, the cost per prevented case can be very high;
    - persons should be treated according to the case management guidelines.

- In areas to which the outbreak may spread:
    - assessments should be made and efforts to improve vaccination coverage should take priority;
    - data collection and data analysis should continue and/or intensify to detect spread of the outbreak or other changes in the epidemiology of measles.

(See *WHO guidelines for epidemic preparedness and response to measles outbreaks* for further information on outbreak response.)

Feeding data forward to more central levels

The reporting of data to more central levels was discussed above in the section entitled "Detecting and reporting".

It is also important to report to staff at the central levels on various surveillance issues at the peripheral levels, possibly including:

- needs of the surveillance system at the peripheral levels; if the central levels have the responsibility of providing equipment, gasoline, training materials, etc., the peripheral levels should inform central level staff in good time;

- feedback from central levels; if staff at the peripheral level are not receiving feedback from central levels or if any corrections need to be made to the data presented in feedback, peripheral surveillance staff should inform central level staff accordingly.

Providing feedback to more peripheral levels

The provision of feedback to more peripheral levels helps the surveillance system at every level by:

· informing health care workers about current measles epidemiology, recommended measles vaccination and surveillance activities and their effectiveness;

· creating a collaborative environment by acknowledging the hard work of data providers and making them aware that their data are being analysed;

· verifying with the peripheral levels that the data received at more central levels are correct;

· improving performance by showing national progress towards specific public health goals and making comparisons between regions, provinces, etc.

The following table provides some suggestions for feedback procedures.

To	From	About	How	Frequency*
Peripheral reporting site	District health office	Measles data (number of cases, age and vaccination status) from health centres Results of laboratory testing and investigation	Information sheet Telephone, email, fax, letter	Monthly Immediately
	State or national health office	State-wide and nationwide measles data, including response activities and recommendations, indicators of the surveillance system	Newsletter	Quarterly
District health office	State or national health office	Measles data by district State-wide and nationwide measles data, including response activities and recommendations, indicators of the surveillance system	Newsletter Newsletter	Monthly Quarterly
Community	District health office	Community health education about measles and other vaccine-preventable diseases	Mass media (television, radio, newspapers)	At least quarterly; more often as needed
	State or national health office	Community health education about measles and other vaccine-preventable diseases	Mass media (television, radio, newspapers)	At least quarterly; more often as needed

* Frequency can be increased in accordance with programme requirements. Weekly feedback may be necessary in countries with elimination goals.

Enhanced surveillance for countries at the low incidence or elimination stage

Detecting and reporting

Case-based reporting and laboratory confirmation of every suspected case is fundamental for monitoring measles virus during the elimination phase. To determine whether measles cases are due to indigenous or imported virus, a small number of samples from each chain of transmission should be collected for virus isolation and genetic analysis.

It is recommended that weekly reporting be established, including zero-reporting when no cases are detected. It is advisable to provide a specific form for this purpose (Annex 7). The form used for weekly reporting of acute flaccid paralysis can be expanded for the reporting of measles and other diseases. It is important that reports of zero cases genuinely reflect the absence of suspected cases in the communities concerned.

In-depth investigation of each suspected case is critical. In addition to reporting the case, it should be the responsibility of the clinician to collect blood and urine or nasopharyngeal samples at the time of examination of the patient, as some cases may be lost to follow-up after the first contact.

Establishing a special "hot line" is recommended to convey information by the fastest means possible (telephone, telegram, aerogram, fax, email, etc.).

A suspected case should be reported to the district within 24-48 hours of detection.

Districts should report to the state or national level within 24-48 hours of confirmation.

Collecting, consolidating and interpreting data

To prevent the occurrence of outbreaks, it is critical to monitor:

· the accumulation of susceptible individuals;

· pockets of unvaccinated populations.

At the elimination stage a single laboratory-confirmed measles case constitutes an outbreak.

Investigating and confirming cases and outbreaks

A single suspected case of measles requires immediate investigation.

The health care provider should:

· make every effort to obtain the basic information, clinical data, a blood sample and a urine or nasopharyngeal sample during the first contact, as it may be the only contact with the patient; it is therefore important to have case investigation forms (Annex 8) distributed to health facilities in advance and for them to be available at the time of contact with the patient;

· inform the patient or parent of the patient that a public health nurse will visit her or his home and explain about measles elimination and why the visit is necessary.

The district health officer should:

· visit the family immediately with measles investigation forms, measles vaccine and a specimen collection kit;

· complete the case investigation form and determine whether the case meets the clinical case definition for measles. It is important to evaluate the presence, date and duration of symptoms (fever, non-vesicular rash, cough, coryza, conjunctivitis);

· initiate an active search for other cases in adjacent homes or in the neighbourhood and complete the active search form (Annex 9) if the case meets the clinical case definition for measles or if there is not enough information to resolve this matter, e.g. if the patient cannot be found;

· advise all families to keep the patient at home and to keep the number of visitors to a minimum until the rash disappears;

· ask the family if they know where the patient contracted the illness, and whether exposure to other persons with rash occurred about ten days before the onset of rash in the patient; note, however, that the patient may have been exposed to a person without rash but in the incubation period and infectious; information should be sought on whether the patient had travelled outside her/his area of residence;

· visit homes up to 1000 metres away from the case or in the same block or neighbourhood and ask whether any cases of rash and fever have occurred during the previous month, and check the vaccination status of all children under 15 years of age living in the households;

· investigate any reports of either illnesses involving rash or general fever and colds. It may be necessary to request that staff from other clinics go to the homes of possible sources to see if there has been an illness involving rash and to investigate cases fully;

· visit preschools, nurseries, schools, etc. in the area to find out if any fever and illnesses involving rash have been occurring;

·	immunize all children in the target age group in those neighbouring areas where the outbreak is most likely to spread (e.g. all susceptible children in nearby villages) who have not received two doses of measles vaccine. An age range (e.g. 6 months to 14 years) may be selected for this vaccination activity, depending on the epidemiology of measles in the area;

·	notify the neighbourhood and schools about the occurrence of the measles case in the area and ask that all persons who have not received two doses of measles vaccine be vaccinated;

·	perform an active search for cases in health facilities in the area;

·	inform local private doctors, laboratories, pharmacies, traditional healers, etc., about the measles case and ask if rash and fever cases have been seen.

Monitoring the size and duration of outbreaks to determine elimination status

Elimination is the situation where sustained transmission cannot occur and secondary spread from importations of disease will end naturally without intervention. This situation exists when the effective reproductive number (R) is less then one. When R is more than one, there will be an epidemic. The status of measles elimination (R<1) and an estimate of R can be determined from three indicators:

·	the proportion of cases that are imported;

·	the distribution of outbreak sizes;

·	the number of generations of spread in an outbreak.

Thus it is critical to:

·	detect all suspected measles cases;

·	laboratory confirm suspect cases;

·	determine their origin of infection;

·	link cases in chains of transmission .

Thus it is possible to estimate the R value (see figure 4) from:

·	the distribution of outbreak size (larger than 3 cases);

·	the distribution of outbreak duration by number generations.

