

# APPENDIX A.1

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## What Software Is Available for Surveillance?

There are numerous software packages available for use in public health surveillance. Many of them are complex and are aimed primarily at statistical analyses of datasets. Several easy-to-use software packages are widely accepted in the surveillance community.

### ***Epi-Info***

Epi-Info and Epi-Map (Centers for Disease Control and Prevention) are public domain software packages designed for the global community of public health practitioners and researchers. Both provide easy form and database construction, data entry, and analysis with epidemiologic statistics, maps, and graphs. A Web site devoted to the dissemination of these softwares, including tutorials

for their use, may be found at <http://www.cdc.gov/epiinfo>.

### ***Prophet***

Prophet offers advanced, easy-to-use software tools for data management, visualization, and statistical analysis. Information concerning this package may be found at [www.prophet.bbn.com](http://www.prophet.bbn.com).

### ***GIDEON***

GIDEON, created by C.Y. Informatics, is an interactive computer program for diagnosis and reference in the fields of tropical and infectious diseases, epidemiology, microbiology, and antimicrobial chemotherapy. Information concerning this package may be found at <http://www.cyinfo.com>.



## APPENDIX A.2

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# What Are International Sources of Surveillance Information?

Increasingly, information on surveillance may be accessed electronically. Several of the more important resources are listed below.

### **World Health Organization**

The WHO maintains a wealth of information about international public health concerns. Useful items for a Task Manager include a series of basic documents outlining WHO policy, disease outbreak news, and the WHO Statistical Information System, which contains the data from the WHO's mortality database on causes of death, causes of infant death, life expectancy, and age-standardized death rates; statistical information on basic health indicators, burden of disease, health personnel, international classifications, HIV/AIDS, United Nations population data, links to national health-related Web sites, member states of the WHO, and links to other sources of health information. This information may be accessed at: [www.who.int](http://www.who.int).

### **Centers for Disease Control and Prevention**

CDC maintains a number of electronic databases that are easily accessible. CDC databases may be accessed at [www.cdc.gov/scientific.html](http://www.cdc.gov/scientific.html)

#### **1. CDC WONDER**

CDC WONDER is an easy-to-use system that provides a single point of access to a wide variety of CDC reports, guidelines, and U.S. public health data. CDC WONDER (<http://wonder.cdc.gov/>) allows the user to:

- Search for and retrieve MMWR articles and prevention guidelines published by CDC.
- Query dozens of CDC datasets via “fill-in-the blank” request screens. Public-use datasets about mortality, cancer incidence, hospital discharges, AIDS, BRFs, diabetes, and many other topics are available for query, and the requested data can be readily summarized and analyzed.
- Locate the name and e-mail addresses of CDC staff and registered CDC WONDER users.
- Post notices, general announcements, data files, or software programs of interest to public health professionals in an electronic forum, for perusal by CDC staff and other CDC WONDER users.

#### **2. WISQARS™**

WISQARS™ (Web-based Injury Statistics Query and Reporting System), pronounced “whiskers,” is an interactive system that provides injury-related mortality data useful for research and for making informed public health decisions. The user can use “injury mortality reports” to determine injury deaths and death rates for specific external causes of injuries. The user can also use “leading causes of death reports” to determine the number of injury-related deaths relative to the number of other leading causes of death in the United States or in individual states.

### 3. Behavioral Risk Factor Surveillance System

In 1984 CDC established the Behavioral Risk Factor Surveillance System (BRFSS) to develop and conduct surveys to monitor state-level prevalence of the major behavioral risks among adults associated with premature morbidity and mortality (such BRFs include smoking, exercise, and seat-belt usage). The premise was to collect data on actual behaviors, rather than on attitudes or knowledge, that would be especially useful for planning, initiating, supporting, and evaluating health promotion and disease prevention programs. The BRFSS, administered and supported by the Division of Adult and Community Health, National Center for Chronic Disease Prevention and Health Promotion (a division of the CDC) is an ongoing data collection program. State-specific data on various BRFs are retrievable.

### *ProMED-mail*

The ProMED-mail electronic outbreak reporting system, sponsored by the International Society for Infectious Diseases, was inaugurated on the Internet in August 1994 to monitor emerging infectious diseases on a global basis. It is the only rapid reporting system of outbreaks open to all sources and free of political restraints. Expert moderators screen all reports before posting.

