# Indicator-based Surveillance

**Checklist**

- Agree on strategy
- Select priority diseases
- Define case definitions
- Define alert thresholds
- Standardise and strengthen reporting
- Analyze trends and trigger {signals/alerts}

**Key points**

- Indicator-based surveillance (IBS) is the most classically-used and visible approach for public health surveillance.
- IBS data is analyzed on a weekly schedule, producing weekly alerts.
- IBS monitors trends in priority diseases based on (a) standardized case definitions to capture disease data, (b) weekly data collection and analysis to provide a consistent stream of reporting, and (c) alert thresholds to trigger {signals/alerts}.
- IBS is most useful in detecting outbreaks of disease that are endemic and therefore are already tracked by a national surveillance system using standardized case definitions.
- Other sources of data (e.g. laboratory, drug use, animal health) can be integrated into IBS.

| [Case study for mock up] \<\<insert infographic of routine surveillance tying together sources, type of data transmitted, and regular reporting expected\>\> |

## The basics of IBS

Indicator-based surveillance (IBS) is the routine collection, monitoring, analysis, and interpretation of data from health facilities that is based on standardized case definitions.

Typically, infectious diseases (e.g., meningococcal disease) are included in IBS. In some systems, non-infectious hazards (e.g. acute broncho-pulmonary injury of chemical origin), are reported through IBS.

IBS data should be collected and immediately analyzed on a weekly schedule to produce alerts on a weekly basis.

IBS is the most classically-used and visible approach for epidemiological surveillance. It generates the most data within the EWAR system. To produce alerts, IBS requires a dedicated data analysis plan.

A summary of the key characteristics of IBS is shown in Table 1.

**Table 1** Key characteristics of IBS

| Characteristic | Description |
|---|---|
| **Key strength** | Triggering {alerts/signals} for known diseases and conditions |
| **Data sources and strategies** | *Traditional*<br>- Healthcare facilities, public and private<br>- Laboratories, public and private<br><br>*Non-traditional*<br>- Mortality registries<br>- Animal health surveillance<br>- Medications sales data<br><br>- Sentinel surveillance (strategy)<br><br>- Syndromic surveillance (strategy) |
| **Characteristics** | - Aggregated data<br>- Well-structured and organized format for data collection and reporting<br>- Limited to 8 to 12 priority diseases<br>- Standardised case definitions<br>- Standardised alert thresholds |
| **Process** | - Systematic and regular data collection<br>- Passive reporting (i.e., there is no active search for cases)<br>- Always the same reporting sites<br>- Weekly frequency<br>- Emphasis on weekly monitoring of alert thresholds, triggering of {signals/alerts}, and determining of public health actions |

# 1. Select priority diseases and other hazards

The key criteria to guide the selection of priority diseases and conditions are shown in Box 1. Note that the list of priority diseases and conditions must be revised regularly to reflect the current epidemiological context and any emerging hazards.

**Note**

It is recommended that between 8 to 12 diseases and conditions are monitored through IBS to avoid overwhelming the system.

**Criteria to guide selection of priority diseases and conditions**

- Does the **disease or condition** have the significant potential for a high impact on morbidity, disability, and/or mortality?
- Does the **disease** have significant potential for sudden epidemics (e.g. cholera) or ongoing transmission with seasonal epidemics (e.g. meningitis, measles)?
- Have there been recent public health emergencies involving non-infectious hazards that warrant the inclusion of a **non-infectious hazard** (e.g. severe lead poisoning in Northern Nigeria)?
- Is the disease a specific target of a national, regional or international control programme?
- Will the information to be collected enable significant, rapid, and cost-effective public health action?

From the outset, consider which diseases have an epidemic profile (e.g., epidemic cholera: no reported cases, then large, unpredictable outbreaks), endemic profile (e.g., malaria, meningococcal disease, endemic cholera: ongoing transmission with seasonal epidemics), or could result from an emergency and its mass movements of people to/from an endemic area to a non-endemic area (e.g., hepatitis E among South Sudanese refugees in Ethiopia). See Figure 1 for a visual description.