Figure 4: Theoretical distribution of outbreak sizes and generations of spread according to effective reproduction number
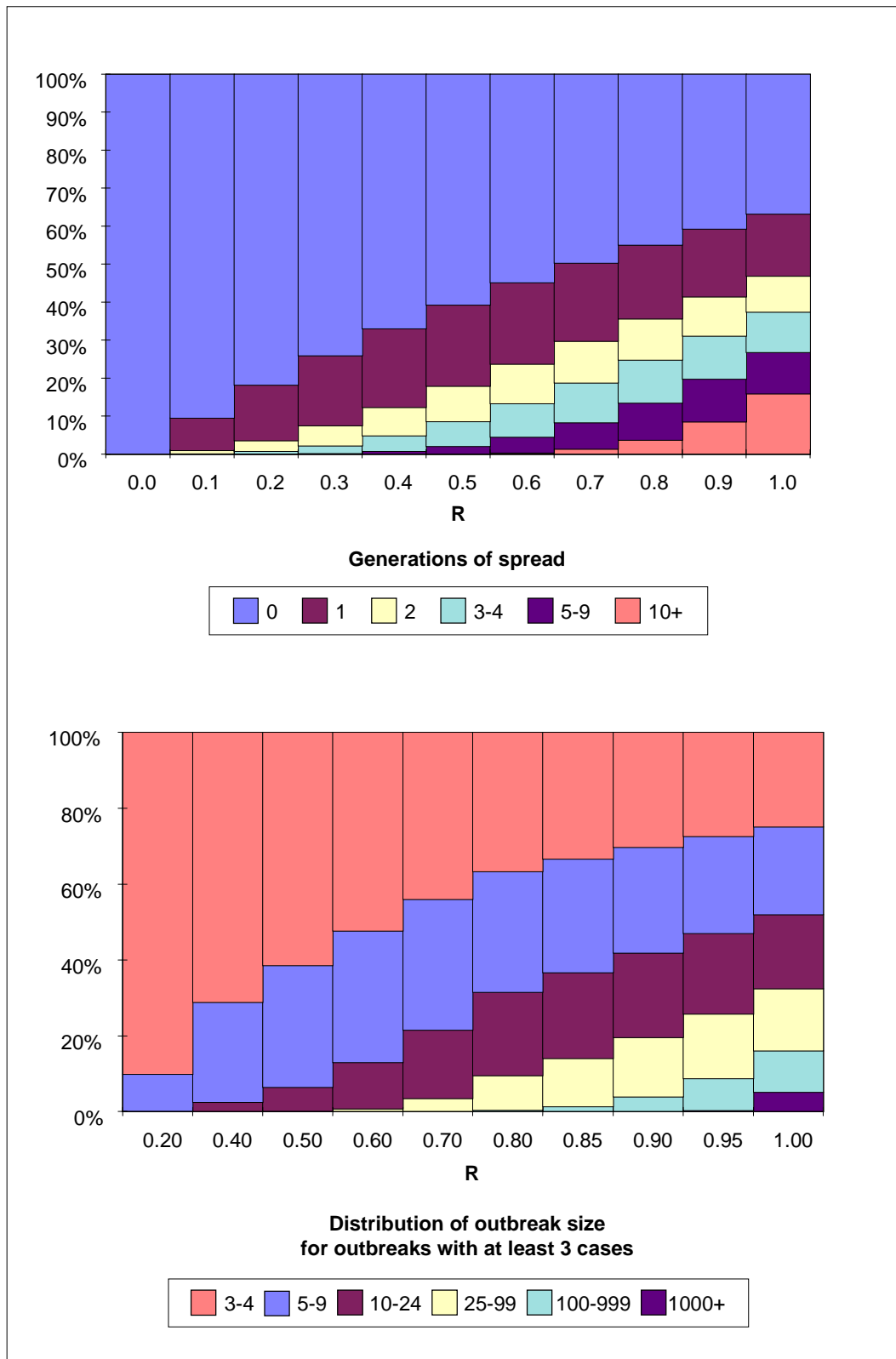
Rubella surveillance and diagnosis

Countries that have introduced routine rubella vaccination should integrate rubella surveillance with their case-based surveillance for measles. Other viruses causing febrile rash illnesses may be incorporated into this surveillance system (e.g. dengue, parvovirus B19).

Countries in the elimination phase with successful measles immunization programmes may find that a high percentage of suspected measles cases are due to rubella. As measles and rubella may be coincidentally eliminated with use of MMR vaccine, testing negative measles serum samples for rubella will provide useful information for rubella surveillance.

The following algorithm will guide laboratory testing procedures and classification of cases for sera collected from suspected measles cases.
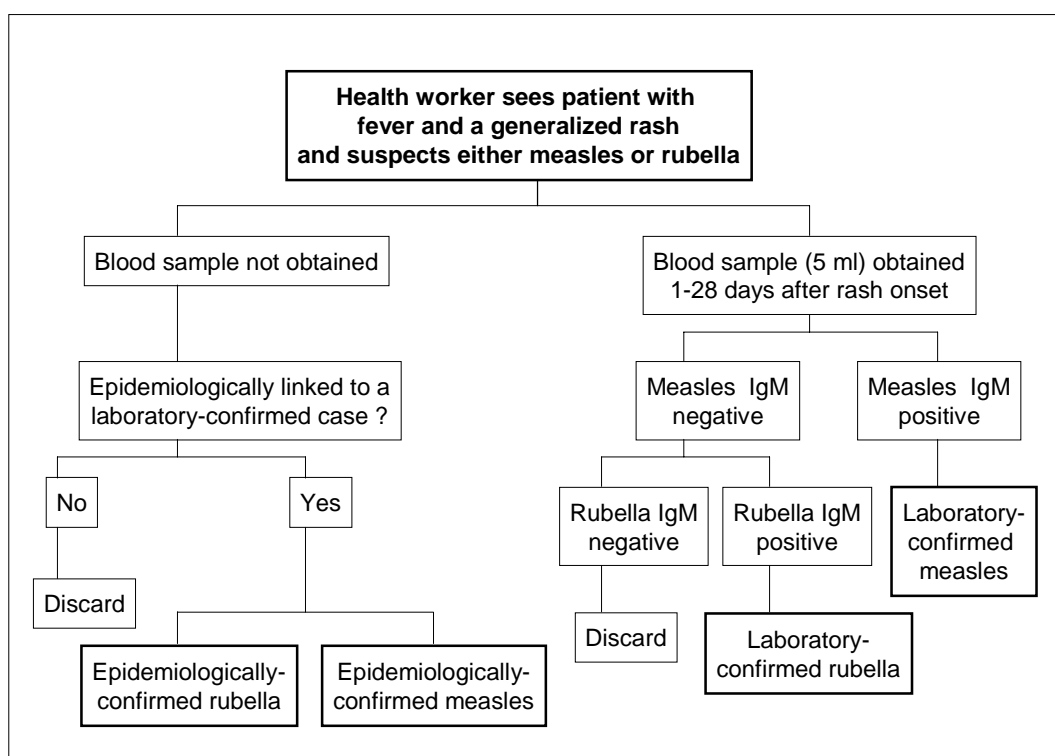
Surveillance logistics

The logistics of surveillance have been presented and discussed in WHO's document *Making surveillance work. Module 3: Logistics management* (WHO/V&B/01.10).

Laboratory network

WHO is establishing a global laboratory network for measles. The network's structure and functions at each level are described below. For further discussion refer to the *Manual for laboratory diagnosis of measles virus infection, December 1999* (WHO/V&B/00.16).

