
Global Epidemiological Surveillance Standards for Influenza





Global
Epidemiological
Surveillance
Standards for
Influenza



WHO Library Cataloguing-in-Publication Data

Global epidemiological surveillance standards for influenza.

1. Influenza, Human - epidemiology. 2. Population surveillance - methods. 3. Pandemics - prevention and control. 4. Disease outbreaks - I. World Health Organization.

ISBN 978 92 4 150660 1

(NLM classification: WC 515)

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Development history of this document:

- Summer 2010: Discussions of key parts of the proposed standards with the WHO Epidemiological Network, the pandemic evaluation group at WHO headquarters, and WHO regional office staff.
- December 2010: A WHO working group on Global Influenza Surveillance Standards was assembled to work on background documents for the Global Consultation planned for March 2011. The working group brought together experts from all six WHO regions who prepared technical briefing documents around key surveillance issues to be included in this document.
- January-February 2011: Teleconferences were held with all six regional offices to share the briefing documents and to discuss key elements in advance of the Global Consultation.
- March 2011: The Global Consultation on Influenza Surveillance Standards was held in Geneva. The consultation included epidemiologists and surveillance officers from 35 countries from all six regions, each of the WHO regional offices, representatives from PATH, the US Centers for Disease Control and Prevention (CDC), the European Centre for Disease Prevention and Control (ECDC), and WHO. The report of the meeting is available on the WHO website at: http://www.who.int/influenza/resources/documents/technical_consultation/en/index.html
- April 2011 – January 2012: Several drafts were produced based on the input from the Global Consultation and shared with the WHO epidemiological network, the working group, and other advisors for comments and input.
- February 2012: A draft document was shared and formal teleconferences were held with the six regional offices.
- March-April 2012: The draft document was circulated to members of the WHO working group and the members of the epidemiological network.
- Recommendations for baselines and threshold calculations were tested by the WHO Regional Office for Europe using data from Romania, and colleagues in Australia using data from Victoria.
- July-October 2012: Publication of the WHO Global Interim Epidemiological Surveillance Standards for Influenza on the WHO influenza website (<http://www.who.int/influenza/en/>) for wider comments.

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Abbreviations and acronyms

AIDS	Acquired Immune Deficiency Syndrome
ARDS	Acute Respiratory Distress Syndrome
ARI	Acute Respiratory Infection
GISRS	Global Influenza Surveillance and Response System
GISN	Global Influenza Surveillance Network
HIV	Human Immunodeficiency Virus
ICPC	International Classification of Primary Care
ICD	International Classification of Diseases
IHR	International Health Regulations
ICU	Intensive Care Unit
ILI	Influenza-Like Illness
MEM	Moving Epidemics Method
NIC	National Influenza Centre
PHEIC	Public Health Emergency of International Concern
PIP	Pandemic Influenza Preparedness Framework
RT	Reverse Transcriptase
PCR	Polymerase Chain Reaction
SARI	Severe Acute Respiratory Infection
WHO	World Health Organization
WHO CC	WHO Collaborating Centre

01



Introduction

Key messages

- Influenza infections cause substantial morbidity and mortality every year.
- Historically, influenza surveillance has focused on *virological* monitoring and collection of specimens to guide vaccine strain selection.
- This document defines global standards for the collection, reporting, and analysis of seasonal influenza *epidemiological* surveillance data.
- Regional and national guidelines should also be consulted for more detailed recommendations on surveillance.

1.1 Historical background of influenza surveillance

The Global Influenza Surveillance and Response System (GISRS)¹, previously known as the Global Influenza Surveillance Network (GISN), has performed influenza virological surveillance since 1952. This network has played a critical role in developing our current understanding of global influenza virus circulation. The primary aims of the system have been threefold: to monitor changes in antigenicity of influenza viruses; to guide the selection of strains for the annual influenza vaccine; and to provide virus samples for use in vaccine production. The GISRS consists of over 140 National Influenza Centres (NICs) around the world that collect and test clinical specimens, submitting a sample of these to WHO Collaborating Centres (WHO CC) and Essential Regulatory Laboratories for further characterization.^{2,3}

In recent years, an increasing awareness has developed of the need to expand influenza surveillance and to include more epidemiological information to complement the virological data collected by GISRS. This need was formally recognized by the World Health Assembly in 2011 in resolution 64.5 and in the adoption of the Pandemic Influenza Preparedness Framework.^{4,5}

The pandemic of 2009 uncovered several specific gaps in global influenza surveillance capacity, which compromised the assessment and monitoring of the event. The lack of any established surveillance for severe disease in most countries and the resulting absence of historical data limited Member States' ability to evaluate the severity of the event in the context of previous seasons or to observe for changes in the behaviour of the virus. The lack of a pre-existing international mechanism for sharing epidemiological data presented challenges to understanding global patterns of transmission and disease. Finally, the non-standardized approach to data collection and outbreak investigations early in the event resulted in data that was often incompletely understood outside the local context. The standardization of influenza data collection addressed in this document will enable national policy makers to better understand risk factors for severe disease, the variation of influenza severity from season to season and its relationship to virus types or subtypes, the burden of disease related to influenza, and other factors critical to public health decision-making; it will also enable them to

1 GISRS is the new name adopted by the World Health Assembly in resolution 64.5, replacing the former name of the Global Influenza Surveillance Network (GISN).

2 For the current list of National Influenza Centres, see http://www.who.int/influenza/gisrs_laboratory/national_influenza_centres/en/.

3 For the current list of Influenza Collaborating Centres and Essential Regulatory Laboratories, see http://www.who.int/influenza/gisrs_laboratory/collaborating_centres/en/.

4 http://apps.who.int/gb/ebwha/pdf_files/WHA64/A64_R5-en.pdf

5 <http://www.who.int/influenza/pip/en/>

interpret their own observations in a global context. The accumulation of historical data for influenza-associated severe respiratory disease will allow rapid comparative assessment of each influenza season and of future pandemics both locally and globally.

1.2 Goals of this document

This document proposes surveillance objectives and describes global standards for a minimal basic respiratory disease surveillance system for the monitoring of influenza. The agreement on objectives allows for the prioritization of the many facets of influenza that might be measured and tracked. Use of international standards will enable Member States to understand how the epidemiology, transmission, and impact of influenza in their own countries differ from those of other Member States; in addition it will allow them to more easily interpret data gathered from other Member States.

The document also provides a framework for influenza surveillance adaptable to national public health resources and public health priorities. It does not require countries to dramatically alter existing respiratory disease surveillance systems but rather to establish minimum standards for inpatient and outpatient respiratory disease surveillance reporting, data collection, and analysis. Existing systems that do not use internationally standardized case definitions or procedures are encouraged to transition over time to the standards described in this document where possible. However, as sustainable surveillance often depends on pre-existing routine systems of data flow, clinical practices and laboratory practices, the national systems developed or adapted may be constrained by such systems.

Severe acute respiratory infection (SARI) and influenza-like illness (ILI) surveillance should be integrated into existing public health systems to efficiently use resources and to promote surveillance sustainability and avoid disruption of other important public health programmes. The incorporation of sentinel influenza surveillance with other healthcare-based surveillance systems can strengthen each system, allowing for efficiencies in data collection, laboratory transport, and other logistics. SARI sentinel surveillance systems can be integrated with pneumonia, bronchiolitis, meningitis, and severe diarrheal illness surveillance, depending on local disease priorities.⁶

1.3 Target audience

This document is intended to be a tool for public health professionals, institutes and national health authorities involved in influenza surveillance.

1.4 How to use this document

Surveillance is usually defined as providing information for action and therefore the most important starting point in reading and using this document is Chapter 2, which identifies the objectives of influenza surveillance and the related decisions and actions that surveillance can inform. When considering whether to initiate or modify surveillance systems, every Ministry of Health will need to first determine its own information needs and surveillance objectives. It is essential that current healthcare systems and clinical and laboratory practices be taken into account in designing and transitioning to surveillance systems that can meet these objectives.

6 Hyde TB, Andrus JK, Dietz VJ and the Integrated All-VPD Surveillance Working Group. Critical Issues in Implementing a National Integrated All-Vaccine Preventable Disease Surveillance System Vaccine. *Vaccine*. 2013

Introduction

While this document advocates a specific approach emphasizing surveillance for ILI and SARI, WHO and the contributors to the development of this document recognize that other approaches may achieve similar objectives and provide data that are comparable to those described here. The basic principle underlying the methods described in this work is that Member States should monitor the occurrence of both mild *and* severe disease related to influenza, using appropriate laboratory methods to confirm the presence of influenza. Establishing and agreeing on consistent case definitions as described in Chapter 4 is essential, although some modification may be needed to achieve compatibility with local data-gathering systems and local clinical practice standards. Hence, it is noted that international classification of diseases (ICD) codes, along with laboratory confirmation of influenza, are occasionally used instead of SARI and ILI, though this approach is not recommended because of its inherent limitations and validation requirements.

The specific objectives of the programme as decided by the Ministry of Health will also determine how the recommendations for selection and location of sentinel sites (Chapter 5) are implemented. Additionally, as it is not possible to test all or even most cases of acute respiratory infection, a selection and sampling strategy has to be agreed upon in order to provide a sample of cases that properly represents the larger group (Chapter 6). A minimum data set is described (Chapter 8) listing key risk factors for severe influenza. Some Member States may desire to expand this list to account for local variations in demographics or patterns of chronic illness. The sharing of data with policy makers will help to ensure well-informed policy decisions, the reporting of data back to those who generate it will improve patient care and encourage continued reporting, and the international reporting of standardized data will benefit all Member States by facilitating long-range planning. Each of these reporting activities will require different types of aggregated and disaggregated data (Chapter 8). Finally, the availability of baseline data will be extremely valuable during unusual outbreaks or pandemics, but some modification and expansion of existing systems will likely be necessary during such an event. Methods to define baseline values of influenza and respiratory disease activity are described in Chapter 10 (and Appendix 8), and the expansion of routine surveillance to better describe and monitor pandemic activity is described in Chapter 12.

02



Objectives of influenza surveillance

Objectives of influenza surveillance

The overarching goal of influenza surveillance is to minimize the impact of the disease by providing useful information to public health authorities so they may better plan appropriate control and intervention measures, allocate health resources, and make case management recommendations.

The specific goal of influenza surveillance is to provide timely and high-quality epidemiological data and viral isolates to perform the following set of functions:

- Describe the seasonality of influenza where feasible.
- Signal the start and end of the influenza season.
- Provide candidate viruses for vaccine production.
- Describe the antigenic character and genetic makeup of circulating viruses.
- Identify and monitor groups at high risk of severe disease and mortality.
- Establish baseline levels of activity for influenza and severe influenza-related disease with which to evaluate the impact and severity of each season and of future pandemic events.
- Generate influenza data that can be used during focused studies to estimate influenza burden and help decision-makers prioritize resources and plan public health interventions.
- Identify locally circulating virus types and subtypes and their relationship to global and regional patterns.
- Assist in developing an understanding of the relationship of virus strains to disease severity.
- Monitor antiviral sensitivity.
- Detect unusual and unexpected events such as outbreaks of influenza outside the typical season, severe influenza among healthcare workers, or clusters of vaccine failures that may herald novel influenza virus.

In addition, by producing baseline data, surveillance systems may also provide a platform for evaluation of vaccine and other intervention effectiveness.

Not all of these objectives will be accomplished by every system, particularly when resources are limited. For example, not every system will describe the genetic makeup of circulating viruses or test for antiviral sensitivity, except when participating in regional and global networks. Health planners will need to decide their own priorities for surveillance before embarking on setting up a system as the primary surveillance objectives will largely determine the configuration, activities, and size of the system. Table 1 describes the public health-related decisions that can be informed by meeting the different surveillance objectives.

Table 1: Objectives of influenza surveillance and its use in decision-making

Principal objective	Use of surveillance data in decision-making
Determine when and where influenza activity is occurring, and who is affected	Alert healthcare providers to anticipate influenza disease in clinics and hospitals Inform and target national prevention and treatment policies such as vaccination timing and the use of pharmaceutical and non-pharmaceutical interventions to control spread
Detect changes in the antigenic and genetic characteristics and antiviral sensitivity of influenza viruses	Inform local clinician use of antiviral therapies Inform choice of vaccine locally and selection of appropriate viruses globally
Determine and monitor underlying risk conditions that are associated with severe disease and use of healthcare resources. Describe the clinical patterns of disease	Improve clinical management and prevention of disease in high risk patients Inform national policies such as priority groups for vaccination and treatment
Assess and monitor relative severity of annual epidemics or an outbreak of a novel virus	Assist policy makers in making decisions about public interventions Inform cost-benefit type decisions related to public interventions
Estimate contribution of influenza to severe respiratory illness or overall disease burden	Allow appropriate allocation of limited health resources among competing disease-related priorities Establish epidemic thresholds for comparison of disease severity between years and localities Contribute to global knowledge base regarding burden of disease attributable to influenza disease
Detection of unusual events	Rapid detection to alert the International Health Regulation focal points about potential public health events of international concern
Measure impact of interventions	Inform choice of intervention strategies

2.1 Relationship to early detection of signal events

A routine sentinel surveillance system for influenza as described in this document is intended to provide data to assist healthcare policy makers and providers in programme management and patient-care decisions. The establishment of historical trends and baselines provides a range of usual, expected values against which to compare outbreaks related to new viruses or unexpected events related to previously circulating viruses. Such historical data will allow, rapid assessment of future pandemic severity and provide the necessary infrastructure to follow the impact of an event, such as an outbreak of a novel influenza virus, as it unfolds over time. The data will provide valuable information on the usual seasonality of influenza and the groups at risk for severe disease. Creation of a routine surveillance system will establish infrastructure such as systems for specimen transport and testing, systems for information gathering and analysis, and a cadre of trained epidemiologists familiar with influenza and respiratory disease epidemiology.

Although one of the critical functions of influenza surveillance is to detect novel strains of influenza in compliance with the International Health Regulations (2005), it is important to understand that the

surveillance standards and methodology described in this document are not intended to describe a system for rapid detection of emerging novel influenza strains or outbreaks of respiratory disease. Events that call for rapid response for containment or mitigation require detection at a very early stage when the event is geographically localized and involves a relatively small number of people. Such early detection primarily involves identifying and reporting unusual signal events and immediately passing such information on to health authorities. In the context of novel strains of influenza, the objective of early detection is to note the first evidence of sustained human-to-human transmission of an influenza virus with pandemic potential when circulation of the virus is limited.⁷

For more detailed explanation on how to develop your system so that it can capture early detection of a novel virus in addition to collection surveillance data, see Appendix 1.

⁷ See also: Western Pacific Regional Office: A Guide to Establishing Event-based Surveillance. Available at: http://www.wpro.who.int/emerging_diseases/documents/docs/eventbasedsurv.pdf

03



Basic needs

An effective surveillance system includes the following functions:

- Collection, reporting, and consolidation of data.
- Regular analysis and interpretation of data.
- Feed-forward of data analysis to decision makers.
- Feedback of data analysis to those providing the data and other interested parties.
- Detection, evaluation, and response to unusual patterns in the data.
- Quality assurance.

The design of a surveillance system should be based on clear national priorities and disease control objectives. Data collection should be designed to meet information needs of public health decision makers, the general public, and healthcare providers. The surveillance system should be as streamlined as possible, collecting the minimum amount of data needed for decision making. Certain specific and more complex questions about influenza transmission are better answered through targeted research projects, which may make use of an existing surveillance platform, than by attempting to routinely collect large amounts of detail through the entire system.

Use of clear surveillance standards will ensure that data can be understood and interpreted by all who need it. Important aspects to be standardized include the type of surveillance, case definitions, the data elements to be collected, data formats and the basic analyses and reports to be produced.