A central goal of ProMED-mail is to establish a direct partnership among scientists and doctors in all parts of the world by making it possible for all to share information and discuss emerging disease concerns on a timely basis. ProMED-mail welcomes the participation of all interested colleagues, students, and interested people outside the health and biomedical professions. There is no charge for subscribing. Additional information may be found at [www.promedmail.org/pls/promed/promed.home](http://www.promedmail.org/pls/promed/promed.home).

## APPENDIX A.3

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# What Global and Regional Alert Systems Exist?

The WHO publishes notices of outbreaks on their Web site: [www.who.int/disease-outbreak-news/index.html](http://www.who.int/disease-outbreak-news/index.html).

Pro-MED is the most timely source for reports of epidemics ([www.promedmail.org/pls/promed/promed.home](http://www.promedmail.org/pls/promed/promed.home)).

In addition, CDC publishes the *Morbidity and Mortality Weekly Report* (MMWR), which features topical reports of epidemics, surveillance data, and other public health concerns ([www.cdc.gov/mmwr](http://www.cdc.gov/mmwr)).



## APPENDIX A.4

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### What Training Is Available?

**T**raining needs will vary according to the particular circumstance. For instance, World Bank Task Managers have different needs from, say, sanitation specialists. In general, anyone involved in public health surveillance should have some insight into the basics of epidemiology and the purposes of surveillance. The CDC, universities, and—increasingly—the Internet are among the venues that provide opportunities for training. Several of these venues are discussed below.

#### ***Field Epidemiology Training Programs***

For nearly 20 years CDC's international health specialists have collaborated with ministries of health around the world to establish and conduct Field Epidemiology Training Programs (FETPs) for specialists in epidemiology. These programs are modeled on the Epidemic Intelligence Service, CDC's primary applied epidemiology training program. The two-year training and service programs are designed for health professionals in entry- or mid-level positions, and are intended to assist in building capacity in applied epidemiology and enhanced public health practice.

Countries with FETPs include: Australia, Brazil, Canada, the countries in Central America, Colombia, the Arab Republic of Egypt, Germany, Indonesia, Italy, Japan, Jordan, Mexico, Peru, the Philippines, Saudi Arabia, Spain, Taiwan (China), Thailand, and the United States. For further information consult [www.cdc.gov/epo/dih/fetp.html](http://www.cdc.gov/epo/dih/fetp.html).

#### ***Training Programs in Epidemiology and Public Health Intervention Network, Inc.***

In June 1997, the Training Programs in Epidemiology and Public Health Intervention Network, Inc. (TEPHINET) was founded in a meeting in Annécý, France, attended by directors of 17 national and regional training programs, in response to an invitation of the WHO's Division of Communicable Disease Surveillance and Response; CDC; the Foundation Mérieux; and the national programs that have provided continued support to TEPHINET.

TEPHINET programs share a practical field-based or "learning-by-doing" approach to public health training. They are affiliated with governmental institutions, such as ministries of health, national disease prevention and control programs, and academic institutions. Emphasis is placed on developing competencies in the epidemiologic process, communication in public health, professional skills, and other core public health sciences. For further information, consult <http://asclepius.ic.gc.ca/tephinet>.

#### ***Public Health Training Network***

The Public Health Training Network (PHTN) of CDC is a distance learning system that takes training to the learner. PHTN uses a variety of instructional media ranging from print to videotape and multimedia in order to meet the training needs of the public health work force nationwide. Since 1993 PHTN has delivered nearly 1 million training oppor-

tunities to professionals in public health settings and, increasingly, in health care and related settings. For further information consult [www.cdc.gov/phtn/whatis.htm](http://www.cdc.gov/phtn/whatis.htm).

### ***“Surveillance in a Suitcase”***

“Surveillance in a Suitcase” is a training manual developed by CDC that follows the book *Principles and Practice of Public Health Surveillance*, edited by Steven M. Teutsch and R. Elliott Churchill (Teutsch and Churchill 1994). Staff at the CDC wrote each of the 13 chapters in “Surveillance in a Suitcase.” The text provides a practical and up-to-date reference on the topic of public health surveillance and is the basis of this training manual.