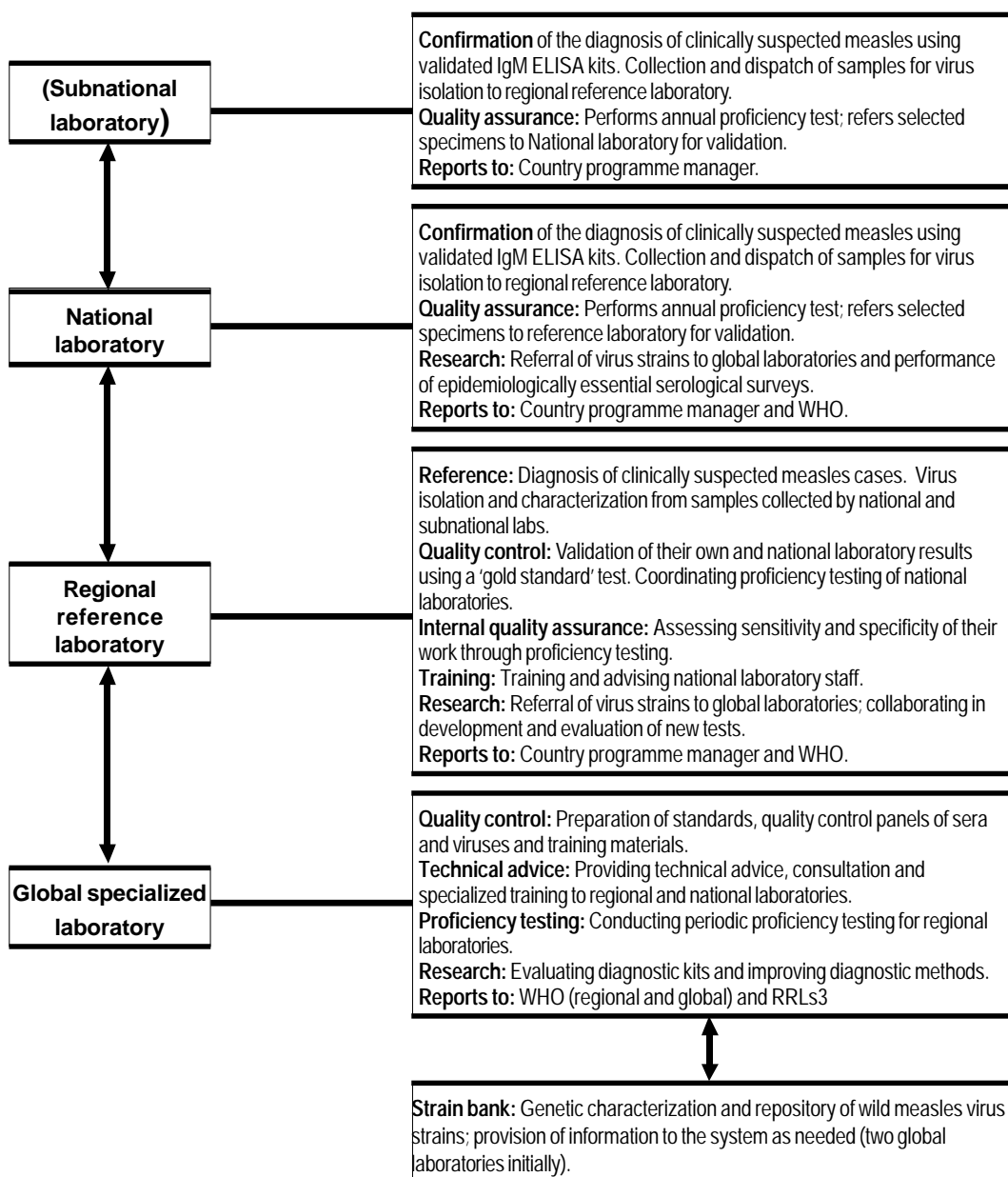|	
(Subnational laboratory)	**Confirmation** of the diagnosis of clinically suspected measles using validated IgM ELISA kits. Collection and dispatch of samples for virus isolation to regional reference laboratory. **Quality assurance:** Performs annual proficiency test; refers selected specimens to National laboratory for validation. **Reports to:** Country programme manager.
National laboratory	**Confirmation** of the diagnosis of clinically suspected measles using validated IgM ELISA kits. Collection and dispatch of samples for virus isolation to regional reference laboratory. **Quality assurance:** Performs annual proficiency test; refers selected specimens to reference laboratory for validation. **Research:** Referral of virus strains to global laboratories and performance of epidemiologically essential serological surveys. **Reports to:** Country programme manager and WHO.
Regional reference laboratory	**Reference:** Diagnosis of clinically suspected measles cases. Virus isolation and characterization from samples collected by national and subnational labs. **Quality control:** Validation of their own and national laboratory results using a 'gold standard' test. Coordinating proficiency testing of national laboratories. **Internal quality assurance:** Assessing sensitivity and specificity of their work through proficiency testing. **Training:** Training and advising national laboratory staff. **Research:** Referral of virus strains to global laboratories; collaborating in development and evaluation of new tests. **Reports to:** Country programme manager and WHO.
Global specialized laboratory	**Quality control:** Preparation of standards, quality control panels of sera and viruses and training materials. **Technical advice:** Providing technical advice, consultation and specialized training to regional and national laboratories. **Proficiency testing:** Conducting periodic proficiency testing for regional laboratories. **Research:** Evaluating diagnostic kits and improving diagnostic methods. **Reports to:** WHO (regional and global) and RRLs3
	Strain bank: Genetic characterization and repository of wild measles virus strains; provision of information to the system as needed (two global laboratories initially).

Evaluation of surveillance system

In order to understand the areas requiring improvement in a surveillance system it may be necessary to conduct an initial evaluation. Please refer to WHO's *Making surveillance work. Module 4: Data management* (WHO/V&B/01.11).

Predetermined performance indicators should be used for the evaluation of performance in a surveillance system. They should be assessed periodically, feedback should be given to the health care providers, and any interventions necessary for improving the system should be effected.

Performance indicators in the control stage for countries where measles is endemic

Target: all indicators to be ≥80%

- % of districts reporting monthly;
- % of districts reporting within a month after the report period;
- % of reported cases containing core data (i.e. age, vaccination status).

These indicators should be evaluated at least monthly. In countries where weekly reporting is established, weekly evaluation of indicators may be preferred.

For countries at the low incidence or elimination stage, the following performance indicators should be evaluated on a weekly basis.

Performance indicators: **Target**: all indicators to be ≥80%

% of sites reporting weekly

% of cases* notified within ≤48 hours of onset of rash

% of cases investigated within ≤48 hours of notification

% of cases with adequate specimen** and laboratory results within 7 days

% of confirmed cases with sources of infection identified

---

*   All cases meeting the clinical case definition.
** One blood specimen collected within 28 days of onset of rash.

References and further reading

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Guidelines for surveillance of congenital rubella syndrome and rubella. Field test version, May 1999. Geneva, World Health Organization, 1999 (unpublished document WHO/V&B/99.22; available from Vaccines and Biologicals, World Health Organization, 1211 Geneva 27, Switzerland and on the Internet at http://www.who.int/vaccines-documents/DocsPDF99/www9934.pdf).

Annex 1:
Reporting form for routine surveillance of measles in countries where measles is endemic

Name of reporting site:

Name of district, etc: _____

Date: _____ from: _____ to: _____

Age group* (years)	Number of measles cases by vaccination status				Total
	Vaccination record**	Vaccination history**	Not vaccinated	Unknown	
<1					
1-4					
5-9					
10-14					
15-19					
20-24					
25-29					
30+					
Total					

Age group* (years)	Number of measles cases by vaccination status				Total
	Vaccination record**	Vaccination history**	Not vaccinated	Unknown	
<1					
1-4					
5-9					
10-14					
15-19					
20-24					
25-29					
30+					
Total					

NB:

* If possible in the context of integrated surveillance it is suggested that the following age groups below 5 years be used: 0-5 months, 6-11 months, 12-23 months, 2-4 years. This would give more specific information on how to adjust programmes.

** For countries where a second vaccination opportunity is provided to children, vaccination status can be grouped into one and two doses of measles vaccine.

Annex 2a:

Collection, storage and shipment of specimens for measles diagnosis and outbreak investigation

> **The ELISA test for the detection of measles-specific IgM antibodies is recommended for the WHO measles laboratory network.**

Samples for measles diagnosis and virus isolation should be collected in accordance with the phase of measles control and elimination in which a country is classified (see following Table).

Samples required for measles serology and measles virus isolation according to control phase

Phase	Function of laboratory	Epidemiological situation	Sample: blood for measles serology	Sample: specimen for virus isolation
Mortality reduction	To confirm initial cases during outbreaks	Isolated case	No	No
	To analyse wild virus strains from selected cases in order to facilitate genetic characterization of circulating measles	Outbreak	Yes From initial 5-10 cases in order to confirm outbreak and cases of suspected spread viruses	Yes Approximately 10 specimens
Elimination	To confirm clinical diagnosis of all suspected cases in order to help in early detection of virus circulation To analyse wild virus strains and monitor their distribution and circulation in order to help with assessment of impact of immunization strategies	Isolated case	Yes From all suspected measles cases	Yes From suspected measles cases
		Outbreak	Yes From initial 10 cases in order to confirm outbreak and cases of suspected spread	Yes Approximately 10 specimens. More may be collected in newly infected districts

Serological specimens for measles diagnosis

Timing of single blood specimen sampling for IgM serology

The correct timing of sampling with respect to the clinical signs is important for interpreting results and arriving at an accurate conclusion.

While IgM ELISA tests are more sensitive between days 4 and 28 after the onset of rash, **a single serum sample obtained at the first contact with the health care system within 28 days after onset is considered adequate for measles surveillance**.