Operationalizing a surveillance system requires planning the overall process, including the tasks at each level, the data and/or specimen flow, logistics, staffing, and training. Performance indicators for supervision and monitoring should be designed so that system weaknesses can be identified and corrective action taken where necessary.

3.1 Rationale for sentinel surveillance of ILI and SARI

Sentinel surveillance involves systematically collecting data on a routine basis from a limited number of surveillance sites. Ideally, the sites are chosen to be representative so that the information gathered can be applied to the population as a whole or, in certain instances, among subpopulations at higher risk of developing severe influenza illness.

Sentinel surveillance is the most efficient way to collect high-quality data in a timely way. A sentinel surveillance system reduces the number of resources required as efforts can be focused on a limited number of carefully selected surveillance sites. The objectives of influenza surveillance can be met and the quality of the data collected more readily assured. Excessively large systems or those that attempt to collect data from all healthcare facilities are resource-intensive and generally do not provide more information than a well-designed and representative sentinel system for common conditions. In addition, it is often difficult to maintain the quality and timeliness of data generated by large systems which can make their findings difficult to interpret. In countries where universal reporting exists, a select few healthcare facilities can be designated to serve as sentinel sites within the larger system.

Sentinel ILI surveillance monitors persons seeking care in ambulatory facilities; sentinel SARI surveillance monitors persons with more severe illness who have been admitted to hospital for their respiratory illness. The ILI and SARI case definitions have low sensitivity and specificity for identifying

influenza illness.⁸ Therefore, ILI and SARI sentinel surveillance is most effective when case patients are laboratory tested for influenza virus. Obtaining respiratory samples from all or a systematic proportion of ILI and SARI case patients contributes to the understanding of the complete spectrum of influenza illness, including differences in the epidemiology of various influenza virus types and subtypes, factors that place individuals at increased risk for severe disease, and the impact that the disease is having on healthcare delivery systems. SARI data are particularly useful for monitoring and assessing the impact of influenza on high-risk populations, the severity of seasonal outbreaks, or even future global pandemics, in relation to previous seasons.

The balance between ILI and SARI surveillance activity in a system will depend on the specific information needs and surveillance priorities in each individual country. The work and resource requirements of a system will depend more on the specific objectives of the data collection than on whether surveillance is done for mild or severe cases. For example, simply describing the timing of the influenza season and collecting influenza virus samples do not require linking laboratory data with extensive epidemiologic data or robust systematic sampling methods. However, to understand risk factors, severity, impact, and clinical outcomes of influenza-associated disease requires expanded epidemiologic data collection and more careful sampling methodologies. Measuring burden of disease in terms of population incidence requires careful site selection and an unbiased approach to case selection for testing.

8 Emmurray EL et al. 2012. What are the most sensitive and specific sign and symptom combinations for influenza in patients hospitalized with acute respiratory illness? Results from western Kenya, January 2007–July 2010. *Epidemiology and Infection*. doi:10.1017/S095026881200043X

04



Case definitions

Key messages

- Influenza infection causes a clinical syndrome not easily distinguished from other respiratory infections.
- The case definitions for ILI and SARI are not necessarily intended to capture all cases but to describe trends over time.
- Using one common case definition globally will allow national health authorities to interpret their data in an international context.

ILI can be caused by a variety of microbial agents other than influenza viruses, and the range of symptoms observed with influenza virus infections is nonspecific and resembles the clinical picture of a variety of other pathogens.⁹ There is no single symptom or group of symptoms that is exclusive only to influenza. Any case definition based only on signs and symptoms will miss some influenza infections and include some non-influenza infections, even with the addition of laboratory confirmation. This uncertainty poses challenges both when diagnosing influenza and when doing influenza surveillance and requires an integration of virological and epidemiological surveillance in order for the data to be most useful.

As the primary goal of influenza surveillance is to recognize trends, describe patterns of risk, and estimate impact, it is not necessary to identify every case. This is also true with estimating disease burden, although special methods are required to understand the sensitivity of the definition as it is used in a specific country and to estimate the missing fraction of cases. As with all case definitions, there is a balance to be achieved between sensitivity and specificity. A more sensitive definition will capture a larger proportion of all cases at the cost of testing a large number of cases caused by agents other than influenza. A more specific definition will result in more accurate capture of cases but will miss a larger proportion of the total and perhaps provide a more biased picture of the pattern of disease occurring in the community.

Importantly, a surveillance case definition is not intended to be used for diagnostic purposes or for treating influenza or influenza-like illnesses.

4.1 Surveillance case definitions for ILI and SARI

ILI case definition

An acute respiratory infection with:

- measured fever of $\geq 38\text{ C}^\circ$;
- and cough;
- with onset within the last 10 days.

SARI case definition

An acute respiratory infection with:

- history of fever or measured fever of $\geq 38\text{ C}^\circ$;
- and cough;
- with onset within the last 10 days;
- and requires hospitalization.

⁹ Monto AS et al. Clinical Signs and Symptoms Predicting Influenza Infection. *Archives of Internal Medicine*. 2000;160:3243-3247.

The ILI case definition is generally intended for use in outpatient treatment centres and the SARI definition for inpatient hospital settings. Countries may want to use more liberal case definitions (e.g. history of feverishness for ILI among children) as long as they can readily determine and report case patients who meet the ILI case definition above (i.e. fever $\geq 38\text{ C}^\circ$ with cough within 10 days of presentation). The SARI definition aims to capture both the influenza-related pneumonias and influenza-related exacerbations of chronic illnesses such as asthma or heart disease. In countries where the burden of influenza has been carefully studied, a proportion of influenza-related hospitalizations and deaths receive other diagnoses than pneumonia.^{10,11}

The focus of ILI and SARI surveillance is on the proportion of laboratory confirmed influenza-associated disease. For the purposes of surveillance, laboratory confirmation can be by any of the following (see Chapter 7 for more information on recommended laboratory tests):

- Conventional or real-time reverse transcriptase-polymerase chain reaction (RT-PCR).
- Viral antigen detection by immunofluorescence or enzyme immunoassay methods (including commercially available bedside tests).
- Viral culture with a second identification step to identify influenza viruses (immunofluorescence, haemagglutination-inhibition, or RT-PCR).
- Four-fold rise in antibody titre in paired acute and convalescent sera.

Although viral detection methods for laboratory confirmation of influenza will be most successful when done within the first five days after onset of illness, a significant portion of influenza cases may present with SARI after this time period. Thus, SARI cases may be identified and tested for influenza up to 10 days after illness onset with little increase in the cost per positive test.

4.2 Surveillance of ILI and SARI using automated electronic data collection

Many health systems are now able to collect summary data from electronic data reporting systems that have information coded according to the ICD or the International Classification of Primary Care (ICPC) coding systems. While WHO has not carried out a formal evaluation of the correlation between various disease codes and the clinical syndromes of ILI and SARI, anecdotal reports from countries using ICD or ICPC-coded databases indicate that they may be useful to supplement data gathered directly from sentinel surveillance systems. The influenza-specific ICD 10 codes, J09–J11 (influenza due to certain identified influenza viruses; influenza due to other identified influenza viruses; and influenza, virus not identified),¹² appear to correspond most closely with SARI surveillance and the ICPC R80 code¹³ to ILI. A broader range of codes, including all respiratory syndromes, has also been used in some programmes, but seems to be less strongly associated with influenza specifically.

10 Li CK et al. Influenza-related deaths and hospitalizations in Hong Kong: A subtropical area. *Public Health*. 2006 120, 517–524

11 Thompson WW et al. Influenza-Associated Hospitalizations in the United States. *JAMA*. 2004;292(11):1333–1340 (doi:10.1001/jama.292.11.1333).

12 International Classification of Diseases (ICD) <http://www.who.int/classifications/icd/en/>

13 International Classification of Primary Care, Second edition (ICPC-2) <http://www.who.int/classifications/icd/adaptations/icpc2/en/>

The interpretation of the data derived from these kinds of systems will depend heavily on the local coding practices, the external forces that influence coding decisions (such as reimbursement), and clinician understanding of the coding system. Programme designers should consider a period of overlap and comparison of ICD or ICPC data with laboratory-confirmed ILI and SARI data before abandoning previously established sentinel systems. Surveillance systems using ICD codes as proxies for ILI and SARI will still need to collect clinical samples from a subset of cases for virological testing and it is recommended that this be done in the same manner as described for sentinel systems elsewhere in this document, including collection of the minimum set of epidemiological and demographic data.

4.2.1 Limitations

Depending on how the data are entered and aggregated in the system, use of automated coded data may limit the programme's ability to understand the risk factors associated with severe disease, the age distribution, and other factors that may be directly related to clearly understanding local influenza epidemiology. Data from systems using coded data are less likely to have epidemiological data that can be directly linked to virological data. The epidemiological data without accompanying laboratory confirmation will have less meaning for influenza specifically as it would include data for large numbers of non-influenza-related illness. In addition, as selection of cases for testing is generally driven by clinical judgements in these systems, it is likely that the proportion of specimens testing positive, the proportion of cases with chronic pre-existing medical conditions, and the age range of cases may all be different from systems in which cases are selected through an unbiased systematic process as described in Chapter 6. The importance of these issues will depend on the surveillance objectives established by health policy makers of the country.

05



Selection and location of sentinel sites

Key messages

- Feasibility and representativeness are the most important factors to consider when choosing a sentinel site.
- There is no ideal number of sentinel sites in a country. Start small with one or a few sentinel sites and only expand if these function well.
- In general, small amounts of good quality data are more useful than large amounts of poor quality data.

5.1 Feasibility and sustainability

The feasibility of a facility to participate in a sentinel system and the sustainability of the surveillance system are important criteria to consider when selecting a sentinel site. These attributes will depend on the following being present at the facility:

- Facility staff and leadership motivated and committed to voluntarily implement and sustain surveillance.
- Efficient, consistent, and sustainable mechanisms for collection, storage, and transport of clinical specimens.
- Ability to reliably manage and report surveillance data, including the necessary communications infrastructure.
- Stable and long-term funding to cover the general cost of the surveillance operations at the site.

Laboratory capacity at a site to test specimens may facilitate surveillance but is not absolutely necessary if specimens can be tested at a central facility and the site has the capacity for storage and timely transport.

5.2 Representativeness

Sentinel sites should include patients that will appropriately represent the population. Sites like this can be used if patients receive primary care here and if these sites can be balanced with others representing other segments of the population. Some issues to consider with regard to representativeness:

- For ILI sentinel sites, general outpatient clinics or acute care facilities are often appropriate choices. Specialty outpatient clinics, such as obstetrical–gynaecological or diabetes clinics, do not represent the wider patient range.
- For SARI sentinel sites, general or community hospitals are more likely to be representative of the general population than specialty or tertiary care referral hospitals.
- Within the hospital facility, the surveillance system should include all wards where SARI patients are expected to be treated.
- Urban versus rural representativeness.
- The population served by the sentinel site should be representative of the target age and socioeconomic groups in the population under surveillance.
- When multiple sentinel sites are being established, consideration should be given to representing additional population centres or climate zones, each of which may have unique demographic and socio-economic characteristics resulting in differences in transmission patterns.

5.3 Disease burden

If there is interest in developing disease burden estimates for influenza, several things must be considered when selecting sites. Population-based incidence, i.e. the number of new cases of a disease per 100,000 people in the population per year, is the classic way to express burden. This requires the ability to either count or reliably estimate the number of cases that occur in a year *and* the size of the population that generally seeks care at the sentinel site facility (see Chapter 6 for more information on sampling strategies). Some considerations when selecting sites for surveillance when disease burden estimates are desired:

Availability of reliable numerator data

- Ability to either capture all cases meeting the case definition or to reliably estimate the fraction captured. This may not be feasible, for example, in very large, busy, chaotic tertiary care centers.
- Adequate patient volume. It is just as important that a facility have sufficient patient volume to make the surveillance data meaningful. Accordingly, a register review may therefore be necessary to estimate the number of SARI and ILI patients seen by the facility throughout the year.

Availability of useful denominator data

- It is necessary to have population denominators for the catchment area of the sentinel sites interested in estimating influenza disease burden. Estimation of denominators may require additional work, such as a health facility utilization survey in the catchment area to determine the proportion of the population that uses the sentinel site for healthcare; or a review of admission statistics of other facilities in the area to determine the fraction of the population with respiratory disease that is admitted to the sentinel site.
- When population denominators are not known, the proportion of all admissions to the facility that are due to influenza-associated SARI or visits to the outpatient department for influenza-associated ILI per week or month will reflect the burden placed on the healthcare system by influenza. This information will also allow the comparison of severity between one season and the next. Required hospital denominators will include number of admissions for all causes or, for ILI burden, total consultation rates. With additional data, it may be possible to extrapolate estimates from sentinel sites to national healthcare systems.
- Although most pneumonias may be caused by etiologies other than influenza virus, the proportion of pneumonia or other respiratory disease caused by influenza will reflect the influenza disease burden. As with the proportion of all admissions, knowing the proportion of pneumonia cases caused by influenza is also a useful parameter for tracking influenza severity from season to season and for estimating the burden placed on the healthcare delivery system by influenza. This proportion will not permit an estimate of the true overall burden of influenza, however, as severe disease caused by influenza very often does not present as pneumonia.

Even if disease burden estimation is not an objective for national health authorities, these data can serve as basic indicators to monitor trends in the severity of respiratory disease over time.

5.4 Number of sites and expansion of the system

There is no ideal minimum number of sentinel sites for either ILI or SARI surveillance. This is because of the high degree of variability in national population sizes, variation in the geographic distribution of

Selection and location of sentinel sites

populations and ethnic groups, and variation in climate and geography in many countries. All sentinel systems should begin small and expand only as data needs expand and sites have been appropriately evaluated. The more important concerns are that the data represent the population, meet the needs of policy makers, and be of good quality.

In general, small amounts of good quality data will be more useful than large amounts of poor quality data. Therefore, when establishing a system it is important to not establish more sites than can be effectively managed, monitored, and sustained. See also Chapter 11 on monitoring and evaluating the surveillance system. Appendix 2 provides a checklist for selection of sentinel sites.

06



Case selection and sampling strategy

Key messages

- Testing all patients for influenza at a site is ideal, if feasible, but otherwise a sampling strategy should be implemented for selection of patients for testing and data collection.
- Patient selection for testing and data collection should be done in such a way as to minimize bias.
- The sampling strategy to implement will depend in part on the specific surveillance objectives of each country.

6.1 Sampling (case selection) methodology

The number of patients to be included in the sample should be decided after reviewing the laboratory capacity and other resources available. Staff should anticipate increased workloads and throughput needs to accommodate surveillance requirements during epidemics. While laboratory testing and data collection on all patients seen in an outpatient department with ILI or admitted to a sentinel hospital for SARI would produce data with the least bias, this is not likely to be feasible for most sites. Therefore, selection of a subset of cases will usually be necessary. In order to collect data that accurately depicts the distribution of risk factors, the impact of influenza on different age groups and the general pattern of disease, and that can be extrapolated to the total number presenting for care, cases should be selected in a manner that minimizes bias. For example, systems interested primarily in virological surveillance often select the first two cases of the day for testing. However, it is well recognized that there are differences in health-seeking behaviour between adults and children, for example, or in those with chronic conditions and disabilities. This approach to case selection will result in a systematic bias in the types of individuals from whom samples and data are taken. It could yield a skewed perspective of the types of individuals affected, their risk factors, and their general demographic characteristics. Selections of cases based on a clinician's judgment will also likely result in bias as clinicians will be more likely to identify patients with underlying conditions, young children, or the elderly as having influenza – which may be a correct judgment but will not give an accurate representation of the proportions with these conditions.

