EPIDEMIC ANALYSIS for RESPONSE DECISION-MAKING

SYSTEMATIC ORGANIZATION OF MULTI-SOURCE INFORMATION TO INFORM RESPONSE DECISIONS

World Health Organization
Western Pacific Region

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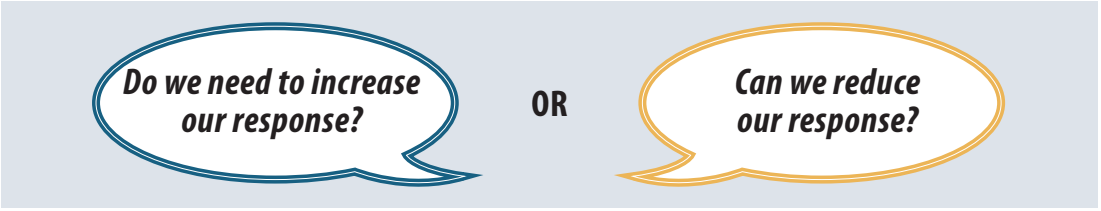
EPIDEMIC ANALYSIS FOR RESPONSE DECISION-MAKING (ERD)

Epidemic analysis for response decision-making (ERD) is a practical process for informing response decisions by systematically, logically and clearly organizing multi-source information to optimize assessment.

ERD begins when decision-makers must decide between a few defined response options, which generally ask either:



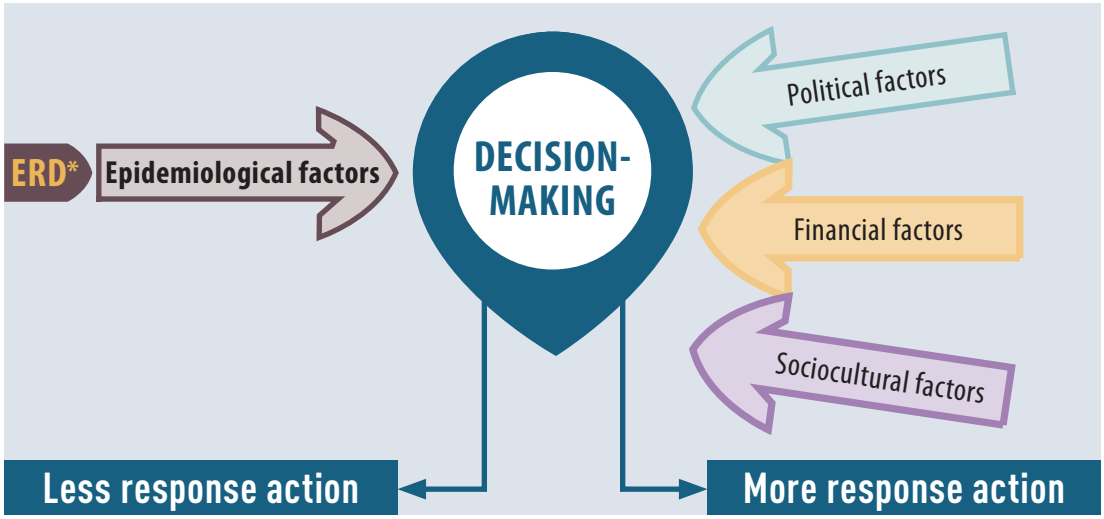
Such questions arise after an epidemic or a public health event has begun, and they continue to arise throughout the course of the event.

Decision-makers consider multiple factors (for instance, financial, political, sociocultural or epidemiological) when deciding among response options, and ERD helps to inform the epidemiological considerations by synthesizing the epidemiological information (Fig. 1). It also helps to identify information that should be collected for similar events in the future.

Importantly, ERD is:

- not a process for prediction or determination of likelihood;
- not a quantitative method; and
- not appropriate when there are few cases.