Second blood samples

These may occasionally be required under the following circumstances:

·   The measles IgM ELISA gives an equivocal result

·   The clinician needs to make a definitive diagnosis on an individual patient with an initial negative result

A second sample for IgM testing may be collected anytime between 4 and 28 days after rash onset. Collection of a second sample 10 - 20 days after the first will permit the laboratory to retest for IgM or, if a quantitative method is available, test for an increase in IgG antibody level. This, however, is not recommended on a regular basis since additional information obtained will be limited.

Collection procedures

·   Collect 5 ml blood by venepuncture in a sterile tube labelled with patient identification and collection date

·   Whole blood should be centrifuged at 1000g for 10 minutes to separate the serum.

·   Blood can be stored at 4-8°C for up to 24 hours before the serum is separated.

·   Do not freeze whole blood.

·   If there is no centrifuge the blood should be kept in a refrigerator until there is complete retraction of the clot from the serum.

·   Carefully remove the serum, avoid extracting red cells, and transfer aseptically to a sterile labelled vial.

·   Label the vial with the patient's name or identifier, date of collection and specimen type.

·   Store the serum at 4-8°C until shipment takes place.

·   Fill in case investigation forms completely (Annex 2b and, in the elimination phase, Annex 8). Three dates are very important:

–   date of last measles vaccination;

–   date of onset of rash;

–   date of collection of sample.

Storage of blood specimens

- Whole blood may be held at refrigerator temperatures (4-8°C) if it can be transported to the testing laboratory within 24 hours.

- If the latter step is not possible the tube must be centrifuged to separate the serum, which is transferred to a sterile labelled screw-capped tube for transportation to the laboratory.

- If no centrifuge is available the blood is held in a refrigerator for 24 hours for clot retraction. The serum is then carefully removed with a fine-bore pipette and transferred to a sterile tube.

- Sterile serum should be shipped on wet ice within 48 hours or stored at 4-8°C for a maximum period of 7 days.

- Sera must be frozen at -20°C for longer periods and transported to the testing laboratory on frozen ice packs. Repeated freezing and thawing can have detrimental effects on the stability of IgM antibodies.

Shipment of blood specimens

- Specimens should be shipped to the laboratory as soon as possible. Do not wait to collect additional specimens before shipping.

- Place specimens in Ziplock or plastic bags.

- Use Styrofoam boxes or a Thermos flask.

- For each specimen, place the specimen form and the investigation form in a plastic bag and tape to the inner surface of the top of a Styrofoam box.

- If using ice packs, which should be frozen, place them at the bottom of the box and along the sides, place the samples in the centre, and place more ice packs on top.

- Arrange a shipping date.

- When the arrangements have been finalized, inform the receiver of the time and manner of transportation.

- More details on how to package and ship samples are given in the *Manual for laboratory diagnosis of measles virus infection.*

Urine for measles virus isolation

Samples of between 10 and 50 ml urine are adequate for this purpose. It is preferable to obtain the first urine passed in the morning. Most of the measles virus excreted in urine samples is located in epithelial cells. The virus is concentrated by centrifugation of the urine and resuspension of the pelleted cells in a suitable viral transport medium. Urine should NOT be frozen before the concentration procedure is carried out.

Timing

The isolation of measles virus is most successful if the specimens are collected as soon as possible after the onset of rash and at least within 7 days after onset.

Collection procedure

· The urine should be collected in a sterile container.

· It should be placed at 4 -8°C before centrifugation.

· Centrifugation should be performed within a few hours (see below).

Storage and shipment of urine samples

· Whole urine samples may be shipped in well-sealed containers at 4°C but centrifugation within 24 hours after collection is preferable.

· Centrifugation should be performed at 500g (approximately 1500 rpm) and 4°C for 5 minutes.

· The supernatant should be discarded and the sediment resuspended in 1ml viral transport medium or tissue culture medium.

· DO NOT FREEZE the sediment if shipment is possible within 48 hours and DO NOT FREEZE urine before the concentration procedure is carried out.

· The resuspended pellet may be stored at 4°C and shipped within 48 hours to a measles reference laboratory. Alternatively, it may be frozen at -70°C in viral transport medium and shipped on dry ice in a well-sealed screw-capped vial to protect against CO2 contamination.

Nasopharyngeal specimens for measles virus isolation

Timing

Nasopharyngeal specimens for virus isolation must be collected as soon as possible after onset and not longer than 7 days after the appearance of the rash, when the virus is present in high concentration.

Collection procedures

Nasopharyngeal specimens can be taken as follows (in order of increasing yield of virus):

· aspiration;

· lavage;

· swabbing the mucous membranes.

Nasal aspirates are collected by introducing a few ml of sterile saline into the nose with a syringe fitted with fine rubber tubing and collecting the fluid in a screw-capped centrifuge tube containing viral transport medium[3] (see *Manual for laboratory diagnosis of measles virus infection, December 1999* (WHO/V&B/00.16).

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[3] If viral transport medium is not available, isotonic saline solution, tissue culture medium or phosphate-buffered saline may be used.

Throat washes are obtained by asking the subject to gargle with a small volume of sterile saline and collecting the fluid in viral transport medium.

Nasopharyngeal swabs are obtained by firmly rubbing the nasopharyngeal passage and throat with sterile cotton swabs to dislodge epithelial cells. The swabs are placed in sterile viral transport medium[*] in labelled screw-capped tubes, refrigerated and transported to the laboratory on wet ice (4-8°C) within 48 hours.

Storage and transport of nasopharyngeal specimens

· Nasopharyngeal specimens should be transported in viral transport medium[*] and shipped on wet ice (4-8°C), and should arrive at the testing laboratory within 48 hours.

· If arrangements cannot be made for rapid shipment, swabs should be shaken in the medium to elute the cells and then removed.

· The medium or nasal aspirate should be centrifuged at 500g approximately 1500 rpm) and 4°C for 5 minutes and the resulting pellet should be resuspended in cell culture medium.

· The suspended pellet and the supernatant are stored separately at -70°C and shipped to the testing laboratory on dry ice in well-sealed screw-capped vials to protect against CO_2 contamination.

NOTE: Samples for virus isolation

The laboratory should agree in advance with the epidemiologists on the number, type and locations that are most appropriate for collection of samples for virus isolation. Ideally, the samples for virus isolation should be collected simultaneously with the blood samples for serological diagnosis and confirmation of measles virus as the cause of the outbreak. Since each type of sample has different requirements the decision on the type of samples depends on the local resources and facilities for transportation and storage.

Because virus is more likely to be isolated when specimens are collected within three days of the onset of rash, the collection of specimens for virus isolation should not be delayed until laboratory confirmation of a suspected case of measles is obtained.

Specimen kit for measles diagnosis

The components required in a specimen collection kit for measles diagnosis have been laid down. They are suitable for distribution to facilities collecting samples from suspected cases in countries at the stage of measles elimination.

The basic kit for blood collection consists of:

- a 5-ml vacutainer tube (non-heparinized) with a 23 gauge needle;
- a tourniquet;
- sterilizing swabs;
- serum storage vials;
- specimen labels;
- band aid;
- Ziplock plastic bags;
- specimen referral form;
- cold box with ice packs.

Interpreting laboratory results

Final classification of suspected measles cases for countries in the Measles elimination phase

- Only patients that have a positive result with a validated IgM ELISA assay are considered to be laboratory confirmed measles cases.
- Patients with assays results obtained by other methods are considered as suspected pending final laboratory testing.

If for any reason, an approved IgM ELISA is not performed on samples positive by other methods, these cases, for surveillance purposes, are considered as "clinically confirmed" measles cases.

Interpretation of results in recently vaccinated patients

Natural measles infection and measles vaccine can stimulate an IgM response in the host. If the suspected case has been vaccinated **within six weeks before the onset of rash** the interpretation of the results may be problematic because:

- measles vaccine can cause fever in 5% and rash in approximately 20% of vaccinees;
- first-time vaccinees are expected to have detectable measles IgM after vaccination;
- a mild rash lasting one to three days may occur approximately a week after vaccination;
- serological techniques cannot distinguish between the immune responses to natural infection and immunization; this can only be accomplished by viral isolation and characterization.
- other medical conditions, e.g. rubella and dengue, can cause rash and fever in persons who have recently received measles vaccine.

Consequently, an operational definition is required to facilitate the final classification of suspected measles cases with an IgM-positive result.