In general, the larger the proportion of SARI or ILI cases from which clinical specimens for virological testing and epidemiological data are collected, the less bias will be introduced. However, the total number of patients chosen for virological testing and epidemiological data collection will depend on both the ability of the healthcare facility to collect information and process, store, and ship specimens as well as the capacity of the laboratory to process, store, and test the samples.

Selected patients should fulfil the following criteria in order to be tested:

- Meet the clinical case definition for SARI or ILI.
- The onset of symptoms falls within 10 days of sample collection.

6.2 Ad hoc or convenience sampling

Sampling schemes that do not adhere to a pre-determined system are the easiest and least costly to implement but are also the most subject to bias. Differences in the health-seeking behaviour of different groups and preconceived ideas about the risk of healthcare providers can introduce unpredictable biases, consequently yielding patterns in the data that do not represent reality. While this approach may still yield data sufficient to identify transmission seasonality, and provide specimens

for virological surveillance, it will not provide a reliable picture of the epidemiological characteristics of influenza or burden and should not be used if these are the objectives of the system.

6.3 Random sampling schemes

A true random sample of cases is likely to be the most representative, but it is labour intensive and generally only feasible for research projects. It is not recommended for most surveillance sites unless a specific research programme is being built onto a surveillance platform.

6.4 Systematic sampling of SARI patients

A systematic approach to case selection that does not leave the choice of cases to test or gather data from up to healthcare providers (other than to determine that the case meets the definition), and that covers different times of the day and different days of the week is likely to be the most pragmatic, while providing reasonably representative data. Several sampling methods are described in Box 1.

Box 1: Sampling strategies for ILI and SARI

Systematic sampling methods

The alternatives below are presented in order of increasing potential for bias in case selection:

Interval sampling – A straightforward method that would yield data similar to that from a random sampling strategy would be to select every Nth case at the sentinel site. For example, every 5th (or 7th or 10th) patient who meets the case definition would be selected for testing and data collection. Some foreknowledge of the volume of cases at the site is required so that the appropriate sampling interval can be selected. This type of sampling would likely require a designated person to oversee case selection on a daily basis and it is somewhat complicated.

Alternate day sampling – A second systematic sampling method is to select all patients who meet the case definition presenting to a facility on a certain day or days of the week. This can reduce the logistical challenges of surveillance by confining laboratory specimen and data collection efforts to a single day. In order to remove the bias introduced by differences in health-seeking behaviour associated with particular days of the week, the day on which cases are selected should be systematically alternated from week to week. A variant of alternate sampling is sequentially sampling where surveillance staff identify case patients during specific consecutive days of the week (e.g. Monday, Tuesday, and Wednesday).

Modified convenience sampling – A third approach involves testing the first X number of cases that meet the case definition. If this method is used, the time frame for selection should be systematically rotated to take into account local health-seeking behaviours such as differential use of evening or weekend clinics. For example, a site might select the first 2 cases from the morning clinic session (or admissions to hospital, in the case of SARI), the afternoon clinic, and the evening clinic on each day of the week, including weekends. Care would need to be taken not to introduce systematic biases in the types of cases selected.

Note: It is important that in any systematic sampling scheme cases be selected for testing and data collection each week of the surveillance season. Skipping weeks at a time could easily result in missing the start or peak of the season.

07



Laboratory testing

Key messages

- Specimens can be positive seven days or more after the onset of illness but ability to detect virus drops off notably after five to seven days, depending on the test used.
- Reverse transcriptase–polymerase chain reaction (RT-PCR) is the most sensitive method for detecting influenza virus and is the recommended influenza surveillance assay for most laboratories.
- Virus culture is also needed on at least a subset of specimens in order to allow detailed antigenic and genetic characterization of the virus.
- Antiviral resistance testing should be considered for high-risk patients if capacity exists in the laboratory in addition to taking a sample from non-high-risk patients.

7.1 Specimens for laboratory diagnosis

Specimens from influenza-infected individuals may still test positive using molecular diagnostic methods such as reverse transcription–polymerase chain reaction (RT-PCR) beyond one week from symptom onset, but the likelihood of a positive test decreases rapidly after that time. *Viral cultures*, however, are most likely to be positive only if the sample is taken within three days of symptom onset.

A variety of specimens are suitable for influenza virus detection and isolation. Specimens from nasal and nasopharyngeal specimens (e.g. nasal swab, nasopharyngeal swab, nasopharyngeal aspirate, nasal wash, combined nasal and throat swab, and throat swab) have a higher yield of virus detection in ILI cases than do oropharyngeal specimens. For specimens collected from SARI cases, however, the relative sensitivity of nasal versus oropharyngeal swabs is unknown. If patients are intubated, endotracheal aspirates or bronchoalveolar lavages can also be used where clinically indicated and may have a higher yield than upper respiratory specimens in these severe cases. It is also important to note that if other viruses are being tested for in addition to influenza, recovery rates between nasopharyngeal and oropharyngeal specimens may not be the same as with influenza.

Respiratory specimens from the upper respiratory tract should be collected and transported in virus transport media. Specimens should be aliquoted and refrigerated immediately after collection. If they cannot be processed within 48–72 hours, they should be kept frozen at or below -70°C . Care should be taken to prevent repeated freeze/thaw cycles that can result in the loss of virus viability and consequent loss of RNA integrity.

7.2 Diagnostic testing for influenza

The sensitivity and specificity of any test for influenza will depend on the type and quality of specimen collected, the transport and storage conditions, the methodological differences in the laboratories performing the test, and the type of test used. Available tests include RT-PCR, viral culture, rapid diagnostic (antigen) testing, immunofluorescence assays, and serology. Among these, RT-PCR has the highest sensitivity for detection and is the minimum recommended test for most laboratories. Others assays, however, may be used to complement the findings of RT-PCR testing (e.g. viral culture). Details and more information on laboratory standards can be found in the "WHO Global Influenza Surveillance Network: Manual for the laboratory diagnosis and virological surveillance of influenza"¹⁴.

14 http://www.who.int/influenza/resources/documents/manual_diagnosis_surveillance_influenza/en/index.html

RT-PCR and other molecular methods provide a variety of important virological information:

- Differentiate influenza virus type in symptomatic patients from viral RNA in respiratory specimens or from virus culture.
- Determine the subtype of human influenza A viruses or lineage of influenza B viruses.
- Presumptively identify virus in patient respiratory specimens or viral cultures which may be infected with influenza A of subtype H5 (Asian lineage).
- Detect potentially novel or newly evolving influenza A viruses.
- Detect antiviral resistance.

The summary results of testing should be shared with WHO through the global database FluNet¹⁵ or through WHO regional databases linked with FluNet.

For laboratories that have the resources, a combination of use of RT-PCR and virus isolation is recommended. Positive specimens can be rapidly identified by RT-PCR and subsequently used for further analysis, while virus isolates from cultures are used to carry out in-depth characterization of the virus. Virus isolation amplifies the amount of virus in the original specimen, thus producing a sufficient quantity for further antigenic and genetic characterization, and for drug-susceptibility testing if required. Depending on the numbers of positive specimens, and taking into consideration the epidemiological and clinical information available and adequate biosafety requirements, all or a proportion of PCR-positive specimens can be selected for viral culture.

National influenza centres (NICs) are strongly encouraged to send representative clinical specimens and/or virus isolates to one of the WHO Collaborating Centres (WHO CCs) for influenza for further characterization in a timely manner. A recommended way of combining the use of PCR and virus isolation is described in the "Selection of clinical specimens for various isolation and for virus shipment from NIC to WHO Collaborating Centres" in the aforementioned manual for laboratory diagnosis. As a minimum, the following samples should be sent to the WHO CCs¹⁶:

- Viruses that cannot be subtyped locally (these and any new subtype virus should be submitted to a WHO CC as soon as possible for further testing).
- Any virus of a new subtype.
- A representative sample of viruses collected at the beginning, peak, and end of each season.
- Viruses from particularly severe or unusual cases.
- A sample of viruses isolated from outbreak investigations.
- Viruses that are low reactors on the WHO haemagglutination inhibition test.

7.3 Antiviral testing

Some Member States routinely conduct antiviral resistance testing. Where this is undertaken, results should be regularly reported through FluNet. Antiviral resistance data will influence the management decisions of clinicians caring for influenza patients. In addition, data shared internationally through FluNet from countries that experience early influenza activity can aid other countries that have not yet experienced influenza activity or do not have laboratory capacity to perform antiviral resistance testing.

15 http://www.who.int/influenza/gisrs_laboratory/flunet/en/

16 See also: WHO Guidance on regulations for the Transport of Infectious Substances 2013–2014. Available at: http://www.who.int/ihr/publications/who_hse_ihr_20100801/en/index.html

Laboratory testing

Antiviral testing from sentinel sites, selected in an unbiased method, can give useful information about the background rate of resistance in circulating viruses; however, it is also important to specifically monitor resistance in high-risk cases. Member States with limited antiviral testing capacity should consider testing and reporting separately the following high-risk cases as a minimum:

- Treatment failures in case patients given antivirals within 48 hours of symptom onset.
- Patients on long-term treatment with antivirals including patients with severe immunosuppression.

Viruses found to have oseltamivir or zanamivir resistance should be sent to a WHO CC for further characterization, along with information regarding the clinical setting in which they were collected (i.e. from a sentinel versus a high-risk case, whether the case was on oseltamivir when sampled or exposed to someone who was on treatment). If antiviral resistance is detected and confirmed, it is also important to document through careful investigation of cases and contacts whether or not human-to-human transmission has occurred. If sustained human-to-human transmission of resistant viruses is noted, this event should be reported immediately through the International Health Regulations focal point of the country (NFP). (This applies only in the situation where circulating viruses of that subtype are currently predominantly sensitive.)

08



Data collection and reporting – minimum data set

Key messages

- Data collection should be kept at a minimum and include only data needed for public health decision-making.
- The surveillance objectives should guide data collection.
- Some data reporting should take place on a weekly basis, while other data can be summarized and reported less frequently.
- Individual information, including risk factors for severe disease, should be collected for all patients from whom clinical samples are collected for laboratory testing.

The amount of data to be collected in a routine surveillance system needs to be balanced against the costs and labour of collecting the data so that the system will be sustainable. A surveillance system should only collect data that will be used for public health purposes, and the specific objectives of the programme should define the specific data needs. General objectives of surveillance are described in the first chapter of this document, and the recommended minimum data set is based on these objectives. A country may choose to expand their data collection to provide additional details according to specific surveillance objectives.

8.1 SARI and ILI data collection

For individual SARI and ILI patients tested for influenza viruses (see Chapter 6 for guidance on selection of cases for data collection and reporting), the following data are recommended as a minimum for each patient from whom a specimen is collected:

- Unique identifier (to link laboratory and epidemiological data, and for tracking patient if necessary).
- Sex.
- Age.
- History of fever and body temperature at presentation.
- Date of symptom onset.
- Date of hospitalization (SARI patients only).
- Date of specimen collection.
- Antiviral use for present illness at the time of specimen collection.
- Pregnancy status.
- Presence of chronic pre-existing medical illness(es).*

Presence of chronic pre-existing medical illness(es):

- Chronic respiratory disease.
- Asthma.
- Diabetes.
- Chronic cardiac disease.
- Chronic neurological or neuromuscular disease.

* The WHO standardized list of pre-existing medical illnesses or co-morbid conditions includes both known and suspected risk factors for severe influenza disease. The list is based on available data from seasonal and pandemic influenza. For definitions of pre-existing medical conditions, see Appendix 3.

- Haematological disorders.
- Immunodeficiency, including Human Immunodeficiency Virus (HIV).

The conditions have been organized in a standard format to facilitate reporting and comparisons between countries. Individual countries may choose to expand some categories or add additional conditions to the list according to their own surveillance objectives.

Additional data to consider in specific circumstances, depending on the needs of the programme, include:

- Signs and symptoms of illness.
- Smoking history.
- Infection with HIV or Acquired Immune Deficiency Syndrome (AIDS) as a category separate from immunodeficiency.
- Infection with tuberculosis and status of infection (i.e. latent or active).
- Height and weight (to determine body mass index).
- Specific haematological disorders such as sickle cell disease or thalassemia major.
- Ethnicity or belonging to a disadvantaged minority group.
- Date of the current years' influenza vaccination and whether the patient received an influenza vaccine the previous year.
- Patient outcome (death, survival).
- Seasonal influenza vaccination status and date of administration.

Appendix 3 provides an example of a minimum data set collection form. This template can be modified to fit the needs and situation of the national programme.

8.2 Standard age groupings

Data on ILI and SARI can be aggregated by age groups to facilitate analysis and reporting. The use of uniform age groups will allow to understand patterns of disease in their countries as they compare to others and allow aggregating of data globally. Sentinel surveillance systems are encouraged to use the age categories below as a minimum for reporting. Countries may have specific needs or interests requiring that they further divide these groupings into smaller ones, but should use the same major groupings as listed below. For example, countries with very young populations and high infant mortality may be specifically interested in the impact of severe influenza on infants under the age of one year (e.g. children aged 1 to 11 months and 1 to <5 years to match mortality estimates) or even six months and would need an extra age grouping to better monitor and evaluate this situation. Keeping the two-year old age break point when aggregating data, however, will allow data to still be compared to those of other countries. Conversely, some sentinel sites may find too few SARI cases per age group to generate secondary analyses (e.g. age-stratified burden estimates). In such cases, we recommend that countries report ILI and SARI data using the recommended age groups but collapse the age strata for their secondary analyses as needed.

Recommended major age groupings for reporting:

- 0 to <2 years.
- 2 to <5 years.
- 5 to <15 years.
- 15 to <50 years.
- 50 to <65 years.
- ≥ 65 years.

8.3 Laboratory data collection

Results from the laboratory should be collected weekly by the national surveillance centre. As a minimum, it is recommended that the following data be collected:

- The number of samples tested for influenza during the week.
- The proportion of samples that were positive for influenza for ILI and SARI (reported separately).
- Types and subtypes of viruses detected during the week.
- Results from antiviral resistance testing (if applicable).

8.4 Aggregated data to be collected and reported from each sentinel site

ILI data and SARI data should be reported separately:

- The number of new ILI and SARI cases from whom specimens were collected during the week, grouped by standard age groups, and the proportion of each of these that were positive for influenza.
- The total number of new ILI and SARI cases reported during the week, grouped by standard age groups (this includes cases that were not tested and/or did not have detailed data collected).
- The number of total new hospital admissions reported during the week in the sentinel hospital where SARI surveillance is being conducted, ideally grouped by the recommended age groups.
- The number of total new outpatient visits during the week in outpatient clinics where ILI surveillance is being conducted and/or the catchment population to the sentinel site, ideally grouped by the recommended age groups.
- The number of SARI deaths occurring in the healthcare facility sentinel site reported during the week, grouped by standard age groups.
- The proportion of cases having each of the chronic pre-existing medical illnesses for influenza-positive ILI and SARI cases, reported separately.

Once laboratory data are available, they should be linked with epidemiological data, using the unique identifier so that the system can also monitor and report the following:

- The proportion of ILI and SARI cases that test positive for influenza for each influenza virus type or subtype.
- The data on age and other risk factors summarized for influenza positive ILI and SARI cases. A sample data collection form and data reporting form can be found in Appendix 4.

8.5 Timing

Frequency of reporting: Epidemiological and virological data collected from the sentinel sites should be reported to the national health authorities on a weekly basis.