There are 14 lessons in the training package. Each lesson consists of a lecture outline and appropriate overheads that follow the narrative. Two work exercises dealing with public health surveillance and other practical exercises are included. This manual is to be used for teaching public health surveillance to public health and other health professionals. It

was developed for use in the United States, but is in the public domain and can be adapted for use in other countries. “Surveillance in a Suitcase” is available free of charge at: <http://www.cdc.gov/epo/surveillancein/>.

### ***Academic Opportunities***

Numerous universities offer courses in public health surveillance. These include, but are not limited to:

- Washington University (<http://depts.washington.edu/hsic/subject/subjects.html>)
- Emory School of Public Health ([www.sph.emory.edu/home.html](http://www.sph.emory.edu/home.html))
- Johns Hopkins School of Public Health ([www.jhsph.edu](http://www.jhsph.edu))
- Harvard School of Public Health ([www.hsph.harvard.edu](http://www.hsph.harvard.edu))
- London School of Hygiene and Tropical Medicine (<http://www.lshtm.ac.uk/>)

## APPENDIX A.5

# Where Can I Find Useful Textbooks and Articles on Surveillance?

**R**ecommended texts include Teutsch and Churchill 2000b; and Halperin, Baker, and Monson 1992 (See references).

The Internet has become an enormous repository of valuable information on public health surveillance. Useful information and articles include the following:

[www.ph.ucla.edu/epi/snow/broadstreetpump.html](http://www.ph.ucla.edu/epi/snow/broadstreetpump.html)—A fascinating historical look at Dr. John Snow (1813–58), a legendary figure in the history of public health, epidemiology, and anesthesiology.

[www.cdc.gov/mmwr/preview/mmwrhtml/00042730.htm](http://www.cdc.gov/mmwr/preview/mmwrhtml/00042730.htm)—A historical overview of CDC; national morbidity data from June 8, 1946, and June 22, 1996; reprints of articles published in CDC’s “earlier years” reports about an outbreak of smallpox and an outbreak of pentachlorophenol poisoning in newborn infants; and information resources about CDC.

[www.who.int/aboutwho/en/history.htm](http://www.who.int/aboutwho/en/history.htm)—A brief history of the WHO.

[www.who.int/emc-documents/surveillance/whocdscsr992c.html](http://www.who.int/emc-documents/surveillance/whocdscsr992c.html)—Protocol for the Assessment of National Communicable Disease Surveillance and Response Systems: Guidelines for Assessment Teams.

[www.who.int/emc-documents/surveillance/whoemcd972c.html](http://www.who.int/emc-documents/surveillance/whoemcd972c.html)—Protocol for the Evaluation of Epidemiological Surveillance Systems.

[www.who.int/emc/surveill/index.html](http://www.who.int/emc/surveill/index.html)—Integrated Disease Surveillance.

### Other sources

[www.who.int/emc/surveill/index.html](http://www.who.int/emc/surveill/index.html)

[www.cdc.gov/preview/mmwrhtml/rr5013a1.htm](http://www.cdc.gov/preview/mmwrhtml/rr5013a1.htm)

[www.who.int/emc-documents/surveillance/whocdscsr992c.html](http://www.who.int/emc-documents/surveillance/whocdscsr992c.html)

[http://www.who.int/emc/amr\\_interventions.htm](http://www.who.int/emc/amr_interventions.htm)

### Additional readings

Aylward, R. B., H. F. Hull, S. L. Cochi, R. W. Sutter, J. M. Olive, and B. Melgaard. 2000. “Disease Eradication as a Public Health Strategy: A Case Study of Poliomyelitis Eradication.” *Bull WHO* 78: 285–97.

CDC (Centers for Disease Control and Prevention). 1991. “Transmission of Multidrug-Resistant Tuberculosis among Immunocompromised Persons in a Correctional System.” *MMWR* 41 (28): 507–09.

———. 1993. “Recommendations of the International Task Force for Disease Eradication.” *MMWR* 1993; 42 (RR-16): 1–38.

Dowdle, W. R., and D. R. Hopkins, eds. “The Eradication of Infectious Diseases.” Dahlem workshop report. John Wiley & Sons Ltd, Chichester, England, 1998.

Hennekens CH and Buring JE. *Epidemiology in Medicine*. Little, Brown and Company. Boston. 1987.