Classification of cases with IgM-positive result and recent history of measles vaccination

Final classification	Vaccination history	Epidemiological findings
Discarded	History of measles vaccination within six weeks before onset of rash	Active search in community does not reveal evidence of measles transmission. No history of travelling to areas where measles virus is known to be circulating
Confirmed	History of measles vaccination within six weeks before onset of rash	Active search in community reveals other laboratory-confirmed measles cases

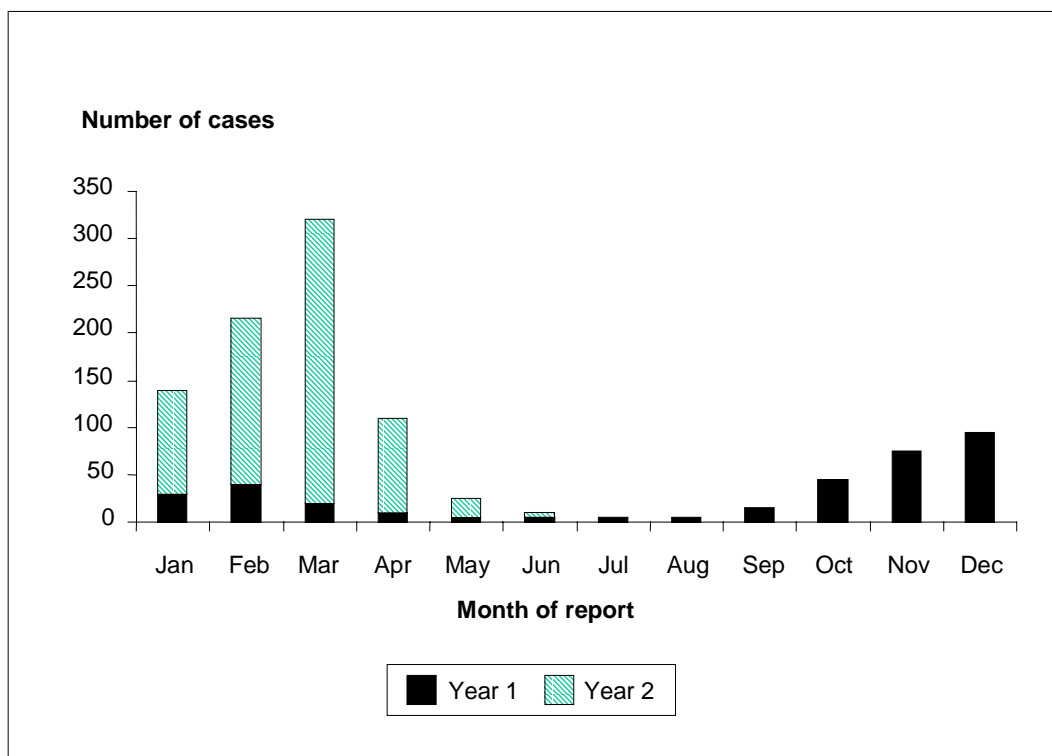**Most of Annex 2a has been taken from the Manual for laboratory diagnosis of measles virus infection.**

Annex 2b:
Measles laboratory request and result form

Measles laboratory request and result form				
Country:		Patient number:	Date / /	
Patient name:			M	F
Date of birth / /			Age in months:	
Name of parent or guardian:				
Address:				

Number of doses of measles vaccine:	Date of last dose / /	
Date of onset of fever / /	Date of onset of rash / /	
Type of rash:		
Provisional clinical diagnosis:		

Specimen	Date of collection	Date of shipment
(1)	/ /	/ /
(2)	/ /	/ /
(3)	/ /	/ /

Name of person to whom laboratory results should be sent:	
Address:	
Telephone number:	Fax number:
For use by the receiving laboratory:	
Name of laboratory:	
Name of person receiving the specimen:	
Specimen condition:	

Specimen	Date received in laboratory	Date of result	Type of test	Test result	Comment
	/ /	/ /			
	/ /	/ /			
	/ /	/ /			
	/ /	/ /			

Annex 3a:

Number of measles cases and deaths reported by month

(Place, year 1 and year 2)

Number of cases

Annex 3b:
Spot map of measles cases

(Place, year 2)

City

City

City

City

Capital

City

• = 1 case

Note: Areas with no measles cases may indicate poor surveillance and lack of reporting.
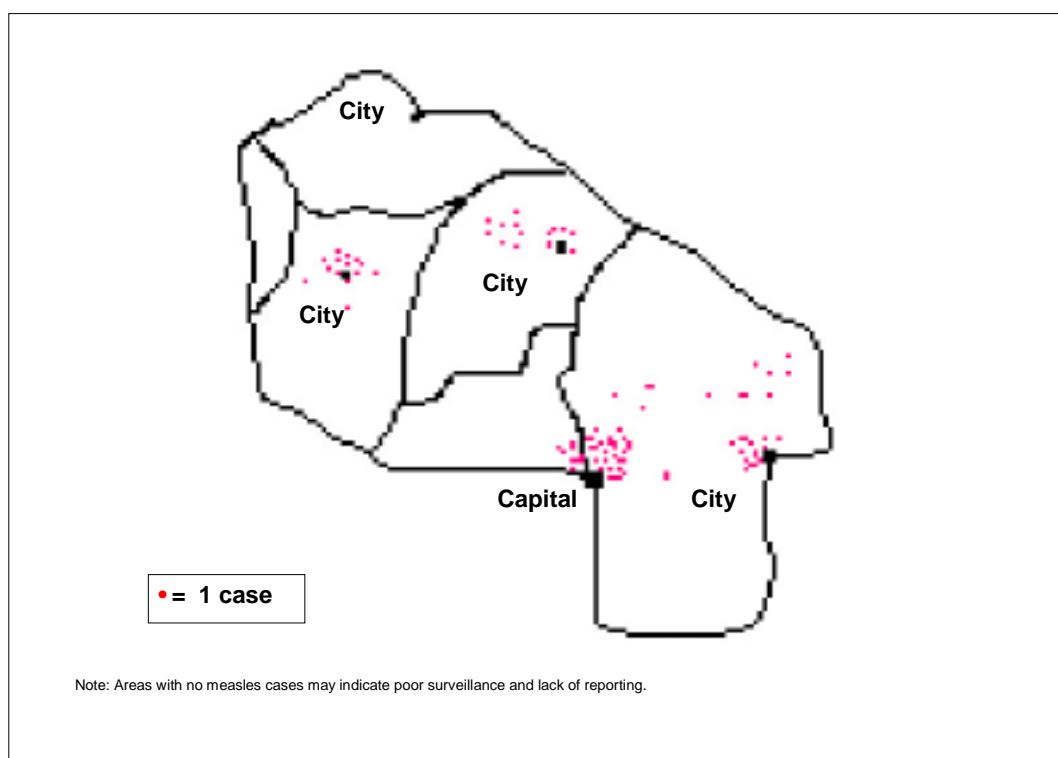
Annex 3c:
Number of measles cases by age group and vaccination status

(Place, January-June, year)