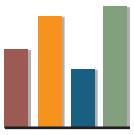
FIG. 1 Multiple factors influencing decision-making



* *ERD contributes in "epidemiological factors" for decision-making*

CAUTION

1. ERD is not just for one-time decisions. A series of decisions (for instance, continual decision-making as when responding to an influenza pandemic) can benefit from ERD. After completing the ERD process, continue to monitor the information for changes that might require another ERD.
2. ERD is not best when there are very few cases – ERD is optimized for national and subnational areas where a sufficient number of cases of the event have been detected and multiple sources of information are available. Areas with small populations may lack enough cases to provide sufficient information, so it may be better in such areas to respond without ERD.



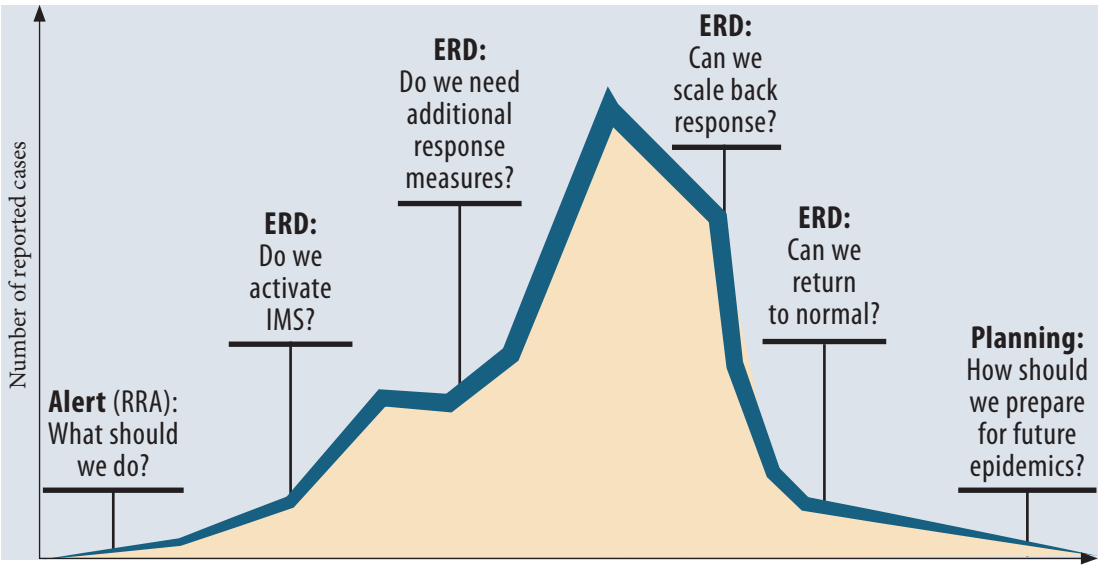
ERD is best applied when we have some idea about the cause, spread and severity of the event, and when the uncertainty is about whether the situation is getting worse (trend increase) or better (trend decrease). ERD questions have clear answers for response.

During the alert (initial) phase of an event, public health workers need to understand the cause of the event and the likeliness of its spread and severity. Because the questions asked are different from ERD questions and because many response options are available, tools other than ERD (for instance, rapid risk assessment) work better during the alert phase.

During the planning (for instance, inter-epidemic or "peacetime") phase, public health professionals try to understand the risk of future events. Planning phase questions may not require decision-making in a short period, so approaches other than ERD may apply better.

Fig. 2 shows examples of response decision questions that arise during an epidemic. As situations change, public health professionals must ask different questions and apply different approaches to answering them. ERD works best after an event has begun and before it has ended, when there are clear decision questions with few response options.