Time frame of data collection: In temperate climate zones where influenza seasonality is well understood, data collection and reporting should occur at a minimum during the known influenza season and for a short period preceding and following the season. For example, in temperate climates with clear seasonality in the northern hemisphere, surveillance could be limited to a period starting at epidemiological week 40 and continuing through to week 20 of the next calendar year. Performing year-round surveillance in countries with well-defined influenza seasons is recommended, however, because it adds to a general understanding of out-of-season influenza activity and provides essential information about the emergence of novel influenza strain and antiviral resistance markers. In tropical and subtropical countries, data collection and reporting should occur throughout the year. In all Member States, even if routine sentinel influenza surveillance is suspended during the summer (or non-seasonal influenza) months, surveillance activities aimed at early detection of unusual influenza-related events should continue throughout the year (see Appendix 1). As noted above in the section on sampling, data and clinical specimens should be collected during each week that surveillance is being carried out if a sampling scheme is adopted.

8.6 Reporting data to WHO

Member States are strongly encouraged to share data and reports of analyses internationally. Routine data sharing will facilitate global tracking and monitoring of influenza progress and impact. This will help inform all Member States of the location and occurrence of seasonal epidemic disease, the type of virus currently circulating, and the impact that it is having. Such information can be of great value to national health authorities for planning and resource allocation purposes. Globally, data reported to WHO are used to produce a regularly updated global report on the current epidemiological and virological situation, available for the Member States and the public in general.

There are two reporting systems run by WHO at the global level: FluNet¹⁷ for the reporting of virological data from laboratories and FluID¹⁸ for reporting of epidemiological data. Some WHO regions have regional platforms that connect to these global networks. These platforms link directly to FluNet and FluID so data entered into the regional databases appear in the global databases and do not have to be entered separately into the global databases. Appendix 5 gives more detailed information on FluID and FluNet.

National aggregated epidemiological data for each age group to be reported to WHO, via FluID, include:

- The number of new influenza-positive ILI and SARI cases during the week being reported.
- The number of total new outpatient visits in outpatient clinics where ILI surveillance is being conducted and/or the catchment population to the sentinel site during the week being reported.
- The number of total new hospital admissions on wards where SARI surveillance is being conducted during the week being reported.

17 http://www.who.int/influenza/gisrs_laboratory/flunet/en/

18 http://www.who.int/influenza/surveillance_monitoring/fluid/en/

- The number of ILI or SARI cases sampled during the week being reported.
- The proportion of ILI and SARI specimens testing positive during the week being reported.
- Total number of inpatient respiratory deaths during the week being reported.

In addition, the IHR (2005) require Member States to immediately report unusual events of potential international concern.¹⁹ These would include unusual clusters of severe disease, novel influenza viruses, or significant changes in the epidemiology of influenza occurrence that might indicate the appearance of a novel influenza virus or significant change in the antiviral sensitivity of the virus. See also Appendix 1 on the implementation of the pandemic early warning system and the IHR (2005).

19 International Health Regulations (IHR) <http://www.who.int/ihr/en/>

09



Reporting of summary analyses

Key messages

- Regular reporting of the analysis and interpretation of surveillance data to both policy makers and clinicians who collect the data is an important part of maintaining a system and ensuring maximum benefit.
- Weekly surveillance reports should be produced and made accessible to relevant partners.
- A yearly surveillance report with surveillance and risk factor data should be produced.
- Data should be aggregated and reported to the international data sharing platforms according to global standards and protocols.

9.1 Regular surveillance reports

Regular summary analysis and reporting will help to ensure that the information is available to policy makers, healthcare providers, and the general public, and will also improve the consistency of reporting from sentinel sites. Reports should provide timely information on influenza activity and types of influenza viruses circulating. Whenever feasible, such reports should be available to the public on the national surveillance website. Minimal information that should be presented in the weekly report includes:

- Graphical presentation of the proportion of SARI cases by catchment population and/or total hospitalizations by week, together with data from previous seasons for comparison, if available.
- Graphical presentation of the proportion of ILI cases by catchment population and/or outpatients visits by week, together with data from previous seasons for comparison, if available.
- Number of SARI/ILI patients from whom samples were laboratory tested and the proportion testing positive, by influenza type and subtype.
- Number of sentinel sites reporting.

The data should be presented by age group where available.

An example of a weekly surveillance report may be found in Appendix 6.

9.2 Annual surveillance reports

Following each influenza season, additional analyses should be undertaken with a summary review of influenza activity during that season. These analyses can help inform the future timing of vaccination and identify high risk groups for targeted interventions. Ideally the following analyses can be presented in an annual report:

- Description of laboratory confirmed influenza-associated SARI and ILI cases within each month or week of the year for each age group.
- Summary data on the proportions of influenza-positive cases with underlying medical conditions.
- Types and subtypes of circulating influenza viruses during the season and how these matched with the seasonal influenza vaccine.

Reporting of summary analyses

- Proportion of samples testing positive for influenza by week or month of the year.
 - Comparison of data from the most recent influenza season to previous seasons. Notable or unusual features of the season when compared to previous seasons should be highlighted.
- Seasonal vaccine coverage in risk groups (these data could be acquired through surveys or means other than collection of case-specific data from the surveillance system if vaccination status is not part of the data collection scheme).
- Data from the monitoring of the system:
 - proportion of sentinel sites reporting weekly to the national level;
 - if feasible, the proportion of sentinel sites regularly submitting specimens for laboratory testing;
 - number of specimens sent from the sentinel sites;
 - proportion of weeks with reporting to FluNet and FluID and/or other reporting systems.

Appendix 7 provides a sample annual report.

10



Defining baselines and thresholds: using surveillance data for monitoring influenza activity over time

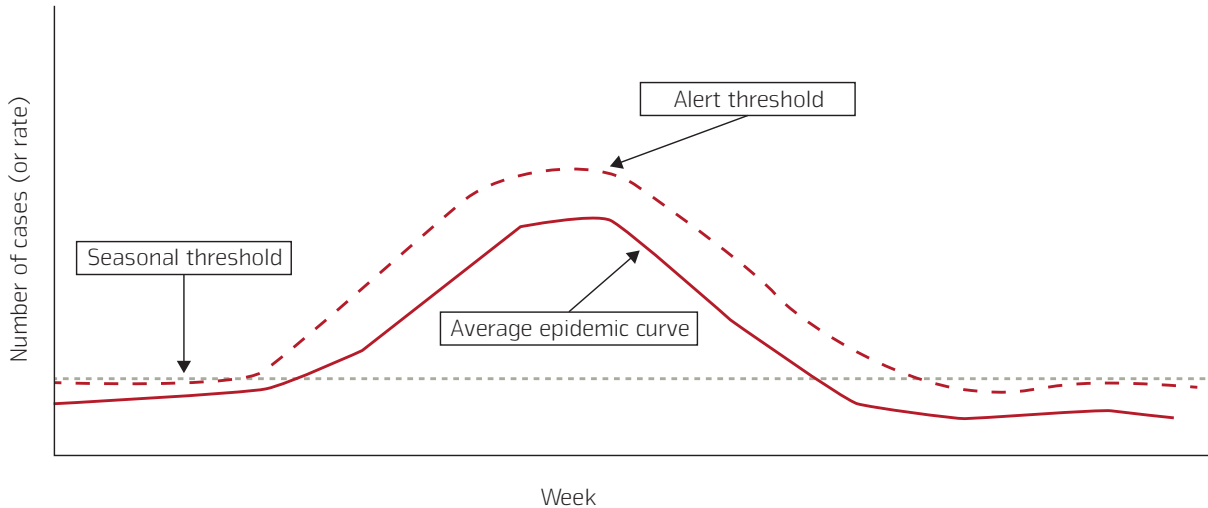
Key messages

Two important uses of the data gathered through influenza surveillance systems are to compare current activity to previous years and to detect periods of increased activity such as the start of an influenza epidemic. These two concepts are expressed by the terms **baseline** and **threshold**. The terms are often used interchangeably and used to represent different concepts by different programmes. The term baseline is also used to mean different things by different researchers. Some use it to mean the lowest level of respiratory disease or influenza activity that occurs between seasons. Others use it to mean the average level of activity that occurs throughout the year. In order to avoid confusion, this document will use the term *average epidemic curve* to mean *the usual level of influenza activity*, which varies over time during the influenza season and the off-season. Threshold is used to mean *a level of activity that indicates the occurrence of a specific situation* such as the start of a season or an unusually high season (see below). Thresholds are set at values that exceed average epidemic curve values by a previously established amount.

Average epidemic curve	The usual level of influenza activity that occurs during a typical year. This is the calculated average of several epidemic years. The average epidemic curve level will vary throughout the year. Sometimes referred to as <i>baseline</i> activity. Note that some modellers also use the term baseline to mean the lowest level of influenza activity which occurs between influenza seasons.
Seasonal threshold	The level of influenza activity that signals the start and end of the annual influenza season(s). When a weekly rate exceeds the seasonal threshold, sustained community transmission is presumed to be occurring and the influenza season started.
Alert threshold	A level above which, varying by time of year, influenza activity is higher than most years. An analogous lower correlate of the alert threshold below the average epidemic curve can also be used to indicate an unusually mild season. This term may also be known as <i>the thresholds for different levels of intensity</i> . ²⁰

Typically, programmes express average epidemic curves and thresholds in terms of the number or rate of ILI or SARI cases per week (or the same as a proportion of total outpatient visits, in the case of ILI; or the number of total hospitalizations, in the case of SARI), the number or rate of pneumonia and influenza deaths, the percentage of specimens testing positive for influenza, the number or rate of respiratory deaths, or the number or rate of confirmed influenza cases. Knowing the usual average epidemic curve level of disease and the seasonal pattern as a point of reference aids in determining whether the current season is atypical both in timing and relative severity compared to previous ones. This information can help improve the accuracy of clinical diagnosis, appropriate use of antiviral medication, and the uptake and timeliness of seasonal influenza vaccines.

20 Vega T et al. (2012) Influenza surveillance in Europe: establishing epidemic thresholds by the moving epidemic method. *Influenza and Other Respiratory Viruses*. DOI: 10.1111/j.1750-2659.2012.00422.x



For each of these parameters the values to be used need to be determined for each country individually based on historical data and may even vary from place to place within a country. While there is no single method that is universally applicable for every country, there are some relatively simple ways of expressing **average epidemic curves** by creating an average curve centred around the median week of peak transmission for several years and using simple statistical measures of variance to define an **alert threshold** above the average weekly values to detect unusually severe seasons (see Appendix 8 for details). A useful alert threshold is the value 1.645 standard deviations above the mean for each week, which defines the 90% confidence interval of the mean. This would result in 1 out of every 20 seasons significantly exceeding the upper threshold.

The **seasonal threshold** defines a value above which the country or area is considered to be in an influenza season (seasonal threshold is sometimes referred to as epidemic threshold, using epidemic in the sense of recurrent seasonal epidemics). This value indicates an increased likelihood that a respiratory illness seen by a treating clinician in the community is actually related to influenza because influenza is transmitting in a sustained manner. The same parameters that define average epidemic curve values (ILI or SARI numbers, proportions, or rates; percentage of specimens testing positive for influenza; etc.) can also be used to define the seasonal threshold; experience in country will determine the most useful parameter(s) to use. In some cases a combination of parameters may be preferable. For example, a seasonal threshold could be defined as the week in which the ILI rate crosses a certain value *and* the percentage of specimens testing positive reaches a certain point.²¹ To be useful, the seasonal threshold needs to be set low enough to signal the start of the season in a timely manner but high enough to avoid false signals (see Appendix 8 for details). Tropical countries may find it more challenging to define a seasonal threshold as influenza seasons may not be as clearly distinguished from non-seasons; and indeed in some tropical countries it has been observed that sustained low-level community transmission can occur during inter-seasonal periods. The implication of crossing the threshold value may be slightly different than it would be in temperate countries as being below the threshold would not necessarily indicate that community transmission was not occurring.

21 Azziz-Baumgartner E, Dao CN, Nasreen S et al. (2012) Seasonality, Timing, and Climate Drivers of Influenza Activity Worldwide. *The Journal of Infectious Diseases*. 206 (6): 838-846. doi: 10.1093/infdis/jjs467

A brief description of methods for establishing a seasonal threshold is provided in Table 2, together with references to papers that have examples of implementation of these methods.

Table 2: Methods for determining seasonal thresholds

Method description	Examples	Advantages	Disadvantages
<i>Visual</i> Based on a visual analysis of past data, define average epidemic curve, off-seasonal average epidemic curve, threshold and seasonal threshold values ²²	Graphically based ²³ Model based ²⁴	Very simple to implement and understand	Overly simplified, will not capture any trend changes over time
<i>Averaging</i> Involves calculating the arithmetic mean of pre- or post-epidemic rates for all historical seasons	Moving Epidemics Method (MEM) ²⁵	Simple to implement	Can allow a past season's or week's aberrant values to influence current time prediction of average epidemic curve and threshold values
<i>Process control</i> Based on similar processes to those used in detecting anomalies in industrial production processes. Most methods rely on some method of setting an upper control limit. Some methods also involve looking at the rate of <i>change</i> in the data series	Shewhart charts ²⁶ CUSUM charts ²⁷ Exponentially weighted moving average charts	Best for detection of start of season and unusual patterns Works well in situations where rates are low May be the best method to use in tropical climates Good at detecting the start of the season when the start is slow	Not as accurate as time series methods May be sensitive to small changes in reporting efficiency

22 Azziz-Baumgartner E et al. (2012). Seasonality, Timing, and Climate Drivers of Influenza Activity Worldwide. *The Journal of Infectious Diseases*. 206 (6): 838–846. doi: 10.1093/infdis/jis467

23 Watts Cg et al. Establishing thresholds for influenza surveillance in Victoria (2003). *Aust N Z Journal of Public Health*.;27(4):409–12. PubMed PMID: 14705303

24 Cooper DL et al. Can syndromic thresholds provide early warning of national influenza outbreaks? *Journal of Public Health (Oxf)* (2009) Mar;31(1):17–25.

25 Vega T et al. (2013) Influenza surveillance in Europe: establishing epidemic thresholds by the moving epidemic method. *Influenza and Other Respiratory Viruses*. Jul 7(4):546–558. DOI: 10.1111/j.1750–2659.2012.00422.x.

26 Hashimoto S et al. Detection of epidemics in their early stage through infectious disease surveillance. *The International Journal of Epidemiology* (2000), Oct;29(5):905–10. PubMed PMID: 11034976.

27 O'Brien SJ, Christie P. Do CuSums have a role in routine communicable disease surveillance? *Journal of Public Health* (1997) Jul;111(4):255–8. PubMed PMID: 9242040.

11



Monitoring and evaluating the surveillance system

Key messages

- Continuous monitoring of the data for completeness, timeliness, and aberrations or unexpected patterns should be performed at all levels of the surveillance system.
- An aberration in the data may signal a problem in the data collection system or may represent an unusual event of public health concern.
- A yearly report describing the performance of the system is recommended.
- An in-depth evaluation of the surveillance system should be done before expanding the system with more sentinel sites.
- Surveillance systems should be evaluated according to whether they meet their own specific objectives.

Monitoring and evaluating surveillance systems is done to ensure that data collected are of consistent quality, that the system is meeting its stated objectives, and that it is performing as expected. As used in this document, *monitoring* is defined as ongoing review of the data entered into the system. An *evaluation* is a more comprehensive process, where all parts of the surveillance system are thoroughly examined and checked for performance.

11.1 Continuous monitoring

It is important to note that aberrations in data are commonly observed during holidays and may also occur because of changes in the system itself: for example, a changeover in staff at a site may produce a sudden increase or decrease in reporting. However, such changes may also represent true changes in the behaviour of a disease. Unusual and unexpected patterns in data should prompt an enquiry to the reporting unit. Surveillance data should be monitored at each administrative level, beginning at the site where data are collected and entered and continuing at the regional and national levels. Surveillance staff should monitor:

- **Timeliness.** Are data submitted, entered, analysed, and reported in a timely manner? Are laboratory specimens tested and the reports issued in a timely manner?
- **Completeness.** Are all data fields collected from all patients? Are all sites reporting? Are all data entered from the forms into the database?
- **Consistency.** Are there aberrations in the data that might be caused by a change in collection or reporting methods? For example, are there unexpected changes such as sudden decreases or increases, changes in age or risk factor distribution, or regional differences that were not there previously? Are there changes in the data that might indicate an outbreak or a change in disease transmission?