Number of cases

Note: Adult age groups can be grouped together if few cases are occurring in these groups
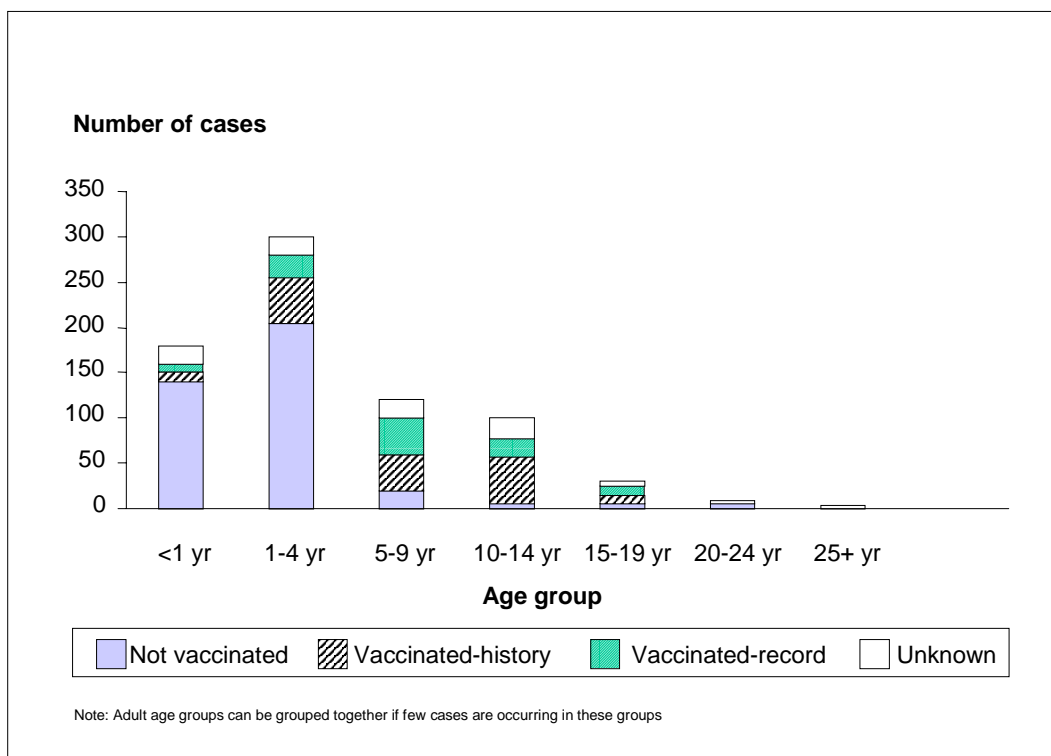
Annex 3d:

Number of measles deaths by age group and vaccination status

(Place, January-June, year)

Number of deaths

Not vaccinated | Vaccinated-history | Vaccinated-record | Unknown
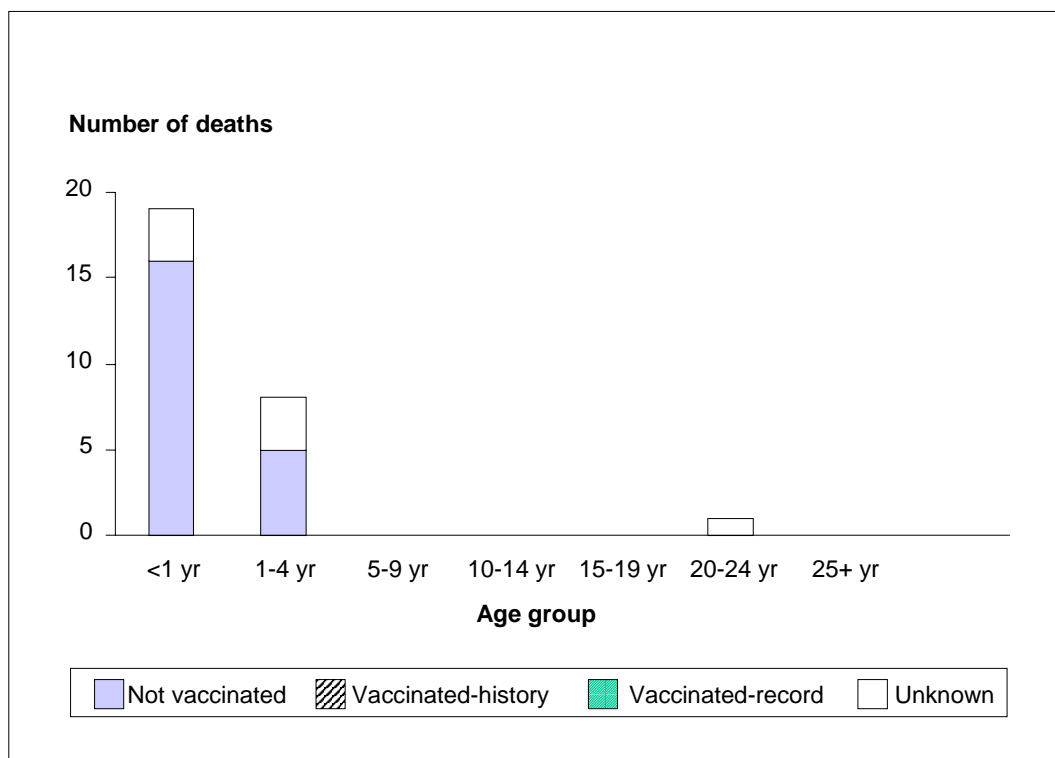
Age group

Annex 4a:

Number of measles cases by year

(Place, 1994-2000*)

Number of cases

1994	1995	1996	1997	1998	1999	2000

Year

* The number of years can be expanded depending on the availability of data and objectives of analysis.
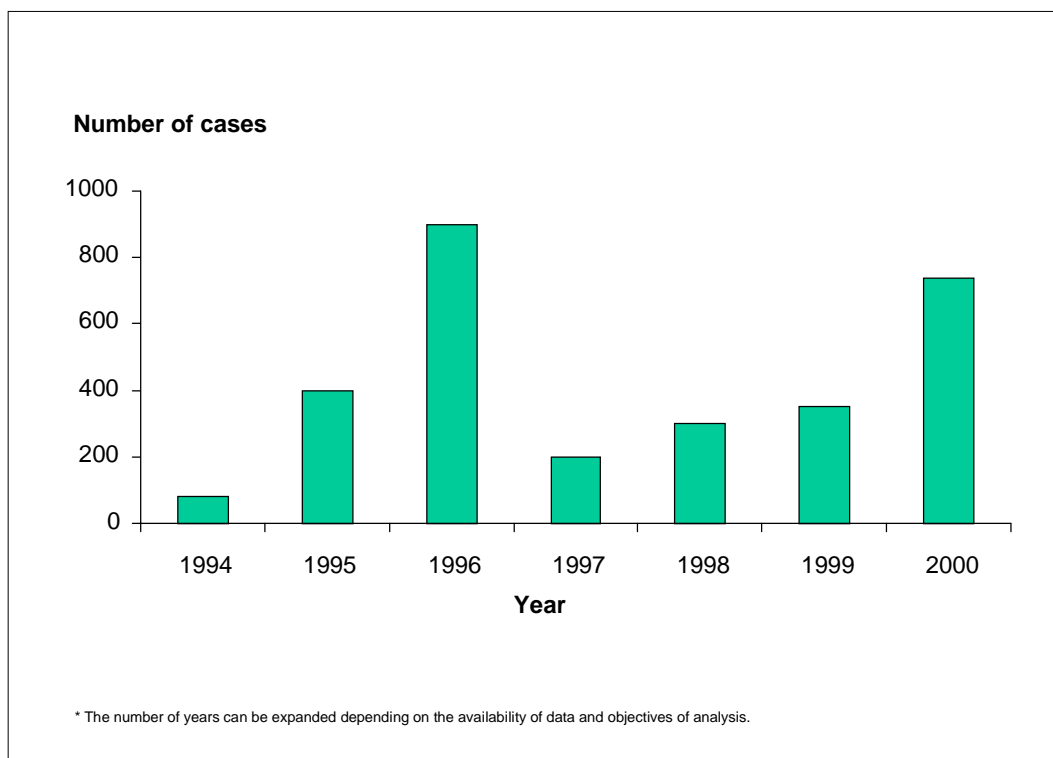
Annex 4b:

Number of measles deaths by year

(Place, 1994-2000*)