E3C9 **Typical list of diseases and hazards**

Typically, the list contains a common set of emergency-prone diseases which are monitored as syndromes for early detection. This is a good starting point for team discussion on the list of applicable diseases and hazards.

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1. Acute flaccid paralysis (suspected poliomyelitis)
2. Acute hemorrhagic fever syndrome (suspected dengue, Ebola-Marburg viral diseases, Lassa
fever, yellow fever, etc.)
3. Acute jaundice syndrome (suspected hepatitis A/E)
4. Acute respiratory infection (suspected pneumonia)
5. Acute watery diarrhea (suspected cholera)
6. Bloody diarrhea (suspected dysentery)
7. Malaria (confirmed)
8. Measles
9. Suspected meningitis
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**Note**

Non-communicable diseases, injuries, malnutrition, and mortality are **not** typically included in the IBS component of EWAR. Despite their clear importance to population health, they will not benefit from immediate reporting and EWAR does not support the calculation of prevalence needed for their surveillance. If included, their data collection may overwhelm the daily operation of the system.

**Figure 1: Epidemiological profiles of epidemic and endemic diseases** (source: WHO MOOC on Cholera)

# 2. Define case definitions

Each priority disease or condition will usually have a known standardized case definition defined by the Ministry of Health.

Case definitions must be clear, appropriate and consistent throughout the surveillance system. All healthcare workers that are responsible for reporting cases to IBS must ensure that the patients meet these standardized case definition.

Case definitions can be based on clinical criteria, laboratory criteria or a combination of the two with the elements of person, place, and time.

**Note**

A case definition is a set of diagnostic criteria that must be fulfilled for an individual to be regarded as a case of a particular disease for surveillance and outbreak investigation purposes. |

The case definitions is designed for the purposes of public health surveillance only. As such, it is important to remember that they are not used as diagnostic criteria for treatment as it is not an indication of intention to treat.

Case definitions are meant to be dynamic and changes to the definition can be implemented to improve the EWAR function. For instance, sensitive case definitions are more inclusive and do not include a requirement for laboratory confirmation of the pathogen. They will generate many {signals/alerts} to generate more indications of acute public health events. However, these {signals/alerts} require further verification to determine if a risk assessment is needed. False-positives (or low specificity) is expected and tolerated in order to reduce the chance of missing an outbreak.

Cholera case definitions are explained in Box 2. Resources for standardized surveillance, community, and outbreak case definitions are given in Box 3.

**Cholera case definitions**

A typical example is the case definition for a suspect cholera case in areas where a cholera outbreak is declared *(any person presenting with or dying from acute watery diarrhoea).*

This definition is meant to include as many potential cases of cholera as possible, but is likely to erroneously include cases of rotavirus and *E. coli*, which exhibit similar symptoms.Syndrome-based case definitions are used to represent a few easily-identified symptoms rather than the actual clinically diagnosed disease itself as it increases the likelihood that it will capture all persons with the disease (alongside a fair number of false positive cases).

EWAR systems in emergencies rely heavily on syndromes for early detection over diagnoses. Community case definitions may be developed in a similar way to provide the most simplified means for untrained community members to identify suspect cases of disease . For instance, the community case definition for cholera may be _sudden onset of watery diarrhoea._In addition, upon declaration of the cholera outbreak, the case definition has changed from a surveillance definition to an outbreak case definition. This is done to improve the search for cases which match the characteristics of those affected by the outbreak.

For more information, see Module 6.

**Surveillance, outbreak, and community case definitions**

Up to date outbreak and community case definitions can be found in the **WHO Outbreak Toolkit: LINK** Surveillance case definitions can be found in the **WHO Surveillance Standards** |

# 3. Define alert thresholds

Alongside a case definition, a strategy for data collection, and a data source, each disease and condition prioritised in EWAR must be assigned an alert threshold and potentially, an epidemic threshold.