Table 3 provides a number of parameters that can be monitored to judge the timeliness and completeness of the data. The target values are somewhat arbitrary and Member States may consider setting more stringent criteria as appropriate. Observing for aberrations requires regular analysis of data and familiarity with the data history.

Monitoring and evaluating the surveillance system

Timeliness: Describes the success of the programme in meeting targets for several different time intervals in the surveillance and reporting process

Time interval	Parameter	Target
Data reporting from the sentinel site to the next administrative level	Percentage of time that a site achieves target date for data reporting	Individual sites deliver at least 80%* of their reports by the target date
Data reporting from the next administrative level to the national level (if applicable)	Percentage of time that an administrative level achieves targets for timeliness	Individual sites should achieve target date for data transfer at least 80% of the time.
Shipment of specimens to laboratory	Percentage of time that a site ships specimens by the target number of days after collection	Individual sites ship at least 80% of specimens within targeted time limit
Date of receipt of specimen in the laboratory until result availability	Percentage of time that a lab has test results available within a target time frame set by the programme	Will vary by lab, depending on capacity. Programme should establish time frame and monitoring the achievement
Result reporting to healthcare worker participating in the surveillance system	Percentage of time that the testing facility reports results back to surveillance site within target time frame set by the programme	At least 80% of the results are reported within target time frame

Completeness: Monitoring of the completeness of data is performed for both the completeness of sites reporting and the completeness of data entered

Report completion	Percentage of reports received from each site with complete data	At least 80% of the reports have all data fields completed
Report transmission	Percentage of data reports that are received	At least 80% of all sentinel sites deliver every reporting interval
Data collection	Percentage of sampled cases that have data collected	At least 80% of cases from which specimens are collected have data collected

Aberrations: Any sudden or unexpected change in the observed pattern of the data should be investigated. The following are examples of the kinds of changes that might represent either problems with reporting or a change in behaviour of the disease

- Unexpected or sudden increase or decrease in the number of reported cases of SARI and ILI or SARI deaths reported
- Unexpected or sudden change in the percentage of specimens testing positive for influenza
- Unexpected or sudden shift in the type or subtype of virus detected
- Changes in the distribution of risk factors reported
- Change in the age distribution of cases reported

* The use of 80% as a target is arbitrary. Individual countries may want to establish their own more stringent targets.

A routine monitoring plan should be designed at the onset of surveillance activities to avoid embedding problems in the system from the beginning. Together with the data management plan (see Appendix 9 on data management) this will ensure the data quality, data completeness, and data flow.

11.2 Periodic evaluation

A thorough periodic review of the surveillance system provides users and stakeholders with a more detailed understanding of how well the system is functioning, whether all sites are functioning in a satisfactory manner, and where the system might benefit from updated employee training, data management, or other activities.

In addition to the individual site parameters described above, some national level performance indicators might be used, including:

- The percentage of sites meeting the timeliness target.
- The percentage of sites that are meeting the completeness target.
- Average number of days required for data reporting to central level from time of collection, number of days from receipt of specimen in laboratory to test result, and number of days from result availability to reporting back to site.
- The percentage of cases that meet the case definition falls within the sampling frame (if all cases are not targeted for testing) and have specimens and data collected within 24 hours of admission.

A comprehensive evaluation of the system should be done regularly, beginning one to two years after initial implementation of the surveillance system. This is especially important if an expansion of the system is being considered. System reviews should evaluate the system at all levels – national, site, and laboratory – to ensure that all parts of the system are working together as effectively as possible. (See Appendix 10 for a sample document to guide the evaluation procedure).

12



Using a routine sentinel surveillance system
in an outbreak or pandemic

Key messages

- Routine sentinel surveillance can provide baseline data against which to judge the severity and specific epidemiological features of an epidemic or pandemic of a novel influenza virus.
- An established surveillance system will provide the means with which to monitor the progress of an epidemic.
- Some surveillance enhancements and additional studies will be necessary to fully characterize an emerging event.

The experience of the influenza A(H1N1) pandemic in 2009–2010 demonstrated the importance of having a surveillance system in place at the start of an event. Although enhancements were needed for most systems, having an established system allowed changes to be made rapidly and also provided historical baseline data against which to compare data being collected as the event progressed. Attempts to introduce new systems in the midst of a pandemic have rarely been successful without great efforts.

In addition to describing the groups at highest risk and the clinical picture, one of the most urgent needs in the earliest days of an outbreak of a novel influenza virus is to understand the relative severity of the event. Specifically, there is a need to estimate the number of severe cases and deaths the health system will likely have to manage to enable policy makers to evaluate the costs and benefits of available interventions. Most parameters that would allow projections of impact or severity are extremely difficult to measure in the early days of an outbreak or pandemic when only the most severe cases are typically reported. However, historical data gathered over time in the course of routine sentinel surveillance can provide benchmarks against which to compare the early course of an event, particularly if baselines and thresholds have previously been defined. Rates of reporting both ILI and SARI, pneumonia hospitalizations and SARI deaths at sentinel sites compared to historical averages will likely give the first indications of the severity of a pandemic as it unfolds. In addition, the degree to which these parameters exceed historical averages for a given country will be an important parameter to allow comparisons of severity between countries, even when different kinds of data are being collected by their respective systems.

Most programmes will need to make enhancements in the event of a novel influenza virus with sustained community transmission to provide additional critical information. These might include:

- Expanded data collection to include additional risk factors, additional clinical data on signs and symptoms, course of illness, complications, and outcome.
- Admission and discharge diagnoses from severe cases.
- Additional monitoring of high-risk populations such as minority and other disadvantaged groups.
- Specific monitoring of intensive care units (ICUs) and cases requiring mechanical ventilation.
- Collection of mortality data including cause of death.

Health-seeking behaviour during an outbreak is very likely to be strongly influenced by public concern and perception of risk, which in turn will affect ILI and SARI surveillance data. Data may also be affected by increased testing by clinicians, a lowered threshold for admission, and more aggressive data collection in general. The collection of additional data elements such as clinical signs and symptoms, X-ray evidence of pneumonia, and the cause of admission will assist to determine clinical presentation and severity of illness on admission. Data on the most severe cases are least subject to bias due to changes in health-seeking behaviour, though may be affected by changes in testing and reporting. Nevertheless, the additional monitoring of cases requiring ICU admission, mechanical ventilation, and respiratory deaths may provide a robust and stable indicator of relative severity. Case fatality rates are

notoriously difficult to estimate in the early stages of an outbreak, but cause-specific mortality rates, or similar population-based rates of intensive care admission or mechanical ventilation in comparison to previous years may be useful to estimate overall relative severity. These data pose a challenge for most systems to collect on a routine basis; however, the availability of historical trends for each will greatly enhance their usefulness during an early outbreak evaluation.

Useful indicators may include the following:

- The proportion of pneumonias detected as influenza positive from sentinel surveillance using a representative sampling system.
- Ratio of respiratory illness-related hospital admissions and deaths to total admissions at the sentinel site.
- Proportion of respiratory illness hospital admissions that required ICU admission, mechanical ventilation or that died.
- Proportion of influenza hospital admissions, influenza intensive care admissions, and influenza deaths with pre-existing medical conditions.

12.1 Additional studies

There are a number of additional information needs that must be addressed early in the course of an epidemic of respiratory disease or the emergence of a novel influenza virus. These may require additional data collection beyond that of even an enhanced surveillance system. The data will inform a number of critical decisions needed to judge the appropriate level of response and target intervention activities effectively.

12.1.1 Virological

Virological data are likely to be the earliest available at the start of an epidemic with a novel strain of influenza. While the genetic markers of severity are incompletely understood, there are several pieces of data that will help guide early response and the estimation of severity or impact.

- *Antigenic relatedness to previously circulating strains and candidate vaccines.* Completely novel influenza viruses to which the population has had no previous exposure or immunity are more likely to have higher attack rates.
- *Seroprevalence of cross-reactive antibodies in the affected population.* This can assist in anticipating the proportion of the population and the age groups most likely to be susceptible. Susceptibility to infection does not necessarily correlate with clinical severity, however in terms of impact on a healthcare system, the actual number of cases that the system will have to accommodate will depend on the interplay between population attack rate (a reflection of population susceptibility) and the virulence of the virus. Studies that can address these issues include the testing of the novel virus against standard antibody panels and cross sectional, representative seroprevalence studies.
- *Antiviral resistance.* Several genetic markers for resistance to currently available antiviral medications are known. The presence of antiviral resistance has not been associated with increased virulence in previously circulating influenza viruses; however, antiviral medications are important tools to manage severe cases, protect those at highest risk for severe disease, and mitigate the impact of the event. For these reasons, it is important to know the antiviral susceptibility of a novel virus very early in the course of an outbreak. If the national laboratory does not have the capacity to test for antiviral resistance, samples from early cases should be sent to a WHO Collaborating Centre or Essential Reference Laboratory with that capacity.

12.1.2 Clinical

- *Presentation.* The typical clinical presentation of seasonal human influenza is well described; knowing the potentially unique or unusual aspects of a novel virus will facilitate development of case definitions for case detection in both surveillance and case management. In the influenza A(H1N1) pandemic of 2009–2010, unusual features included a high rate of gastrointestinal symptoms and, less commonly, neurological manifestations. While enhanced data collection in a sentinel surveillance system can provide some of these data, additional data could also be provided through detailed data collection from early cases.
- *Sub-clinical infection rates.* To understand the case-fatality proportion, the “denominator” of the total number of infections will need to be known, as well as cross-reactive immunity and the population infected. This information is best provided through the use of serosurveys but it requires pre-event representative sera for comparison. These data will also provide information on susceptible age groups.
- *Risk groups.* The medical conditions associated with higher risk of severe disease are also well described for seasonal influenza; however, the prevalence of these conditions and their association may differ from place to place (e.g. prevalence of HIV in pregnant women). Historical data on risk conditions will be useful for anticipating the impact of a novel virus in these groups and will provide useful comparative data when evaluating the risk conditions associated with the novel virus. In addition, the age-specific attack rates and rates of severe disease will be useful for estimating ultimate severity and impact on the healthcare system. A virus whose primary target involves a specific age group will behave differently from one that affects the population more broadly.
- *Clinical course.* Information on the occurrence of complications such as secondary bacterial infections and systemic reactions to infection including Systemic Inflammatory Response Syndrome are critical for both anticipating resource needs and assisting clinicians in making management decisions. These data can be collected through the sentinel surveillance system by the addition of follow-up to admitted cases or through chart reviews of severe cases.
- *Incubation period and period of infectivity.* These parameters will require careful study of early clusters and exposed individuals.

12.1.3 Epidemiological

- *Mortality.* Mortality indicators can include cause-specific population mortality, case fatality proportion, and proportion of hospitalized cases that die. As above, mortality proportions will be most useful, particularly early on in the course of an event, if they can be put into the context of historical trends.
- *Transmission.* Speed of spread, R_0 , attack rates. The rapidity with which a virus moves through a community will be a factor in determining the intensity with which it impacts the healthcare system during peak influenza activity. Being able to describe the speed of transmission will help authorities make informed decisions about interventions such as school closures and other social distancing measures. Information about transmission can be gathered through community surveys, household transmission studies, early outbreak investigations, and eventually through serosurveys. The speed at which cases detected by a surveillance system rises and falls is a critical indicator of transmission.

12.2 Monitoring

A sentinel surveillance system will provide both the means to monitor the course of the epidemic and a tool to assist in the evaluation of the impact of interventions. Monitoring the course of the event in terms of numbers of admissions or other surveillance indicators will allow health professionals to know when cases are increasing, when the event has peaked, whether interventions are having an impact and whether changes have occurred in the behaviour of the virus.

Key questions to ask at the beginning of an outbreak (and periodically throughout):	Implications, related decisions, or recommendations:
<p>1. How different is this virus from previous ones?</p> <p>a. Is it a new subtype? How is it different antigenically from previously circulating viruses?</p> <p>b. Is there pre-existing immunity (i.e. cross-reactive antibodies) in the population? How much and in whom?</p> <p>c. Is it sensitive to antivirals?</p> <p>d. Which virus could be used as a vaccine?</p>	<ul style="list-style-type: none"> Information will aid in projection of how severe the event may be and which age groups might have some protection Antiviral sensitivity critical for management recommendations Inform vaccine production, procurement, and distribution decision.
<p>2. Is community transmission sustained? If so, how fast is it spreading?</p> <p>a. From person to person? (i.e. R_0, generation time, attack rate)</p> <p>b. Geographic spread from community to community; country to country?</p> <p>c. How is it spreading? (e.g. are schools playing a key role? Other routes?)</p>	<ul style="list-style-type: none"> Will inform decisions about feasibility of pharmaceutical and non-pharmaceutical interventions such as school and border closures Allow projections of the period of time over which the event is likely to occur, i.e. the height and breadth of the epidemic curve
<p>3. What proportion of cases are severe or what number of severe cases are occurring in the population?</p> <p>a. What is the mortality rate?</p> <p>b. What is the hospitalization rate?</p> <p>c. What is the proportion of cases that die? Proportion that are hospitalized? Proportion that require mechanical ventilation?</p> <p>d. How are these figures affected by the local environment (e.g. healthcare access, climate, social factors, prevalence of chronic conditions in the population, or other issues of vulnerability)?</p> <p>e. How does this event compare to previous ones at this location?</p>	<p>Projection of impact of the epidemic over a specific period in terms of numbers of severe cases, beds needed, healthcare workers needed, etc.</p>
<p>4. Who is most vulnerable?</p> <p>a. Age group with highest rate/number of severe cases?</p> <p>b. What are the risk factors for severe outcomes (e.g. pregnancy and obesity)?</p>	<ul style="list-style-type: none"> Formulation of management plans Inform decisions regarding whom to prioritize for vaccination, treatment, etc.
<p>5. What are the clinical features of the disease?</p> <p>a. How does it present? What is the clinical course?</p> <p>b. What proportion of cases is asymptomatic?</p> <p>c. What kinds of complications are being observed (e.g. secondary bacterial infections, Acute Respiratory Distress Syndrome (ARDS), and renal failure)?</p>	<ul style="list-style-type: none"> Clinical management planning: quantities of antibiotics to order; dialysis machines; ventilators; and ECMO machines Guide clinical management guidance Creation of case definitions

13



Legal issues

13.1 Influenza surveillance and the International Health Regulations

According to the International Health Regulations (2005) [IHR (2005)], “each country shall develop, strengthen and maintain (...) the capacity to detect, assess, notify and report events in accordance with these Regulations.” (Article 5.1, IHR (2005)).

13.2 Use of data collected by WHO

Article 5 of the IHR (2005) describes the role of WHO in surveillance:

WHO shall collect information regarding events through its surveillance activities and assess their potential to cause international disease spread and possible interference with international traffic. Information received by WHO under this paragraph shall be handled in accordance with Articles 11 and 45 [of IHR 2005] where appropriate.²⁸

The IHR (2005) are the international legal framework for public health actions of WHO and all of its Member States to prevent, control, and respond to the international spread of disease. The IHR (2005) include a number of rights and obligations of Member States relevant to pandemic influenza, such as notification, reporting and verification of public health events to WHO (including all cases of new subtype human influenza), implementation of measures at international borders, ports and airports, protections for international travellers, required capacities for domestic surveillance and response in all States, and coordinated response to public health emergencies of international concern (PHEIC).