Number of deaths

* The number of years can be expanded depending on the availability of data and objectives of analysis.
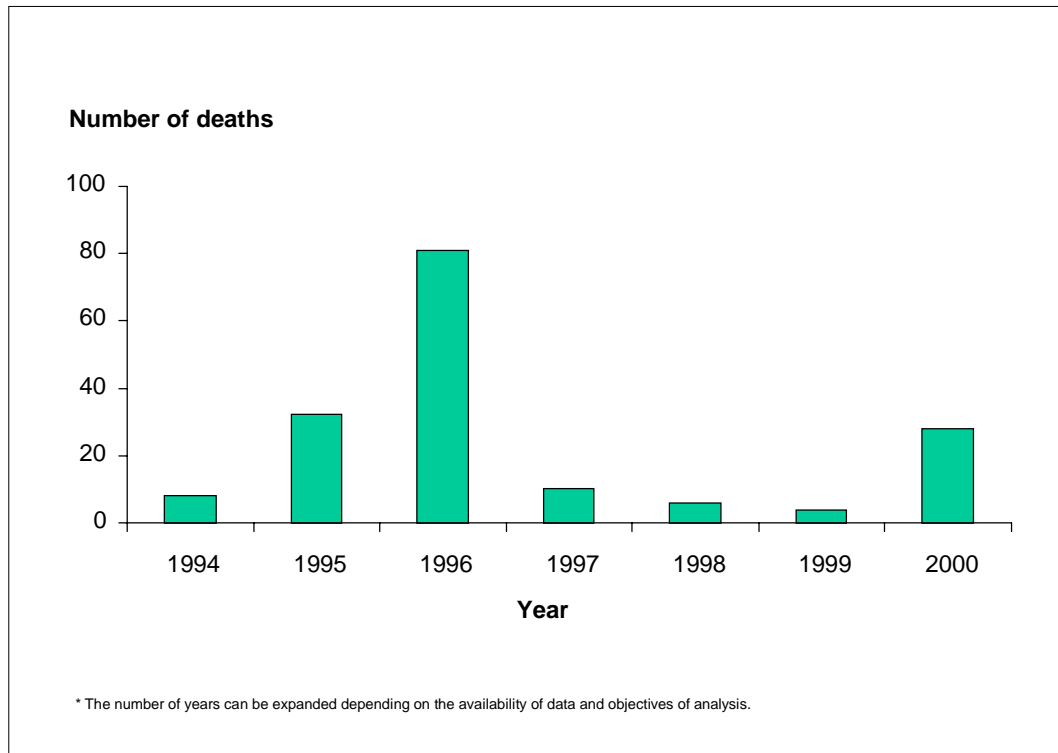
Annex 4c:

Proportion of measles cases
by age group and year

(Place, 1994-2000*)

Proportion (%)

Year

Legend: <1 yr | 1-4 yr | 5-9 yr | 10-14 yr | 15-19 yr | 20-24 yr | 25+ yr

* The number of years can be expanded depending on the availability of data and objectives of analysis.
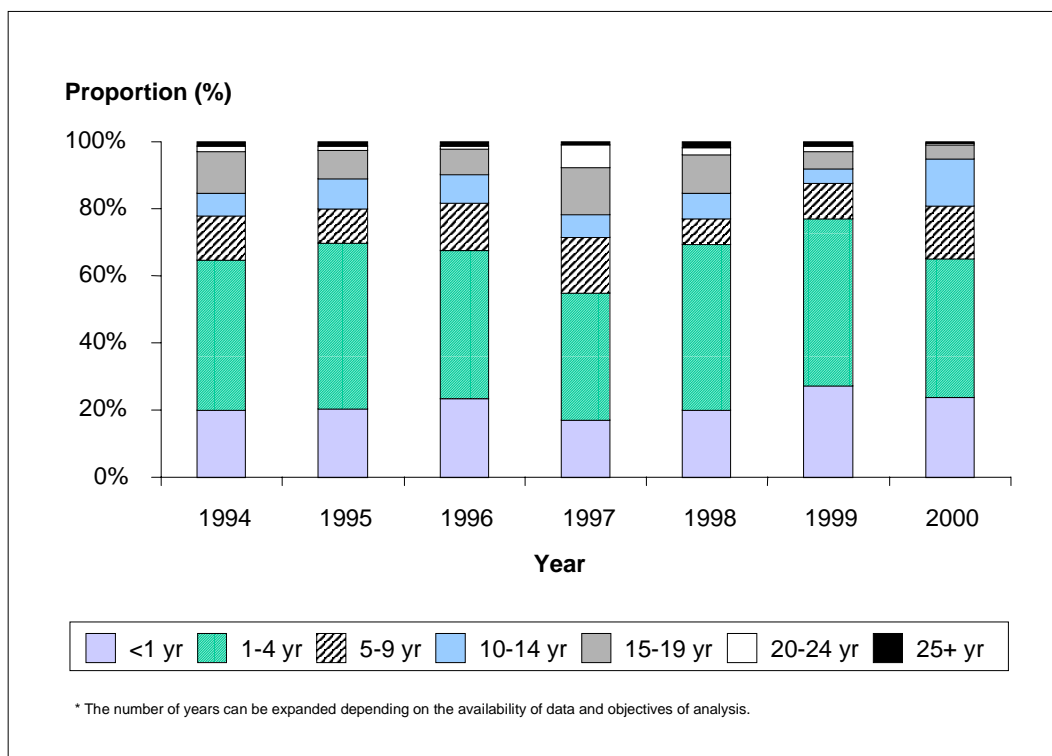
Annex 4d:

Proportion of measles cases by vaccination status and year

(Place, 1994-2000*)

Proportion (%)

* The number of years can be expanded depending on the availability of data and objectives of analysis.
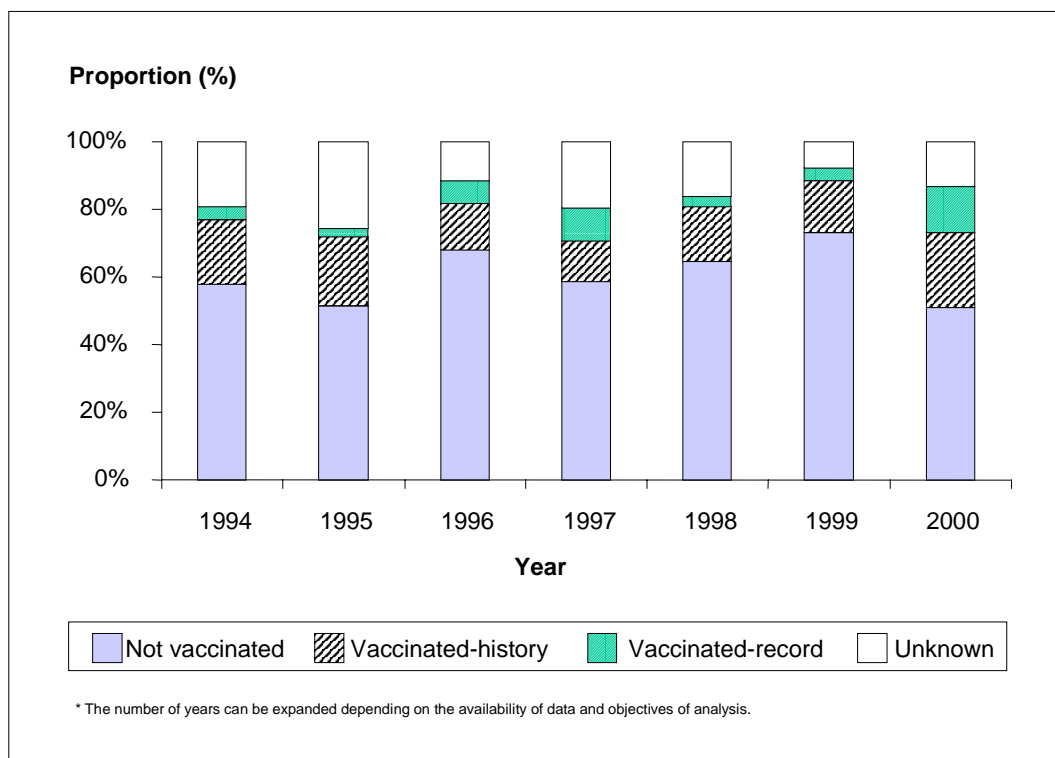
Annex 4e:

Proportion of measles cases by outcome and year

(Place, 1994-2000*)