**Definitions**

An **alert threshold** is the critical number of cases used to trigger an alert. All alerts must be verified to determine if further risk assessment and response is required (see Module 5).

An **epidemic threshold** is the critical number of cases required for an epidemic to occur. It is used to confirm the emergence of an epidemic so as to step-up appropriate control measures.

An alert threshold depends on the disease's ability to cause an outbreak. Alert thresholds can be broadly categorised into two types:

1. **Fixed value alert threshold.** For diseases with especially high risk of transmission and high-impact on morbidity and mortality, the threshold is set at an absolute value, which when exceeded will trigger a {signal/alert}. For many diseases, this threshold is a single case (see Figure 1).
2. **Changing alert trend using a comparison with historical trends.** For diseases that are endemic and/or may be predicted (e.g. due to seasonal increases in incidence), the threshold can be set as a calculated value, based on an increase in the number of cases that is greater than the incidence that is expected during a given time period.

In routine settings, where historical data may be available, an alert threshold can be calculated (see Figure 3). If fairly accurate population data is available, attack rates or incidence can be calculated. In emergencies, where no prior baseline data is available and where displacement has occurred, these are often calculated based on moving averages over short time frames (see Figure 2).

**Figure 1** Example of fixed value alert threshold

Alert threshold based on a single case in a previously unaffected area: - e.g. suspected measles, cholera, viral haemorrhagic fever, yellow fever - An alert threshold can be raised for a provincial/ state/district in a country where an outbreak is already occurring in another area.

Alert threshold based on an attack rate: - 5 cases of meningococcal disease per 100,000 persons per week is an **alert threshold** to trigger preparation for mass vaccination, refresh of health facility reporting procedures to ensure weekly and zero reporting - 10 cases per 100,000 persons per week is an **epidemic threshold** to declare the outbreak, initiate active case finding, daily reporting of suspect cases and deaths

**Figure 2** Example of a changing alert trend in emergency setting

Suspected malaria: twice the mean number of cases seen in the previous three weeks for a given location

RDT+ malaria cases, refugee camp, weeks 1 to 10

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- Here, we see that the number of cases has crossed the threshold in weeks 4
to 6 and falls below the threshold with a declining trend in weeks 7 to 10
(indicating natural decrease and/or outbreak control) .
- For Week 5, this is achieved by calculating 2 x the mean of the number of
cases in the previous 3 weeks
= 2 x (∑20+30+60) = 73 cases is the alert threshold for week 4 (versus 101
cases observed)
- Therefore, the case count for week 5 crosses the alert threshold and
outbreak control actions should be undertaken
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**Figure 3** Example of trend in routine settingDengue: greater than 2 x the standard deviation (SD) of the baseline rate (mean monthly number of the previous five years)

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- The trendline shows a changing trend by month determined by seasonality
during the previous five years.
- Here, we see that the number of cases has crossed the threshold in month 10
only.
- For month 5, this is achieved by calculating 2 x the mean of the number of
cases in the previous 5 years for month 10 (October)
= 2 x (∑20+30+60) = 11,698 cases is the alert threshold for month 10 (versus
12,987 cases observed)
- Therefore, the case count for month 10 crosses the alert threshold and
outbreak control actions should be undertaken
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 Other examples include: malaria, acute watery diarrhoea, acute respiratory
infection.
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**More detail**

Integration of population and geography into alert thresholds **Alert thresholds can also be** adjusted for population size **(e.g. meningitis alert and epidemic thresholds for populations 30,000-100,000 differ from those less than 30,000). They can also** aggregated to higher geographic levels **, if the dynamics of transmission at health facility level is not sufficient to determine the public health risk (e.g. malaria thresholds can be defined at subnational levels). Analytical techniques that** integrate temporal trends and the spatial distribution of cases** are useful for setting a threshold. For example, geospatial methods including spatiotemporal analysis (i.e., using SaTScan) are commonly used to identify potential clusters of suspect disease that are more closely aggregated in time and space than would be expected historically.