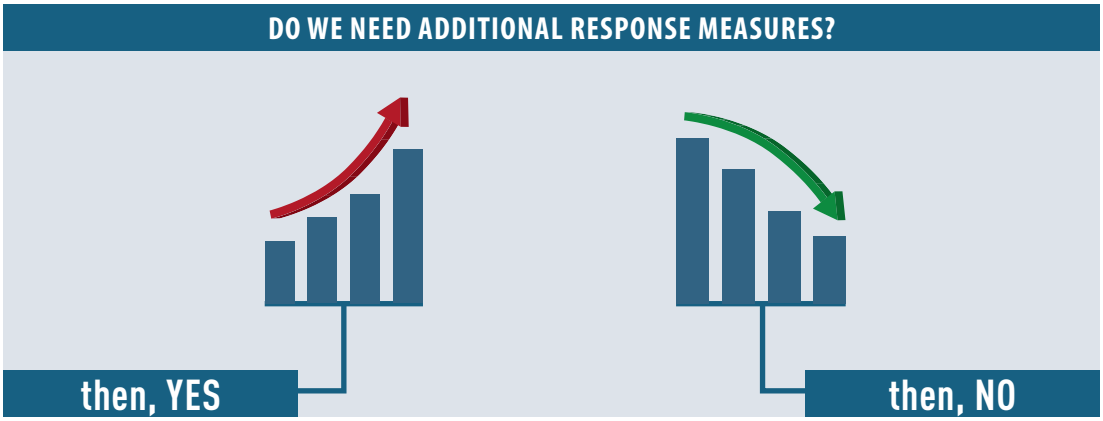
FIG. 2 Examples of response decision questions during an epidemic



RRA: rapid risk assessment; IMS: incident management system

Most response decisions for which ERD applies relate to whether additional response measures are necessary or whether current measures can be reduced. ERD organizes data from multiple sources to identify patterns in the information that indicate an answer to a decision question. Fig. 3 is a simplification of ERD indicating the decision when there is a trend decrease or increase of reported cases. See Box 1 for a list of examples of response decision questions that benefit from ERD.

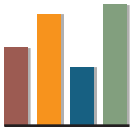
FIG. 3 Simplification of ERD



BOX 1 Examples of response decision questions that benefit from ERD

1. **Pandemic influenza:** Do we shift from containment to mitigation?
2. **Measles epidemic:** Do we need to conduct outbreak response immunization?
3. **Cholera outbreak:** Do we declare a state of emergency?
4. **Hand, foot and mouth disease (HFMD) outbreak:** Can we reopen childcare centres?
5. **Acute respiratory illness outbreak:** Do we restrict population movement?

Rationale for ERD



During epidemics and public health events, decision-makers must make timely decisions to save lives. They decide to start, keep, scale up, change or scale down response activities, and they make these decisions while faced with many uncertainties and limited information.

Surveillance systems are essential for responding to public health events. They help public health professionals detect unusual occurrences early, and their data inform assessments for response decision-making. Before and after a public health event, surveillance data also guide planning and preparation for future events.

Unfortunately, no single surveillance system in any country is sufficient. Every surveillance system and source of information has limitations and biases, and information needs always change. Analysis of information from multiple sources is thus necessary to reveal the true situation.

ERD is a systematic and practical approach to rapidly identify, organize and assess multi-source information. ERD aims to justify and inform decisions based on how the surveillance data are synthesized and interpreted. By aiming to include information that is affected by different limitations and biases, ERD helps to reduce the chances of misinterpreting the information. When patterns in this multi-source information support a conclusion, those patterns help to provide epidemiological input into decision-making and reduce the chances of making the wrong response decision (see Box 2 for a case study). With more data and information available, the need is even greater now for a clear, systematic approach like this one.

The need for multi-source information means ERD is applicable to specific decision points. During the early (alert) phase, too little information may be available and there may be too many response options. As time passes and more information becomes available, fewer options become justifiable. ERD targets those decision-making points during a public health event when a few defined options are feasible, neither too early nor too late in the event.

WHO LEADS ERD?

Although staff in epidemiology, risk assessment, immunization, response and surveillance units may not be responsible for response decisions, their skills and access to data may make them the most appropriate people to lead ERD to inform response decisions. Nevertheless, the decision about who leads ERD should be made by each country and depend on the nature of the event.

BOX 2 Case Study – Viet Nam

Viet Nam experienced a large measles outbreak in 2014. The outbreak began as a community outbreak in late 2013 and grew to affect nearly 22 000 people*.