The IHR (2005) also outline WHO's functions concerning international surveillance, assessment, and public health response. Once there is credible reason to believe that an animal or human–animal influenza virus has evolved that is capable of sustained human transmission in a community, the IHR (2005) give the Director-General of WHO the authority to determine that the event constitutes a PHEIC. On such occasions, an IHR Emergency Committee will provide its views to the Director-General on temporary recommendations for the most appropriate and necessary public health measures to prevent or reduce the international spread of disease and avoid unnecessary interference with international traffic.

These recommendations may include the activation of national pandemic surveillance systems:

- To rapidly detect, characterize, and notify additional human clusters.
- To assess the virological, clinical, and epidemiological features of infection by the new virus.
- To monitor disease spread and the impact of response measures.

13.3 Member States' regulations

Member States' laws on surveillance, data collection, storage and reporting, and patients' confidentiality must be followed when setting up a surveillance system for influenza.

²⁸ <http://www.who.int/ihr/9789241596664/en/index.html>

13.4 Ethical considerations

Ensuring the safety and confidentiality of patients and informing them as to why sampling is done and how the specimen is being processed are considered good practice and are recommended. Article 45 in the IHR (2005) describes the "Treatment of personal data". Person-identifiable data collected under IHR should be kept confidential and processed anonymously as required by national law, but may be shared with WHO for assessments and management of public health risks.

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Appendices

- Appendix 1 Implementation of a pandemic early warning system
- Appendix 2 Checklist for selecting sentinel sites for influenza surveillance
- Appendix 3 Minimum data set: form for data collection and definitions of pre-existing conditions
- Appendix 4 Weekly aggregated data form for ILI and SARI
- Appendix 5 Global reporting networks: FluID and FluNet
- Appendix 6 Example of a weekly influenza surveillance report
- Appendix 7 Example of an annual influenza surveillance report
- Appendix 8 Defining average epidemic curves and alert thresholds
- Appendix 9 Data management
- Appendix 10 Performance indicators to measure quality of influenza sentinel surveillance

Appendix 1: Implementation of a pandemic early warning system

An early warning system for outbreaks should have three basic components:

- A defined list of signal events that need to be immediately notified to public health authorities.
- A clear mechanism for reporting signal events.
- A mechanism for investigating, evaluating, and responding to signal events.

The primary focus of early detection is to detect events that may signal human-to-human transmission of an influenza virus with the potential to spread widely in humans. Examples of specific respiratory triggers include the following:

- Abrupt, unexpected changes in the trend of respiratory disease observed in routine surveillance systems.
- Clusters of severe respiratory disease or pneumonia in families, work places, or social networks.
- An unexpected pattern of respiratory disease or pneumonia such as an increase in apparent mortality, a shift in the age group associated with severe influenza, or a change in the pattern of clinical presentation of influenza-associated disease.
- Persistent changes noted in treatment response or outcome of severe lower respiratory illness.
- Severe, unexplained lower respiratory illness occurring in healthcare workers who care for patients with respiratory disease.
- Unusually high levels of sales of pharmaceuticals used for respiratory disease treatment.
- Respiratory disease in humans that is associated with illness in animals.
- Outbreaks of death or illness in fowl (e.g. poultry or ducks) or other animals (e.g. swine, cats).
- Human cases of infection with an unsubtypeable respiratory sample or any influenza virus not currently circulating in human populations.

To detect signal events early enough to permit effective investigation and possible intervention, a very sensitive system with wide participation is needed. The early detection activities that individual Member States carry out will vary greatly according to available resources, but may include any of the following:

- Education of healthcare providers about signal events that should be immediately reported.
- Monitoring and analysis of the routinely reported data from existing surveillance networks.
- Monitoring media sources for reports of unusual clusters or patterns of respiratory disease.
- Involving the national education authorities in reporting school outbreaks or unusually high levels of absenteeism.
- Monitoring rates of absenteeism in the workplace.
- Monitoring sales of "flu medicines" and other pharmaceuticals used for treatment of respiratory symptoms.
- Monitoring for outbreaks of respiratory disease in animals.

Reporting can happen in a number of ways from toll-free numbers to web-based reporting. Reported events should always be followed up. An investigation of an event reported by a member of the public could consist of a phone call to gather enough detail to determine if the report is worthy of an actual field investigation. More serious reports require more aggressive responses. Failure to respond not

only risks missing a significant event that could have been effectively managed while small, but also discourages further reporting.

(See also: A Guide to Establishing Event-based Surveillance. Available at: http://www.wpro.who.int/emerging_diseases/documents/eventbasedsurv/en/)

Appendix 2: Checklist for selecting sentinel sites for influenza surveillance

This checklist may be used to assess a healthcare facility for its appropriateness as an influenza sentinel surveillance site. It examines certain key aspects:

- Human infrastructure and communication capacities.
- Sufficient and appropriate patient population.
- Geographic representation.
- Infrastructure.

Site Description	
Is hospital management agreeable to implementing influenza surveillance?	yes <input type="checkbox"/> no <input type="checkbox"/>
Is the staff willing to work with influenza surveillance?	yes <input type="checkbox"/> no <input type="checkbox"/>
Does the site offer outpatient services?	yes <input type="checkbox"/> no <input type="checkbox"/>
Does the site offer inpatient services?	yes <input type="checkbox"/> no <input type="checkbox"/>
Are patients from all age groups attending the clinic?	yes <input type="checkbox"/> no <input type="checkbox"/>
Are patients from all socioeconomic strata and ethnic groups attending the clinic?	yes <input type="checkbox"/> no <input type="checkbox"/>
What is the 3-month average number of outpatient consultations?	
What is the 3-month average number of in-patient medical admissions?	
Can the catchment population of the site be estimated?	yes <input type="checkbox"/> no <input type="checkbox"/>
Human Resource Capacity	
Does the site have at least permanent clinical staff who can be trained in the identification of ILI and SARI and in respiratory sample collection?	yes <input type="checkbox"/> no <input type="checkbox"/>
Does the site have at least one permanent lab worker who can be trained in the collection, storage, testing, and transportation of respiratory sample specimens?	yes <input type="checkbox"/> no <input type="checkbox"/>
Infrastructure	
Does the site have a laboratory?	yes <input type="checkbox"/> no <input type="checkbox"/>
Does the surveillance staff have access to computers?	yes <input type="checkbox"/> no <input type="checkbox"/>
Does the surveillance staff have access to the Internet?	yes <input type="checkbox"/> no <input type="checkbox"/>
Does the site have a reliable power supply and fridge where the sample specimens can be kept?	yes <input type="checkbox"/> no <input type="checkbox"/>

Appendix 3: Minimum data set: form for data collection and definitions of pre-existing conditions

Data collection form				
ID number:	Date of symptom onset:	Date of form completion:	Date of first presentation to healthcare system:	Date of specimen collection:
IDENTIFICATION				
Patient unique identification number:			Sex: Male <input type="checkbox"/> Female <input type="checkbox"/>	
Patient's name: (family name), (given name(s))				
Date of birth: _____ or age: Years _____ Months (1-12) _____				
Address:			Contact Telephone Number:	
Clinical information				
Admitted to hospital? <input type="checkbox"/> yes, general ward <input type="checkbox"/> yes, intensive care unit <input type="checkbox"/> no				
Measured temperature: ____°C				
Pre-existing medical conditions:				
<input type="checkbox"/> Chronic cardiac disease <input type="checkbox"/> Asthma <input type="checkbox"/> Chronic respiratory disease <input type="checkbox"/> Chronic liver disease <input type="checkbox"/> Diabetes <input type="checkbox"/> Chronic neurological disease <input type="checkbox"/> Chronic renal disease <input type="checkbox"/> Chronic haematological disorder <input type="checkbox"/> Immune compromised <input type="checkbox"/> Pregnant (trimester: ____) <input type="checkbox"/> Other _____ <input type="checkbox"/> Unknown				
ANTIVIRALS				
Exposure to influenza antiviral drugs during the last 14 days?			<input type="checkbox"/> None <input type="checkbox"/> Yes, patient <input type="checkbox"/> Yes, household contact <input type="checkbox"/> Unknown	
If Yes, name of antiviral:				

Appendices

Definitions of pre-existing conditions associated with increased risk of severe influenza disease or death

Risk condition	Examples, definitions:
Chronic respiratory disease	Chronic obstructive pulmonary disease (COPD), including chronic bronchitis and emphysema, bronchiectasis, cystic fibrosis, interstitial lung fibrosis, pneumoconiosis, and bronchopulmonary dysplasia (BPD). Asthma is not included in this group and should be reported separately.
Asthma	Asthma which requires continuous or repeated use of bronchodilators, inhaled or systemic corticosteroids, or that with previous exacerbation required hospital admission.
Diabetes	Type 1 diabetes Type 2 diabetes requiring insulin or oral hypoglycemic drugs
Chronic cardiac disease	Conditions that require regular medications or follow-up, including Congenital heart disease Cardiomyopathy as the result of prolonged hypertension (hypertension alone in the absence of associated heart disease is not considered a risk factor for severe outcome) Chronic heart failure Ischaemic heart disease
Chronic renal disease	Chronic renal failure Nephrotic syndrome Renal transplantation
Chronic liver disease	Cirrhosis Biliary atresia Chronic hepatitis
Chronic neurological disease	Stroke with persistent neurological deficit Neuromuscular diseases associated with impaired respiratory function or risk of aspiration, such as cerebral palsy or myasthenia gravis Severe developmental disorder in children
Chronic haematological disorder Immune compromise (as a result of disease or treatment)	Sickle cell disease, Thalessemia major Aplastic anemia Immunodeficiencies related to use of immunosuppressive drugs (e.g. chemotherapy or drugs used to suppress transplant rejection) or systemic steroids Asplenia or splenic dysfunction (e.g. with sickle cell anemia) Human Immunodeficiency Virus infection or Acquired Immune Deficiency Syndrome (HIV/AIDS)
Obesity parameter, Body Mass Index (BMI)	BMI is calculated as body weight in kilograms divided by the square of the height in meters (kg/m^2). WHO defines obesity as a BMI of $> 30 \text{ kg}/\text{m}^2$. A commonly used definition for extreme or morbid obesity is a BMI $> 40 \text{ kg}/\text{m}^2$.
Tuberculosis	History of current <i>symptomatic</i> tuberculosis requiring treatment.

Appendix 4: Weekly aggregated data form for ILI

Sentinel site _____

Reporting week nr: _____ from (date) _____ to (date) _____

	0 to < 2 years	2 to < 5 years	5 to <15 years	15 to <50 years	50 to <65 years	≥ 65 years
New ILI cases						
Sampled ILI cases						
Proportion of sampled cases positive for influenza						
Outpatient visits						
Catchment population						

Weekly aggregated data form for SARI

Sentinel site _____

Reporting week nr: _____ from (date) _____ to (date) _____

	0 to < 2 years	2 to < 5 years	5 to <15 years	15 to <50 years	50 to <65 years	≥ 65 years
New SARI cases						
Sampled SARI cases						
Proportion of sampled cases positive for influenza						
New hospital admissions*						
SARI deaths						

*Excluding labour and delivery and elective surgery.

Appendix 5: Global reporting networks: FluID and FluNet

FluID

FluID is the WHO system used to share epidemiological data on influenza on a global level. The system complements the existing FluNet reporting network for virological data. Some WHO regional offices have created regional data entry tools that link directly with FluID and FluNet and can be used by Member States of those regions. FluID is able to accept data on ILI/ARI/SARI pneumonia and mortality by age group with a consultation and/or population denominator. It allows near real-time tracking of respiratory disease trends regionally and globally. Summary data collected from FluID is publicly available in graphic form to all Member States through WHO websites. These data are combined with influenza virological data from FluNet.

FluID on the web: http://www.who.int/influenza/surveillance_monitoring/fluid/en/

FluID email: fluid@who.int

FluNet

The data are provided remotely by National Influenza Centres (NICs) of the of the Global Influenza Surveillance and Response System (GISRS) and other national influenza reference laboratories collaborating actively with GISRS; alternatively these data are uploaded from WHO regional databases. Public users have real-time access to selected data reports including tables, maps, and graphs at the national level; whereas data providers have full access to all virological information at the national level and by laboratory. The virological data entered into FluNet are critical for tracking the movement of viruses globally and interpreting the epidemiological data reported through FluID.

FluNet on the web: <http://www.who.int/flunet>

GISRS email: gisrs-whohq@who.int

Appendix 6: Example of a weekly influenza surveillance report

Influenza report for a week

Description of the activity, which should include the following information:

- trend in both ILI and/or SARI activity, compared with last week's, previous seasons, and baseline;
- proportion of laboratory-confirmed influenza illness among ILI and SARI case patients;
- number of new viruses detected in ILI and SARI surveillance;
- type and subtype of influenza viruses that have been detected;
- results of antiviral susceptibility testing (if available);
- geographical spread (if available);
- impact on healthcare facilities (if available);
- any other information:
 - zoonotic influenza activity;
 - respiratory syncytial virus (RSV) detection;
 - vaccine availability;
 - international influenza activity.

Appendices

The following data should be presented graphically:

- ILI curve, with population and/or consultation denominator, including former years (Figure 1);
- ILI curve from this year, with age break down (Figure 2);
- SARI curve from this year, with age break down (Figure 3);
- Virus detections showing types/subtypes and proportion positivity (Figure 4).

Figure 1: ILI activity as a proportion of consultation where the diagnosis "influenza like-illness" was made, up to week 5, 2012

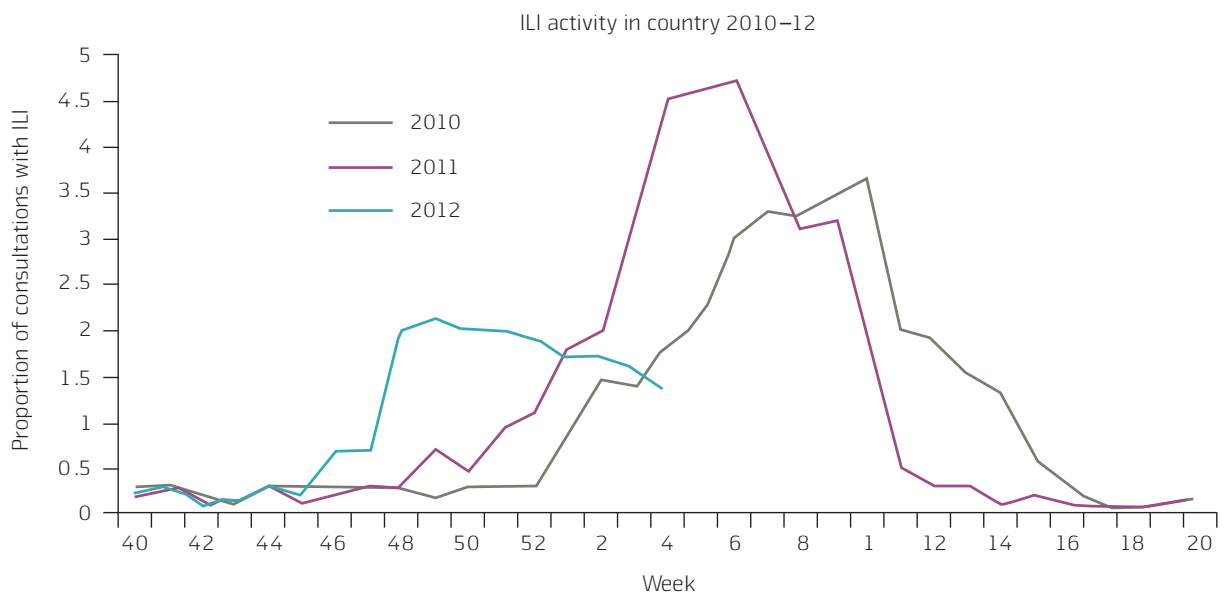


Figure 2: ILI activity as a proportion of all outpatient consultations by age group. Numerator = number of ILI consultations for the week in each age group, denominator = number of all outpatient consultations for the same facility(ies) for the week in each age group.