- Last, J. M. *A Dictionary of Epidemiology*. 2<sup>nd</sup> edition. New York: Oxford University Press, 1988.
- PAHO (Pan American Health Organization). "Epidemiologic Surveillance after Natural Disaster." Washington D.C. 1982.
- Romaguera, R., with R. German, and D. Klaucke. 1993. "Evaluating Public Health Surveillance." In Teutsch, S. M., and R. E. Churchill, eds., *Principles and Practice of Public Health Surveillance*. New York: Oxford University Press.
- White, M. E., and S. M. McDonnel. 2000. "Public Health Surveillance in Low- and Middle-Income Countries." In Teutsch, S. M., and R. E. Churchill, eds., *Principles and Practice of Public Health Surveillance*. Second edition. Oxford University Press.
- Wilcox, L. S., and J. D. Marks, eds. 1994. "From Data to Action: CDC's Public Health Surveillance for Women, Infants, and Children." USDHHS.

ALSO SEE REFERENCES AFTER PART B.

## APPENDIX A.6

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# How Are Surveillance Systems Evaluated?

The evaluation of surveillance systems should promote the best use of public health resources by ensuring that only important problems are under surveillance and that surveillance systems operate efficiently. Insofar as possible the evaluation of surveillance systems should include recommendations for improving quality and efficiency—by eliminating unnecessary duplication, for instance. Most important, an evaluation should assess whether a system is serving a useful public health function and is meeting the system’s objectives.

Because surveillance systems vary widely in methodology, scope, and objectives, characteristics that are important to one system may be less important to another. Efforts to improve certain attributes—such as the ability of a system to detect a health event (sensitivity)—may detract from other attributes, such as simplicity or timeliness. Thus, the success of an individual surveillance system depends on the proper balance of characteristics, and the strength of an evaluation depends on the ability of the evaluator to assess these characteristics with respect to the system’s requirements. Any approach to evaluation must be flexible, in order to accommodate these objectives. With this in mind, the guidelines that follow describe measures that can be applied to surveillance systems, with the understanding that all measures will not be appropriate for all systems and taking into account the time constraints and complexity of the process.

### *Outline of tasks for evaluating a surveillance system*

1. Describe the public health importance of each health event under surveillance. The following are the three most important categories to consider:
  - Total number of cases, incidence and prevalence
  - Indices of severity such as the mortality rate and the case-fatality ratio
  - Preventability
2. Describe the system to be evaluated
  - List the objectives of the system
  - Describe the health event or events under surveillance. State the case definition for each health event.
  - Draw a flowchart of the system
  - Describe the components and operation of the system
  - What is the population under surveillance?
  - What is the timeframe and time period of data collection?
  - What information is collected?
  - Who provides surveillance information?
  - How is information transferred?

- How is information stored?
  - Who analyzes the data?
  - How are the data analyzed and how often?
  - How often are reports disseminated?
  - To whom are reports distributed?
  - How are reports distributed?
3. Indicate the level of usefulness by describing actions taken because of data from the surveillance system. Characterize the entities that have used the data to make decisions and take actions. List other anticipated uses of the data.
  4. Evaluate the system for each of the following attributes:
    - Simplicity
    - Flexibility
    - Data quality
    - Acceptability
    - Sensitivity
    - Predictive value positive
    - Representativeness
    - Timeliness
    - Stability
  5. Describe the resources needed to operate the system (that is, the direct costs).
  6. List conclusions and recommendations. State whether the system is meeting its objectives, and address the need to continue or modify the surveillance system, or both.

*The public health importance of a health event and the need to have that health event under surveillance*

can be described in several ways. Health events that affect many people or require large expenditures of resources clearly have public health importance. However, health events that affect relatively few persons may also be important, especially if the events cluster in time and place—a limited outbreak of a severe disease. At other times, public concerns may focus attention on a particular health event, creating or heightening the sense of importance. Diseases that are now rare because of successful control measures may be perceived as “unimportant,” but their level of importance should be assessed in light of their potential to re-emerge. Finally, the public health importance of a health event is influenced by its preventability.