At one point during the outbreak, decision-makers at the Ministry of Health worried that the epidemic would continue to worsen without more response action. One potential measure to provide national resources to provincial health departments in order to boost control measures was to declare a state of emergency.

Declaring a state of emergency, however, might waste resources and create political challenges if the number of new infections was declining already.

Decision-makers wanted to know if a declaration was needed. They asked whether the situation was improving or not – if it was improving, there would be no need for a state of emergency, but if it was not improving, a state of emergency would be needed.

When monitoring case-based data, the decreasing trend was not clear. Some suspected this might be due to delayed reporting. The Ministry thus requested daily reports of the number of clinical measles cases from all provincial hospitals and reviewed the trends along with those for case-based data, laboratory positivity, acute fever-and-rash (AFR) reports, and clinical measles fatality.

There was a peak followed by a decline in the trends of suspected cases, laboratory submissions, laboratory positivity, AFR reports and clinical measles fatality, providing a strong reason to conclude that the outbreak peak had passed two weeks earlier.

When multiple sources of data were viewed together, the trend was much clearer. Officials thus determined the situation was improving; therefore, no declaration of a state of emergency was necessary.

This case study demonstrates the benefit of multi-source data for response decision-making. Similarly, it demonstrates the ability of this kind of process for identifying gaps in necessary data, such as the clinical cases that the Ministry began requesting.

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* Measles-Rubella Bulletin – Volume 8, Issue 12. Manila: WHO Regional Office for the Western Pacific; 2014 (https://apps.who.int/iris/handle/10665/206672).

1. THE ERD PROCESS

STEP 1
State the decision question and its options

STEP 2
Restate the options as epidemiological situations

STEP 3
Brainstorm and list information that would support one situation

STEP 4
Describe the patterns in the available information

STEP 5
List alternative explanations and then reject or support them

STEP 6
Synthesize the information and inform decision-makers of the conclusion

STEP 7
Evaluate multi-source information and ERD as a system for informing response decisions

STEP 1

State the decision question and its options

– What is the decision that needs to be made?

Objective: To understand the decision options.

Output: A clear decision question with definite answers.

Example: Does the national government need to declare a state of emergency to control this outbreak?

Option 1: YES, it does need to declare one.

Option 2: NO, it does not need to declare one (we can continue with current measures).

In many risk assessments, engagement of decision-makers is avoided to minimize conflicts of interest. Decision-makers may have interests that may pose certain biases in making decisions, and thus risk assessments are often conducted without engagement of decision-makers in order to provide objective information to support a transparent decision-making.

In ERD, however, decision-making has already begun. The decision-makers need input, so the ERD team must proactively seek input from them. When engaging decision-makers, aim to understand:

» what decision-makers are considering;

» the decision options, context and potential consequences;

» what concern triggered the need to make a decision now; and

» the timeline for providing input into the decision.

Decision-makers may be senior officials in the Ministry of Health or a provincial department of health, supervisors in response units, or managers of emergency operations centres (EOC) or incident management systems (IMS). Engage decision-makers to clarify the decision question and its options.

WHAT DO WE DO?

Do not use ERD if the decision options are unclear. ERD starts when a clear decision needs to be made between two or three known options for action. If, instead, the question is: *"What do we do?"*, use the *Rapid risk assessment of acute public health events**.

* Rapid risk assessment of acute public health events. Geneva: World Health Organization; 2012 (https://apps.who.int/iris/handle/10665/70810).

STEP 2

Restate the options as epidemiological situations

– What epidemiological situations justify the decision options?

Objective: To identify situations that would justify the decision options.

Output: One "if-statement" for each decision option that clarifies the situation that would justify the action.

Example: If disease occurrence is decreasing, then the national government does not need to declare a state of emergency.

If disease occurrence is not decreasing, then the national government needs to declare a state of emergency.

Although many factors are important for making decisions, try to identify one or two that are the most important for the decision options.

Factors that might be important for the decision options:

» Size of the affected population is growing (or shrinking).

» Geographical distribution of the disease is growing (or shrinking).

» Severity of the disease is increasing (or decreasing).