**Interpretation and application of alert thresholds**

In general, it is important to note that use of the alert threshold is dependent on the epidemiological context and the geographical area: - For instance, for cholera, in previously unaffected areas with no recent reported cases of a disease (e.g., cholera), alerts of a single case should be immediately reported (i.e., within 24 hours) to public health authorities for field investigation and confirmation of the outbreak. - Where a cholera outbreak is already declared, the number of cases and deaths in health facilities and in the community should be reported on a daily or weekly basis to monitor disease trends, case fatality ratios, and to inform prevention and control efforts. - Where cholera is endemic, the number of cases and deaths in health facilities and in the community should be reported on a weekly basis to monitor incidence, case fatality ratio, attack rates and to describe the epidemiology (person, time, and place) to inform prevention and control efforts.

# 4. Agree on strategy for data collection

A national surveillance system may employ several strategies for public health surveillance and many of these can be used to collect and analyze IBS data for EWAR. An EWAR system may use a mix of these strategies depending on its objectives and the resources available (see Table 3).

**Table 2: IBS strategies for data collection and comparative advantages for EWAR**

| Strategy | Description | Advantage for EWAR | Resources required for EWAR |
| --- | --- | --- | --- |
| **Exhaustive surveillance** | Routine reporting of cases from all health facilities. Required if all cases of disease need to be treated to reduce mortality and spread (e.g. EVD) Routine trend analysis of weekly surveillance data. | Early warning for outbreaks of routinely reported endemic and epidemic diseases (e.g., measles, meningitis, malaria). Main data for outbreak monitoring. | Few **logistics** , as the infrastructure already in place. Trend **analysis** procedures required. |
| **Sentinel surveillance** | A representative sample of reporting sites with a high probability of seeing cases of a particular disease and reports more detailed information (i.e. on causative pathogens) for each case. Serves as a means of monitoring trends among more common diseases that do not require notification (e.g. influenza) Routine trend analysis of weekly surveillance data. | Targets diseases with multiple causative pathogens (e.g., invasive bacterial disease caused by *Haemophilus influenzae* type b, meningococcus or pneumococcus). Targets diseases that may be seen in more specialist services (e.g., pertussis detected by pediatricians). | More **logistics** , if site selection needed, and infrastructure among selected sites is not yet already in place. More complicated trend **analysis** procedures required given sampling of sites. |
| **Syndromic surveillance** | Data from reporting sites on clinical signs and symptoms are analyzed to detect outbreaks faster than laboratory-diagnosis methods. Routine trend analysis of daily surveillance data. | Targets rare diseases that may be recognized late by clinicians and thus laboratory methods (e.g., anthrax, and other diseases which may intentionally released as a result of bioterrorism) | More logistics, if infrastructure for symptom reporting as it is not likely in place. More complicated analysis procedures given emphasis on analyzing various groups of symptoms. |

In addition to healthcare facility data, alternative sources of IBS data may also contribute to the early warning potential of IBS data. This includes (but is not limited to) (Table 3):