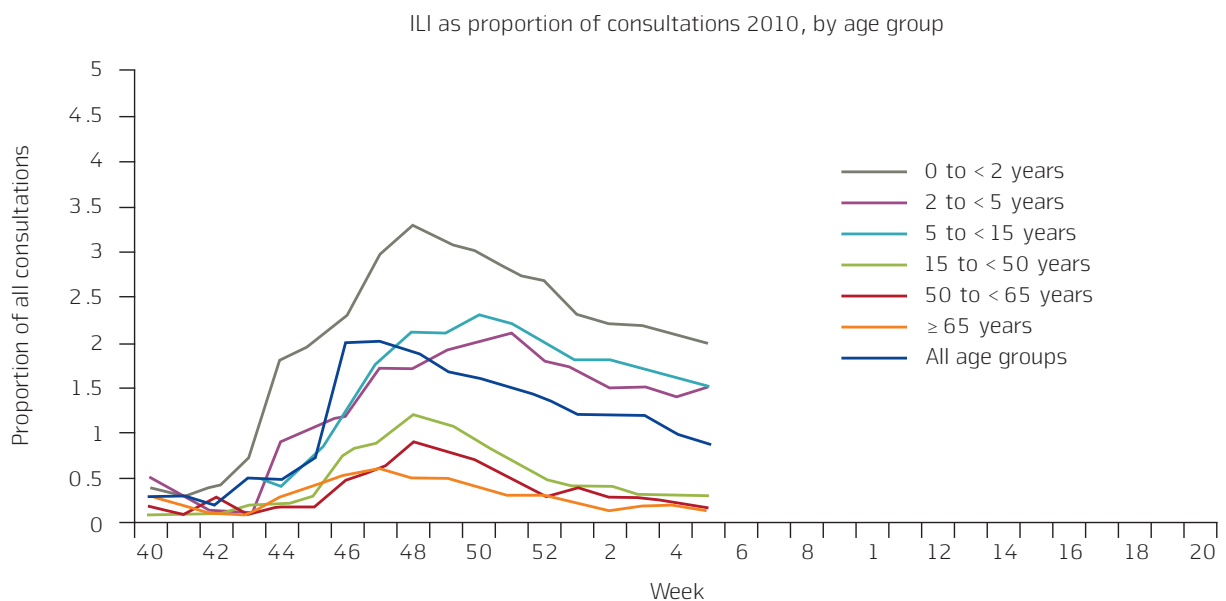


Figure 3: SARI activity as a proportion of all inpatient admissions by age group. Numerator = number of SARI consultations for the week in each age group, denominator = number of all inpatient admissions for the same facility(ies) for the week in each age group.

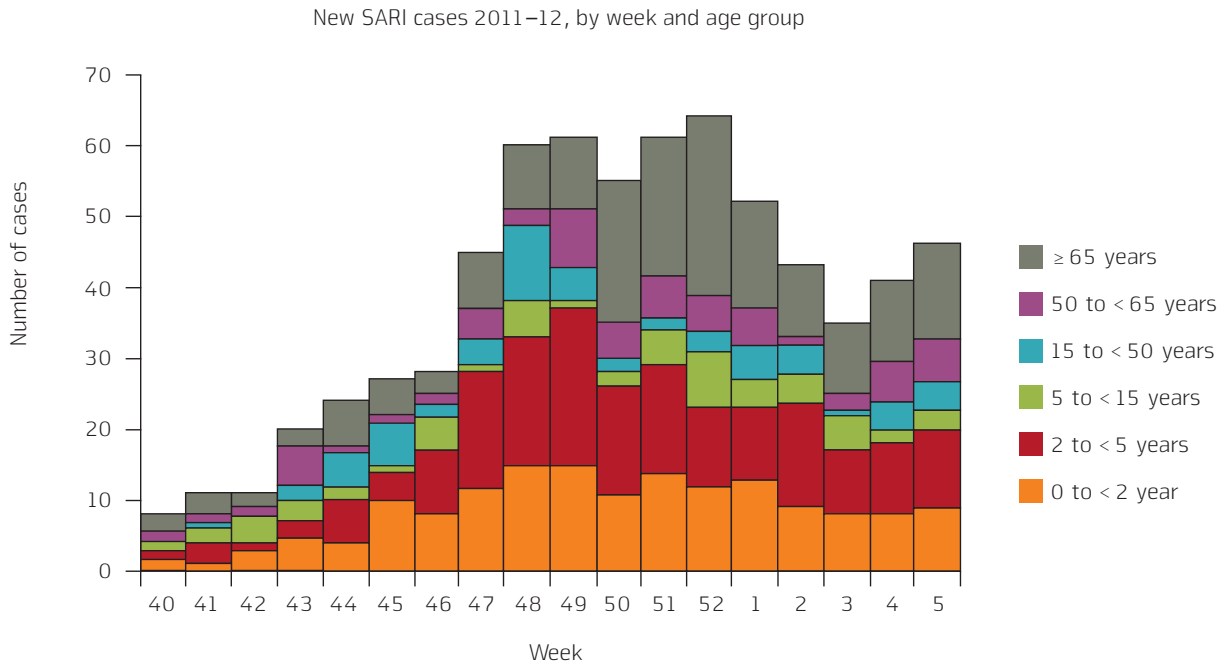
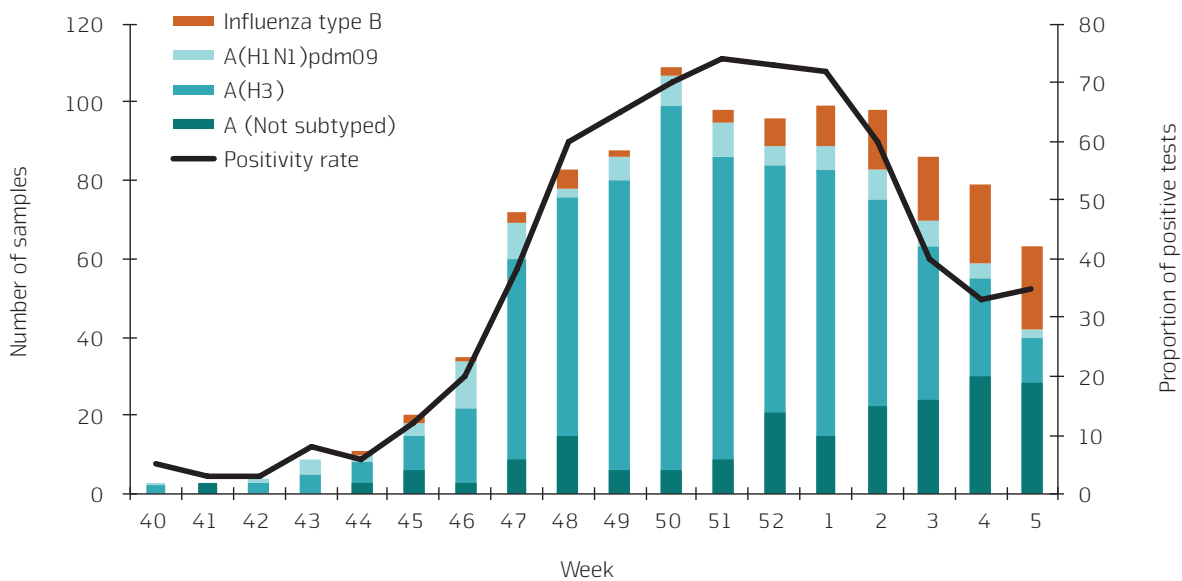


Figure 4: Virus detections by subtype compared with positive specimens for all types, in country X 2011–12



Appendix 7: Example of an annual influenza surveillance report

Summary

- Brief summary description of the epidemiological, virological, ILI, and SARI data.

Description of the surveillance system

- Brief description of how the data are collected and how the surveillance system is organized.
- Reporting procedures.

Epidemiological surveillance

- Present the epidemiological data graphically.
- Describe the season in terms of starting date, duration of outbreak, intensity, and criteria for defining the start and end of the season.
- Age groups most affected.
- Differences in regions (if applicable).
- Comparison of this season to previous seasons.

SARI data

- Description and summary of influenza-associated SARI data collected by week admitted, age, and gender.
- Co-morbidity among cases.
- Vaccine coverage among the SARI patients.
- Fatal cases (if available).

Virological surveillance

- Present the virological data graphically.
- Description of how many influenza detections were done, as well as type and subtypes of influenza viruses.
- Describe differences in the distribution of viruses by age or severity.
- Summarize any notable changes from previous years.

Vaccine data

- Match between circulating viruses and strains covered by the vaccine.
- Vaccination coverage, if possible by age and/or risk groups.

Antiviral resistance data (if available)

- Number of viruses tested for antiviral resistance.
- Result from testing.
- Number of viruses sent to WHO CCs for further testing.

Performance of the surveillance system

- Brief description of the system and its operations.
- Proportion of sentinel sites reporting to the national level weekly.
- Proportion of sentinel sites regularly submitting specimens for laboratory testing.
- Number of specimens sent from the sentinel sites.

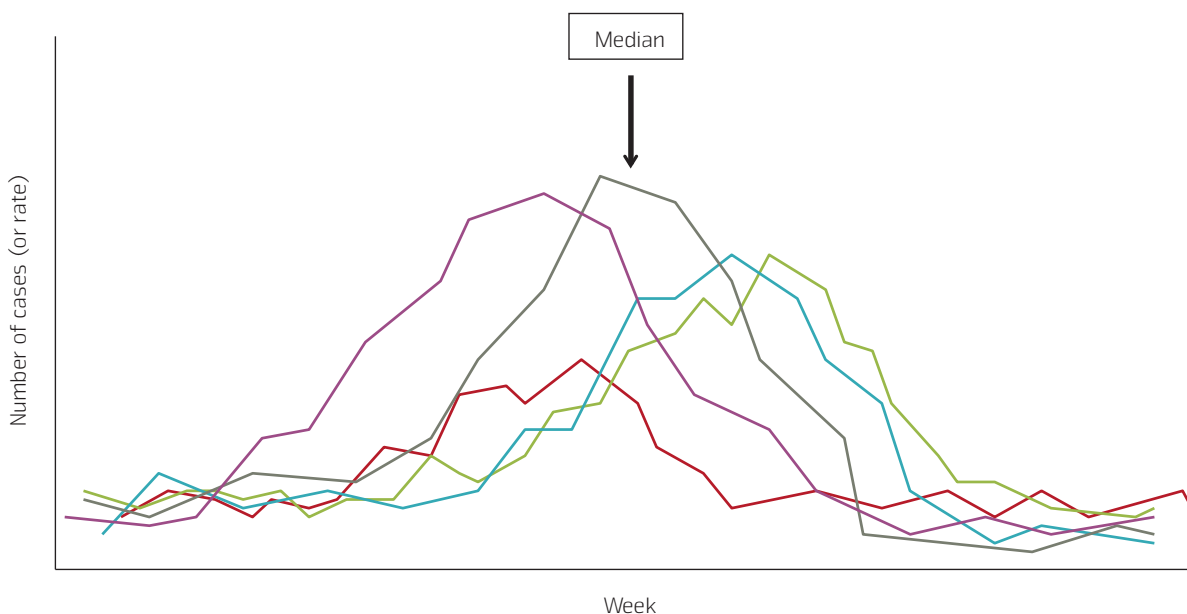
- Timeliness of reporting from sentinel sites (or lag between data collection and reporting).
- Timeliness of reporting of results from laboratories to national level and to clinical level.
- Timeliness of data published in the weekly report.
- Proportion of weeks with reporting to FluNet and FluID and/or other reporting systems.
- Aberrations in observed trends/data.

Appendix 8: Defining average epidemic curves and alert thresholds

Determining average epidemic curves

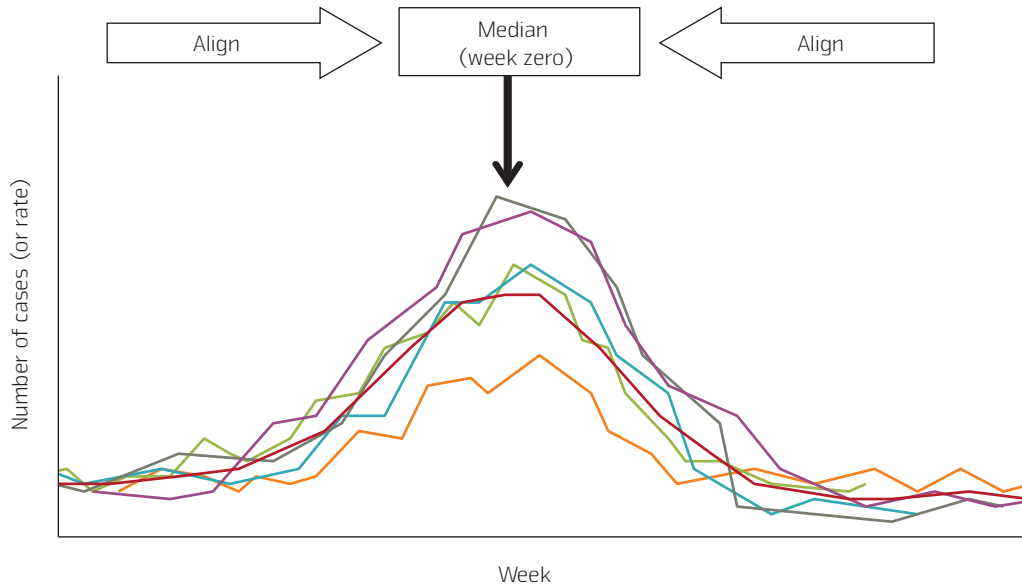
Even in temperate regions, peak transmission can vary widely from year to year. Simple averaging of weekly data over several years will result in a wide summary curve that is less useful for defining what a typical, hypothetical season will look like. Aligning the curves around their peaks will allow for the description of the average amplitude of a peak, rather than the average amplitude of a given calendar week. To accomplish this, follow these simple steps:

1. Identify the median week of peak occurrence for the years for which data are available. For example, if five years of data are available and the five seasons have peaked during Week 1 in January, Week 2 in December, Week 1 in March, and Week 2 in January, then the median week will be the first week of January – hence, half of the previous years for which there are data will have occurred earlier than the median and half will have occurred later.

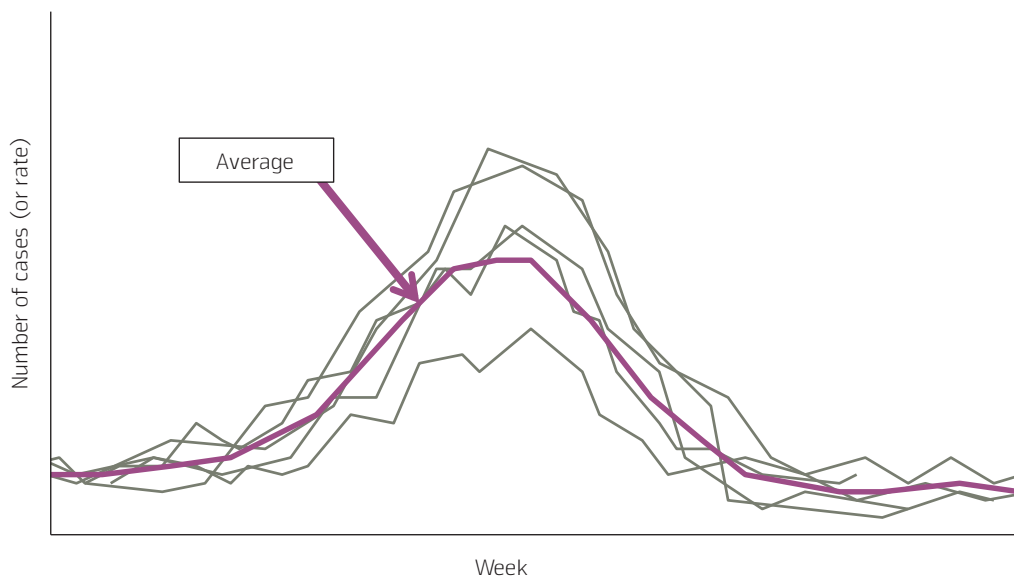


2. Align the data of the previous years' data with their respective peaks aligning on the median week identified in Step 1. This is illustrated graphically below but is most easily done using a spreadsheet, pasting each year's data in a column alongside the previous year's data, with their peaks falling in the same row.