» Special populations, such as health-care workers or high-risk groups, are at higher (or lower) risk of disease or severe outcomes.

» Capacity of the health-care system to manage cases is at its limit.

STEP 3

Brainstorm and list information that would support one situation – If the situation were true, what should the information show?

Objective: To visualize the multi-source information that would indicate a decision option.

Output: List of expected information that fits one situation from Step 2.

Example: If disease occurrence is decreasing, then we should see . . .

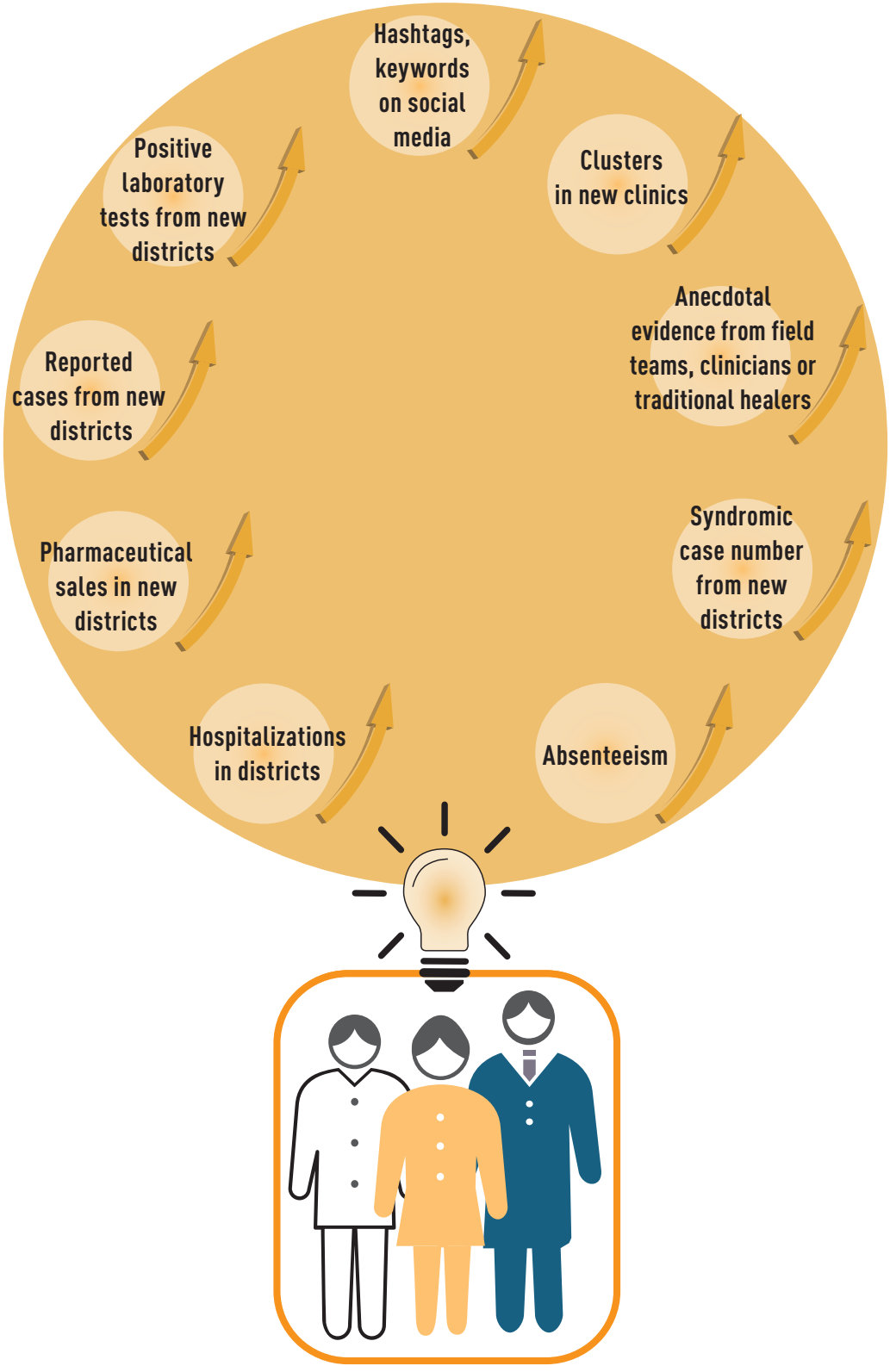
- . . . a decreasing trend of case notifications from case-based/indicator-based surveillance (IBS);
- . . . a decreasing trend of laboratory tests and positivity from pathogen surveillance;
- . . . a decreasing trend in school absenteeism; and
- . . . that supplemental immunization activity coverage has reached x%.