Parameters for measuring the importance of a health event—and therefore the need for a surveillance system with which to monitor it—include:

1. Total number of cases, incidence, and prevalence
2. Indices of severity, such as the case-fatality ratio
3. Mortality rate
4. An index of lost productivity: such as bed-disability days
5. An index of premature mortality: such as YPLL
6. Cost-effectiveness of interventions
7. Preventability
8. Epidemic potential

These measures of importance do not take into account the effect of existing control measures. For example, the number of cases of vaccine-preventable illness has declined following the implementation of school immunization laws in the United States and elsewhere, and the public health importance of these diseases would be underestimated by case

counts alone. In such instances it may be possible to estimate the number of cases that would be expected in the absence of control programs.

*Assessing the usefulness of a surveillance system:* An assessment of the usefulness of a surveillance system should begin with a review of the objectives of the system and should consider the dependence of policy decisions and control measures on surveillance. Depending on the objectives of a particular surveillance system, the system may be considered useful if it satisfactorily addresses at least one of the following questions.

Does the system:

- Detect trends signaling changes in the occurrence of disease?
- Detect epidemics?
- Provide estimates of the magnitude of morbidity and mortality related to the health problem under surveillance?
- Stimulate epidemiological research likely to lead to control or prevention?

- Identify risk factors associated with disease occurrence?
- Permit assessment of the effects of control measures?
- Lead to improved clinical practice by the health-care providers who are the constituents of the surveillance system?

A surveillance system is useful if it contributes to the prevention and control of adverse health events, including an improved understanding of the public health implications of such events. A surveillance system can also be useful if it helps to determine that an adverse health event previously thought to be unimportant is actually important.

Not every surveillance system will meet all the goals of surveillance. Inevitably tradeoffs have to be made that involve resources; work force; infrastructure; and social or political constraints, or both.

*Source:* CDC 2001; WHO 2001a.



## APPENDIX A.7

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# What Are the Key Statistical Concepts for Surveillance?

Statistics and epidemiology form the cornerstone of public health surveillance. An understanding of statistical principles is necessary to comprehend the published literature and practice in a rational manner. The purpose of this section is to review some of the basic statistical principles and formulas. More in-depth discussion can be obtained in texts of epidemiology and biostatistics.

### Measurements of disease frequency

*Prevalence* is the most frequently used measure of disease frequency and is defined as:

$$\text{Prevalence} = \frac{\text{Number of existing cases of a disease}}{\text{Total population at a given point in time}}$$

*Incidence* quantifies the number of new cases that develop in a population at risk during a specific time interval:

$$\text{Cumulative incidence} = \frac{\text{Number of new cases of a disease during a given time period}}{\text{Total population at risk}}$$

*Cumulative incidence* reflects the probability that an individual will develop a disease during a given time period.

*Mortality rate* is an incidence measure:

$$\text{Mortality} = \frac{\text{Number of deaths}}{\text{Total population}}$$

*Case-fatality rate* is another incidence measure:

$$\text{Case-fatality rate} = \frac{\text{Number of deaths from the disease}}{\text{Total number of cases of the disease}}$$

*Attack rate* is also an incidence measure:

$$\text{Attack rate} = \frac{\text{Number of cases of the disease during a given time period}}{\text{Total population at risk due to having been exposed}}$$

### Test result characteristics

It is important to understand predictive value, which helps in interpreting test results for an individual. The *predictive value positive* expresses the probability that a person with a positive test result is actually infected; the *predictive value negative* is the probability that a person with a negative test result is not infected. The predictive value depends not only on the accuracy of the test itself but also on the prevalence (the percentage of persons who are infected in the population tested). The predictive value of a positive test result decreases as the prevalence declines in the population tested.

Table 6 demonstrates how these values are generated.

From this table four important statistics can be derived:

- *Sensitivity*—A sensitive test detects a high proportion of the true cases, and this quality is measured by  $a / a + c$ .

**Table 6**  
**Comparison of a survey test with a reference test**

Survey test result	Reference test result Positive	Negative	Totals
Positive	True positives, correctly identified = (a)	False positives = (b)	Total test positives = (a + b)
Negative	False negatives = (c)	True negatives correctly identified = (d)	Total test negatives = (c + d)
Totals	Total true positives = (a + c)	Total true negatives = (b + d)	Grand total = (a + b + c + d)

- *Specificity*—A specific test has few false positives, and this quality is measured by  $d/b + d$ .
- *Systematic error*—For epidemiological rates it is particularly important for the test to give the right total count of cases. This is measured by the ratio of the total numbers positive to the survey and the reference tests, or  $(a + b) / (a + c)$ .
- *Predictive value*—The proportion of positive test results that are truly positive; it is important in screening. It should be noted that both systematic error and predictive value depend on the relative frequency of true positives and true negatives in the study sample (that is, on the prevalence of the disease or exposure that is being measured). Predictive value is measured by  $a/a+b$ .