**Table 3: IBS sources and comparative advantages and challenges for EWAR**

| Data sources | Advantage for EWAR | Challenges for use in EWAR |
|---|---|---|
| Laboratory databases | Detection of pathogens and resistant strains in the hospital or communityRising trends in requests to confirm pathogensMain data for outbreak monitoring | Often not contained in same database as exhaustive surveillance and difficult to match records using identifying information on laboratory reportsRequires planned analysis, verification, and response mechanismsRepresentative of samples sent to laboratories rather than scale of transmission |
| Mortality registration | Detection of an ongoing epidemic with impact on mortality Track changes in crude numbers of deaths, patterns of causes of death, number of deaths of unknown causesExamples includes mortality surveillance set up for the comprehensive identification of measles cases during an outbreak. | Provides a trailing or late alert to an ongoing epidemicIn developing countries and emergencies, a proportion of deaths may be missed from registration, particularly among the displaced, very young (neonates), or intentionally hidden (EVD deaths) Violates EWAR requirement for weekly alerts given systems for data collection and reporting aligned to monthly or annual schedule. Causes of death are unreliable for the purposes of epidemic detection |
| Medication sales | Tracking of medication sales over time to anticipate or detect an outbreak Examples include tracking sales of oral rehydration solution in pharmacies to detect a seasonal cholera outbreak. | Systems for data collection need to be developed in most cases and are not scaled |
| Animal health surveillance | Changes in morbidity and mortality of animal herds that are systematically tracked over time. This may trigger an investigation into human data. | Systems for data collection need to be developed in most cases and are not scaled |

# 5. Standardize and strengthen reporting

### Frequency

IBS data in EWAR is always reported **weekly**. Monthly reporting is too infrequent, and will lead to lengthy delays in triggering and verifying {signals/alerts} to potential outbreaks.

Daily IBS reporting is not recommended, as it places an overwhelming burden on staff and can easily overwhelm a system. EBS can be used to support this function where real-time, immediate notification of {signals/alerts} is needed (see Module 4).

However, once an outbreak has started, daily reporting of the specific disease by all facilities in the affected area is expected. This is achieved through daily line listing of case and deaths, and submission of the line lists by the health facilities on a daily basis (see Module 6).

Weekly IBS reports should follow an **epidemiological week** as defined by the Ministry of Health. This is commonly Monday to Sunday, but can vary from country to country.

**What is reported**

All reporting sites should be assessed for their ability to perform **zero reporting** (the mandatory reporting of "0" cases if none are seen). Zero reporting avoids misinterpretation of the missing number, while also allowing the identification of non-responsive or "silent" health facilities. For example, zero reporting of EVD among health facilities in Sierra Leone after the peak of cases in 2015 demonstrated the vigilance of health facilities in remaining watchful for disease.

Standard reporting tools should be provided to staff to ensure data is good quality and well collected. Paper-based tools such as tally sheets are key to recording high volume of data collected via IBS. These can be completed by electronic tools to support data entry and reporting (see Module 9).

Reporting should also be strengthened through regular monitoring and supervision, to motivate staff (see Module 10) and through providing epidemiological bulletins directly to staff and feedback on system performance and with examples of how EWAR data is being used (see Module 11).

Where available, national case definitions and associated reporting forms issued by the MoH should be used. In cases where these are not yet available (for example in emergencies, when new epidemiological priorities are identified) then other sources can be used (e.g. WHO and UNHCR).

# 3.4 Who should be involved?

At all levels of an EWAR system, the following key stakeholders should be involved in the implementation of IBS:

- **A multi-disciplinary team of public health coordinators, medical officers, and epidemiologists** to identify theIBS objectives and strategy, including the selection of priority diseases, sources of data, case definitions and alert thresholds.
- **Health informaticians or epidemiologists** to support the design of field-based tools, including paper-based and electronic systems to facilitate timely collection, reporting and analysis of data.
- **Frontline health workers** , from Ministry of Health and partners, who need to be trained on case definitions and best practices for collecting and reporting data from health facilities.
- **Epidemiologists** to support the interpretation and use of data, including the design of epidemiological bulletins.The automatization and complexity level of outputs/reporting needs to be adapted to the level of training of recipients.
- **National and subnational public health officers** involved in the interpretation and use of IBS data in epidemiological bulletins, including their role in managing {signals/alerts} (see Module 5).

**References**

1. WHO Recommended Surveillance Standards. Second edition. Geneva, World Health Organization, 2002.
2. Early detection, assessment and response to acute public health events: implementation of early warning and response with a focus on event-based surveillance. Geneva, World Health Organization, 2014.
3. Outbreak toolkit: disease toolboxes. Geneva, World Health Organization, 2018.