Appendices



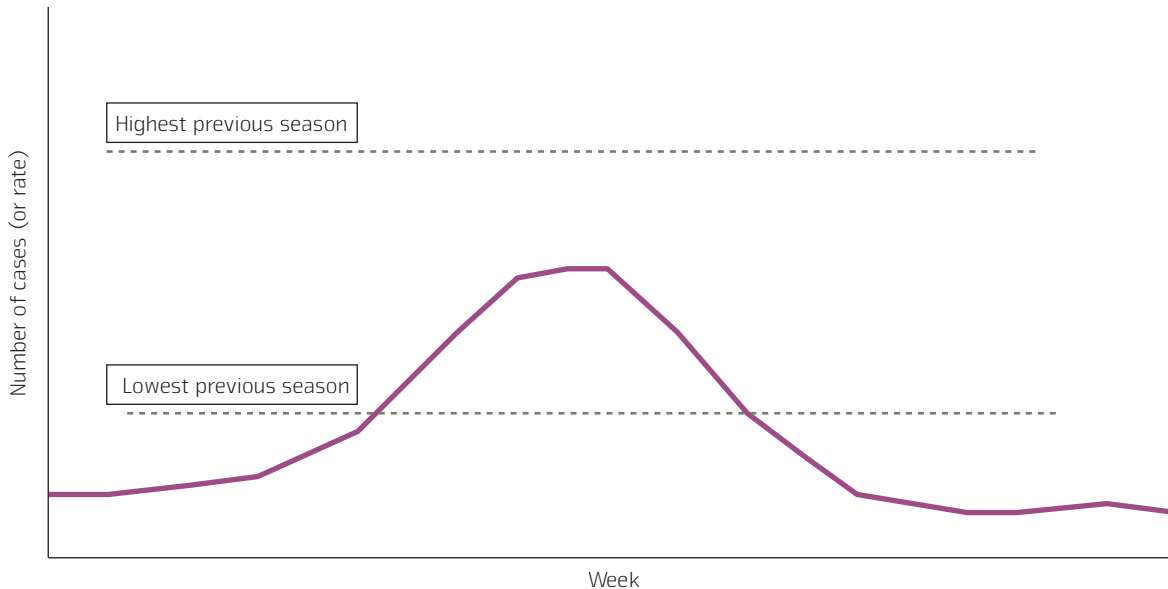
3. Calculate an average for each week. If you have used the spread sheet as described above, this would be the average of each row of data. A four-week running average can be used to smooth the curve.



Defining alert threshold

1. To put a current season into a historical context, it is not enough to describe an average: there should also be limits defined for extreme values, particularly for the upper extreme. This will help those looking at the data to understand if the current season is out of range in comparison to a range of previous seasons. The simplest way to do this is to display the highest and lowest seasons, or range, excluding any exceptional events such as a pandemic.

Appendices



- Another way to define extreme values is to calculate the standard deviation of the mean for each week and then create a curve for those values. A curve based on 1.65 standard deviations above and below the mean would encompass 90% of all seasons. This would mean that 5% of seasons, 1 out of every 20, would be above the upper limit for the season and 5% would be below. The higher value is used as an alert threshold for severe seasons. For example, countries which track the number of laboratory confirmed, influenza-positive samples could estimate the 90% using a few simple equations.

First, calculate the variance of the values for each week:

$$variance = \frac{\sum(x - \bar{x})^2}{n - 1}$$

Where x is the value for that week, \bar{x} is the average of all the years' data for that week, and n is the number of years for which the data are available.

Next, calculate the standard deviation (σ) for each week using the square root of the variance:

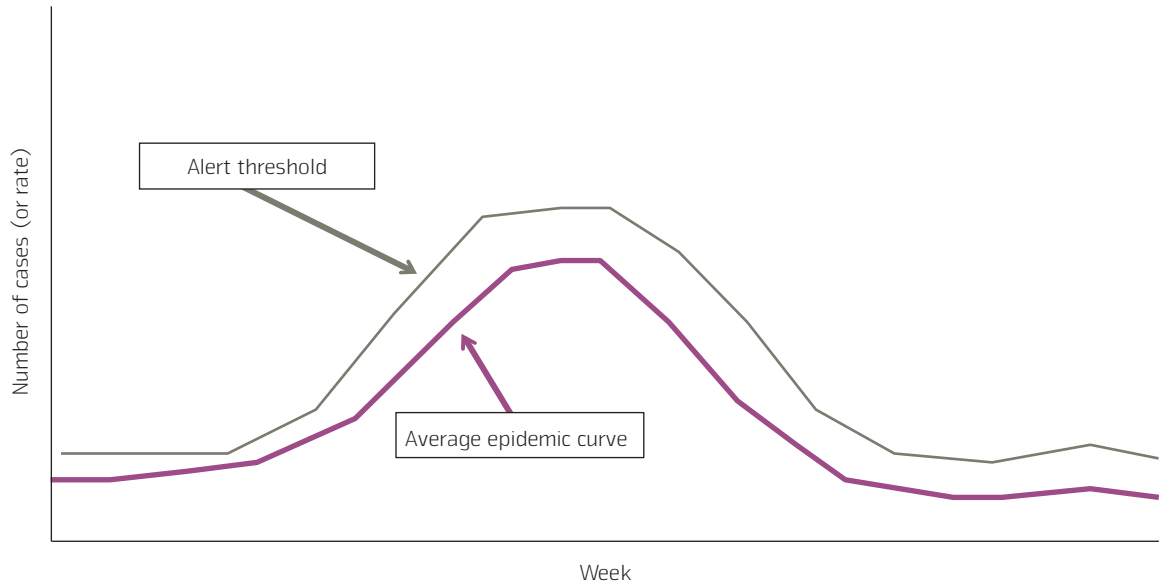
$$\sigma = \sqrt{variance}$$

The upper and lower 90% confidence intervals around the mean for each week will be:

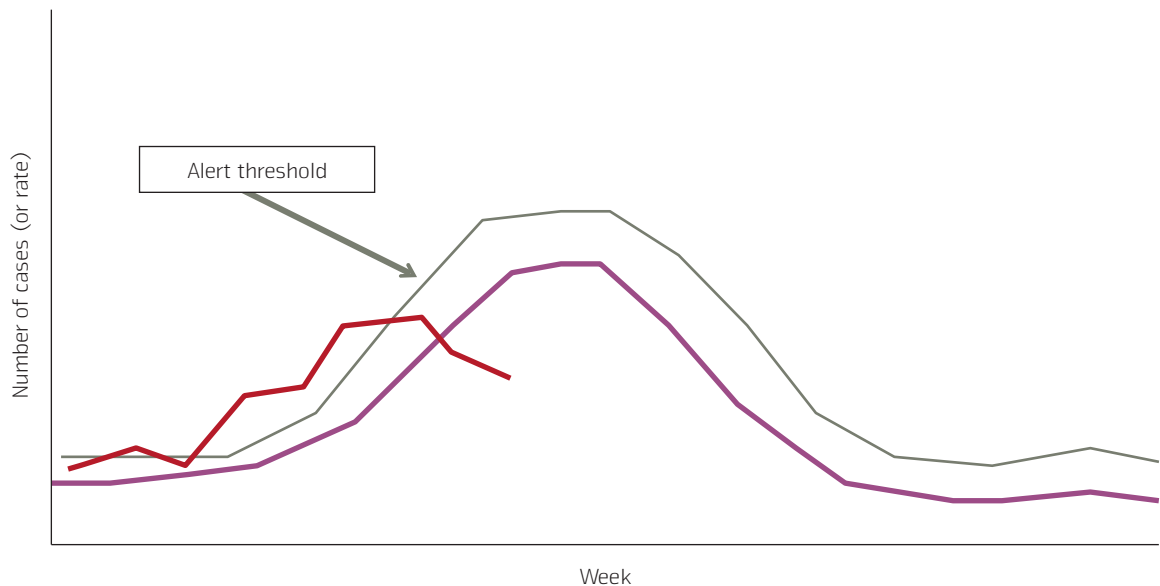
$$\bar{x} \pm 1.645 \times \sigma$$

Appendices

The upper 90% confidence interval will define the alert threshold.



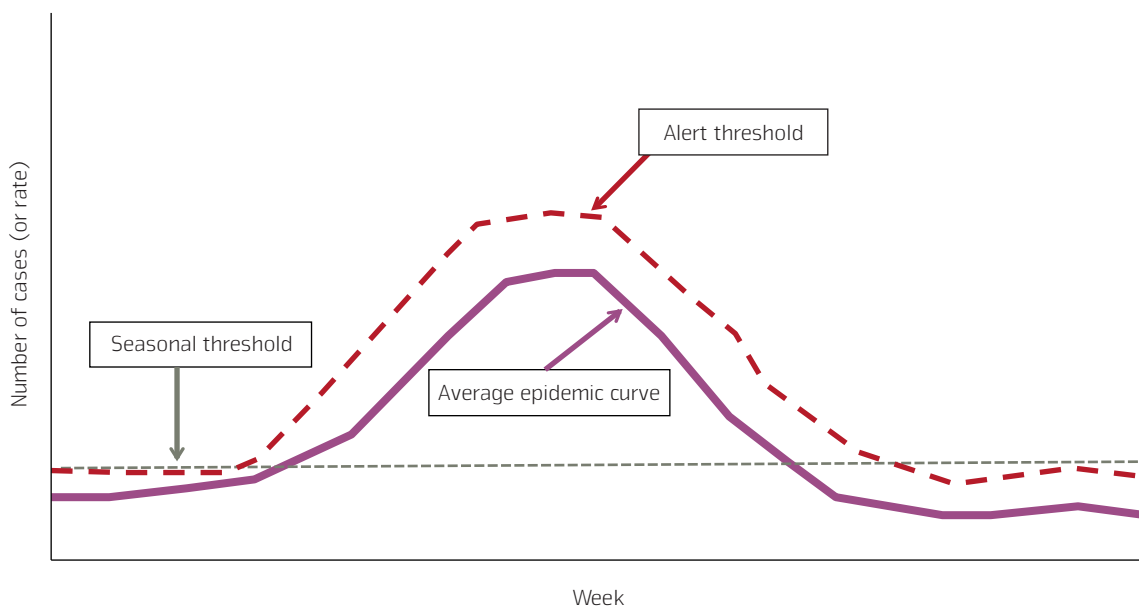
- 3. Plot current year data on curve (the example below displays a year which is relatively mild but earlier than usual in comparison to the previous years on average). If the alert threshold is set at the upper 90% confidence interval, only 1 in 20 seasons should exceed this threshold over the course of the entire season.



Seasonal threshold

Many methods have been described to determine a threshold that defines the start of a season as described earlier in the text. The simplest method involves a visual inspection of several years of data to determine the point or threshold that would consistently be higher than normal random variation in the off-season baseline, while being low enough to signal the start of an influenza season early enough in the season to be useful.

A simple method that results in a numeric value is to calculate the annual median amplitude for the data being plotted. To use this method, it is important that an entire year's worth of data be available for each of the years used in the calculation. For example, countries that track the weekly proportion of samples that test positive for influenza can use the annual median proportion positivity for the average epidemic curve of the proportion positivity as a threshold for seasonal epidemics. When influenza activity occurs consistently (e.g. two to three weeks) above the annual median proportion positivity, countries may consider influenza transmission as epidemic²⁹.



Appendix 9: Data management

Data management is an important consideration in the process of planning a surveillance system. The purpose of data management planning is to facilitate storage and flow of the data so that the collected data is accessible for surveillance personnel at different administrative levels. It is advisable to put in place a dedicated data administrator who is responsible for setting up and securing the data environment, ensuring data archiving, recoverability, integrity, security, and availability to all end-users.

A *unique case identifier* is a number assigned to the individual patient that makes it possible to link epidemiological and virological data from various databases (e.g. SARI surveillance form, specimen form, swab, laboratory report etc.). This number should be used both on epidemiological data forms

²⁹ Azziz-Baumgartner E, Dao CN, Nasreen S et al. (2012) Seasonality, Timing, and Climate Drivers of Influenza Activity Worldwide. *The Journal of Infectious Diseases*. 206 (6): 838-846. doi: 10.1093/infdis/jjs467

and laboratory sampling forms in order to be able to trace the patient's sample and link epidemiological and virological data. The unique identifier also makes it possible to work with anonymous data.

Steps involved in setting up a data management system include:

1. Identify all sources where data are or will be collected (both epidemiological and virological data).
2. Identify all end-users.
3. Identify data administrator(s) at appropriate locations.
4. Develop standardized data structures for each source type. These may vary from simple spread sheets to sophisticated relational databases as back end and browser-based front end applications for data entry.
5. Develop procedures and systems for movement/reporting of data from different sources to the central location.
6. Define how and what data to report from local to regional/national/international level.
7. Develop data quality checks (e.g. consistency checks, validity checks etc.) and develop protocols for management of inconsistent and missing values (see also Chapter 11 on monitoring and evaluation).
8. Plan how to integrate data from different sources and different databases.
9. Develop standardized, easy-to-produce report outputs in tabular and graphical formats, which can easily be published on the Internet.
10. Develop systems to ensure data security, access, dissemination, availability, recovery, and back up.
11. Develop data archival/repository systems including periodic testing of data recovery.

Appendix 10: Performance indicators to measure quality of influenza sentinel surveillance

To evaluate the efficiency and success of the system, a number of process indicators and outcome indicators have been established.

1. Timeliness

Several time intervals are appropriate for routine measurement as quality indicators:

- Target date for data reporting from the sentinel site to the next administrative level until the actual reporting date.
- Target date for data reporting from the next administrative level to the national level until the actual reporting date.
- Date of specimen collection at facility until shipment to laboratory.
- Date of result availability in laboratory until date of report to referring institution and physician.
- Date of receipt of specimen in the laboratory until result availability.

Appendices

Two metrics can be used to reflect timeliness indicators:

- Percentage of times that a site achieves its target for timeliness.
- Average number of days for each interval over time for each site.

2. **Completeness**

- Proportion of reports received with complete data from each site.
- Proportion of weeks when reports are received.
- Proportion of reported cases that have specimens collected.

3. **Audit**

Regular field evaluations and audits at facility level of a subset of medical records to ensure the following:

- Cases are being counted appropriately and not being underreported.
- Reported cases fit the case definition.
- Epidemiologic data are correctly and accurately abstracted.
- Respiratory samples are being taken, stored, processed, tested, and shipped properly and in a timely fashion from all those who meet sampling criteria.
- Sampling procedures are being done uniformly without evidence of bias.

4. **Data to be followed and observed for aberrations over time**

- Number of cases reported by month for each site.
- Number of specimens submitted by month for each site.
- Proportion of specimens that are positive for influenza.
- Number and proportion of ILI and SARI cases tested.

Regular surveillance reviews are recommended to ensure data quality, protocol adherence, and standardization across time. (See also: CDC International Influenza Surveillance Assessment Tool available at: http://www.cdc.gov/flu/pdf/international/cdc_flu_surveillance_tool_508.pdf)



ISBN 978 92 4 150660 1



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