## APPENDIX A.8

# How Does Surveillance Case Definition Relate to Sensitivity and Specificity?

As noted in part A above (discussion of surveillance methods) public health officials rely on health-care providers, laboratory personnel, and other public health personnel to report the occurrence of notifiable diseases, conditions, injuries, and so on to health departments. To facilitate this reporting case definitions are developed to provide uniform criteria for identifying these diseases and conditions.

Case definitions always involve a balancing act of sensitivity as opposed to specificity. A definition is *sensitive* if it identifies all the cases of a disease or condition in question. A definition is *specific* if it excludes individuals without the disease or condition in question. Sensitivity and specificity thus describe the accuracy of the test. Sensitivity determines the percentage of false-negative results, and specificity determines the percentage of false-positive results, when a large number of positive and negative samples are tested.

An insensitive case definition may suffice when cases are plentiful and it does not matter if some cases are missed. On the other hand, in the end-game of control (when a disease nears elimination), it is important to have a sensitive definition to ensure

that all possible cases are captured, even if many are false positive.

The WHO has a catalog of case definitions for infectious diseases (WHO 1999a).

Examples of case definitions from the WHO include:

### CHOLERA

#### Clinical case definition

- In an area where the disease is not known to be present: severe dehydration or death from acute watery diarrhea in a patient aged 5 years or more or
- In an area where there is a cholera epidemic: acute watery diarrhea, with or without vomiting in a patient aged 5 years or more.<sup>6</sup>

#### Laboratory criteria for diagnosis

- Isolation of *Vibrio cholerae* O1 or O139 from stools in any patient with diarrhea.

#### Case classification

- *Suspected*: A case that meets the clinical case definition.
- *Probable*: Not applicable.
- *Confirmed*: A suspected case that is laboratory-confirmed.

*Note*: In a cholera-threatened area, when the number of "confirmed" cases rises, shift should be made to using primarily the "suspected" case classification.

<sup>6</sup>Cholera does appear in children under 5-years old; however, the inclusion of all cases of acute watery diarrhea in the 2- to 4-year-old age group in the reporting of cholera greatly reduces the specificity of reporting. For management of cases of acute watery diarrhea in an area where there is a cholera epidemic, Cholera should be suspected in all patients.

## MEASLES

### Clinical case definition

- Any person with fever, and maculopapular (nonvesicular) rash, and cough, coryza (runny nose) or conjunctivitis (red eyes), *or*
- Any person in whom a clinician suspects measles infection.

### Laboratory criteria for diagnosis

- At least a fourfold increase in antibody titre *or*
- Isolation of measles virus *or*
- Presence of measles-specific IgM antibodies

### Case classification

- *Clinically confirmed*: A case that meets the clinical case definition.
- *Probable*: Not applicable.
- *Laboratory-confirmed*: *only for outbreak confirmation and during elimination phase*. A case that meets the clinical case definition and that is laboratory-confirmed or linked epidemiologically to a laboratory-confirmed case.

## MENINGOCOCCAL DISEASE

### Clinical case definition

- An illness with sudden onset of fever ( $>38.5^{\circ}\text{C}$  rectal or  $>38.0^{\circ}\text{C}$  axillary) *and one or more* of the following:
  - Neck stiffness
  - Altered consciousness
  - Other meningeal sign or petechial or purpurial rash
- In patients younger than  $<1$  year, suspect meningitis when fever accompanied by bulging fontanelle.

### Laboratory criteria for diagnosis

- Positive CSF antigen detection *or*
- Positive culture

### Case classification

- *Suspected*: A case that meets the clinical case definition.
- *Probable*: A suspected case as defined above and: Turbid CSF (with or without positive Gram stain) or ongoing epidemic and epidemiological link to a confirmed case
- *Confirmed*: A suspected or probable case with laboratory confirmation.