* The number of years can be expanded depending on the availability of data and objectives of analysis.
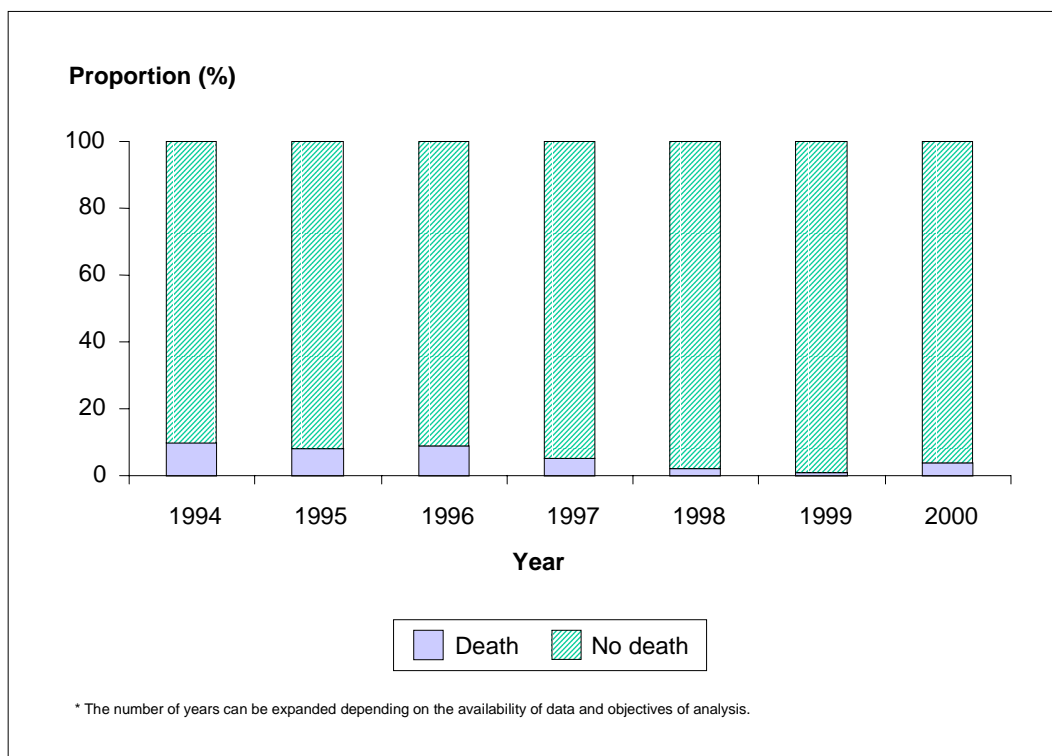
Annex 5:

Incidence rate by district

(State, January to June, year)

Name of district	Population	Number of cases	Incidence rate (per 1000)
A	50 000	50	1.0
B	20 000	25	1.3
C	10 000	100	10.0
D	60 000	30	0.5
E	100 000	1 500	15.0
F	10 000	10	1.0
G	15 000	50	3.3
Total	**265 000**	**1 765**	**6.7**

Annex 6:

Age-specific measles attack rates

(State, January to June, year)

Age group (years)	Population	Number of cases	Attack rate (per 1000)
A	50 000	50	1.0
<1	11 141	181	16.2
1-4	44 521	299	6.7
5-9	55 462	121	2.2
10-14	55 328	99	1.8
15-19	55 256	30	0.5
20-24	61 512	4	0.1
25+	310 652	4	0.0
Total	**593 872**	**738**	**1.2**

NB: If possible in the context of integrated surveillance it is suggested that the following age groups below 5 years be used: 0-5 months, 6-11 months, 12-23 months, 2-4 years. This would give more specific information on how to adjust programmes.

The denominator can be further refined to include only the population at risk (excluding those already vaccinated or who had suffered from measles previously). This may give a more accurate attack rate among the susceptible population. The population included in the denominator should always be clearly stated.

Annex 7:
Weekly zero reporting form for countries with measles elimination goal

Name of reporting site: _____

Name of district, etc: _____

Date: _____ from: _____ to: _____

Name of reporting site: _____

Number of suspected measles cases: _____

(Attach forms on any case; if no cases to report, indicate 0)

Number of acute flaccid paralysis cases: _____

(Attach forms on any case; if no cases to report, indicate 0)

Other: _____

(Other designated disease or condition)

Annex 8:

Case investigation form for countries with measles elimination goal

Fill in this form for all persons in whom a health care provider suspects measles

Initial classification: measles

A. Identification   Case number _____

Name: _____

Sex: Male ☐   Female ☐   Age: ☐ ☐   Date of birth: _____/_____/_____

                                                Years   Months

Health department: _____   District: _____

Address: _____   Name of mother: _____

Report date: _____/_____/_____   Date of investigation _____/_____/_____

Source of notification:

Public ☐   Private ☐   Laboratory ☐   Community ☐   Active Search ☐   Contact to a suspect case ☐   Other ☐

Vaccination: Number of doses   Last vaccination date:

Measles   _____/_____/_____   Written record   Yes ☐   No ☐   Unk. ☐

Rubella   _____/_____/_____   Written record   Yes ☐   No ☐   Unk. ☐

B. Clinical information

Rash: Date of onset: _____/_____/_____   Duration (days): _____

Site of initial rash: Retroauricular ☐   Face ☐   Neck ☐   Thorax ☐   Other ☐   Specify: _____

Type: Maculopapular ☐   Vesicular ☐   Other ☐   Specify: _____

Fever: Yes ☐   No ☐   Unk ☐   Date of onset: _____/_____/_____

Cough: Yes ☐   No ☐   Unk ☐   Coryza: Yes ☐   No ☐   Unk ☐   Conjunctivitis: Yes ☐   No ☐   Unk ☐

Hospitalized: Yes ☐   No ☐   Name of hospital: _____   Nature of complications: _____

Death: Yes ☐   No ☐   Date of death: _____/_____/_____   Cause of death: _____

C. Laboratory data

Take a blood specimen at the first contact with the case for confirmation*
Take an adequate urine or nasopharyngeal sample from each outbreak for viral isolation.

Samples	Date of collection*	Lab.	Arrival at lab.	Test result	Date of result
Serum	___/___/___	_____	___/___/___ Pos. ☐ Neg. ☐ Pend. ☐	___/___/___
Urine	___/___/___	_____	___/___/___ Pos. ☐ Neg. ☐ Pend. ☐	___/___/___
Nasopharyngeal	___/___/___	_____	___/___/___ Pos. ☐ Neg. ☐ Pend. ☐	___/___/___

Codes: **Test.** 1= IgM   2 = isolation

D. Possible source of infection

Did the case have contact with another suspected case of measles 7-23 days before onset of rash?   Yes ☐ No ☐ Unk ☐   Who and where? _____

Was there any suspected case of measles in the area before this case?   Yes ☐ No ☐ Unk ☐

Did the case travel 7-23 days before onset of rash?   Yes ☐ No ☐ Unk ☐   Where? _____

Does the case work in tourism or in an area with a large flow of international tourists/persons?   Yes ☐ No ☐ Unk ☐

Is this case epidemiologically linked to an imported case?   Yes ☐ No ☐ Unk ☐   Who and where? _____

E. Final classification

Measles ☐   Rubella ☐   Dengue ☐   Vaccine reaction ☐   Other ☐   Specify _____   Unknown ☐

Confirmed by: Laboratory ☐   Epidemiological link ☐   Clinical diagnosis ☐

Imported: Yes ☐   No ☐   Unk ☐   from: _____   Date of final classification: ___/___/___

Investigated by:

Name: _____   Position: _____

Signature: _____   Date of investigation: ____/____/____

Observations: _____

Annex 9:
Form for household or workplace investigation of suspected measles cases

[During the investigation, in addition to this form you will need the case investigation report of the index case

It is also useful to plan for availability of summary sheets including information on overall number of household/workplace visited with overall number of persons and suspected cases]

Date of investigation: _____

Investigated by: _____

Residence or institution investigated: _____

District or neighbourhood: _____

Names	Age (Y = years; M = months)	Sex (M/F)	Total number of measles vaccine doses and date of last one*	Suspected case of measles (Yes/No)	If suspected case of measles							Other observations: (a) Does suspected case work in tourist industry or had contact with foreign visitors within 7-18 days before rash onset? (b) Record address if different from others
					Date of onset of rash	Sample taken (serum; urine; nasopharyngeal; none)	Laboratory result when available (positive/negative)	Places visited 7–18 days before rash onset (where suspected case could have been infected)	Date(s) of investigation of places described in previous column	Places where the case had been from the beginning of symptoms until 4 days after onset of rash (infectious period)	Date(s) of investigation of places described in previous column	

*   All usual residents of or visitors to the house or workplace must be visited (including all persons visiting at least weekly).

** The immunization card is required. If it is not available, record "unknown" in this column.

Interview all persons who live (or work) there and those who visited this home/workplace within 7–18 days prior to rash onset and/or since beginning of first respiratory symptoms up to 4 days after rash onset. Also interview here the case-patient that originated the investigation.