Choose an epidemiological situation (if-statement) from Step 2.

List the information you expect to observe if the situation were true, for instance, increasing number of laboratory-confirmed cases, increasing number of hospitalized cases and increasing pharmaceutical sales for the disease. Do not worry about the data availability or quality for now. List as many as possible, including non-traditional information (for instance, Internet search trends and pharmaceutical sales). Structured brainstorming can help complete this step (Annex D).

Review the list and remove any items that do not have group consensus or a good explanation for keeping.

EXAMPLE: If disease occurrence is increasing, then we should see…



STEP 4

Describe the patterns in the available information

– What does the actual multi-source information show?

Objective: To understand the true epidemiological situation.

Output: List of summarized trends, criteria statuses or unavailability of each item from Step 3.

Example: Laboratory positivity:  increasing trend since 5 weeks ago

Event-based surveillance (EBS) signals:  increasing trend since 3 weeks ago

School absenteeism:  unavailable

Outbreak vaccination:  coverage not reached (> 80% of target)

For each expected bit of information from Step 3, summarize the information using the simplest methods of analysis:

» For trends, state if the trend is increasing, decreasing or flat, and state how long the trend has been that way.

» For yes/no criteria (for instance, > 95% coverage), state if the criteria have been met or not.

» If the information is unclear or unavailable, state so.

IS THE LINE INCREASING OR DECREASING?

Most trend lines can be judged as increasing or decreasing by looking at them. When disagreement arises among team members about the trend, try drawing a trend line of best fit or a moving average line. If the trend line is still too unclear to judge, acknowledge that issue. An unclear trend line is important information.

List alternative explanations and then reject or support them

– What else could explain the observed trends?

Objective: To improve understanding of the true epidemiological situation.

Output: List of alternative explanations for each bit of observed information and data or explanations that support or discount the alternative explanations.

Example: A decreasing trend in notifications from case-based surveillance could be due to fewer occurrences of disease or due to:

- delayed reporting, but the decrease began more than two months ago, which is longer than the average delay in reporting;
- reduced health-care-seeking behaviours, but there is also a decrease in hospitalized cases; or
- overwhelmed reporting staff, but field-team reports indicate that disease occurrence is decreasing.

1. For each available summarized item from Step 4, state one to three alternative explanations that could produce similar trends.

Consider limitations and biases of the sources of information:

» Reference period of the information (timeliness of detection, confirmation and reporting).

» Changes in testing algorithms (sensitivity and specificity), case definitions or reporting procedures.

» Representativeness of the population under surveillance.

» Willingness and ability of health-care professionals to report, etc.

Also, consider microbiological, clinical, social and epidemiological contexts:

» Changes in health-care-seeking behaviour and accessibility.

» Changes in testing and reporting behaviour.

» Disease seasonality and periodicity.

» Clinical presentation and changes in suspicion.

» Changes in media or political attention toward the event.

» Characteristics of the pathogen.

» "Ceiling effects", that is, maximum capacity of hospital beds, vaccinations or laboratory testing has been reached, etc.

Some information may not have obvious alternative explanations. For example, in the epidemiological situation (Step 2) in which disease is NOT spreading from the currently affected area, we expect to observe, among other things, that (Step 3) public health officials have conducted sufficient contact tracing of at least 90% of cases. This type of information either meets the criteria we set or it does not. When reviewing the observed information (Step 4), consider the validity of the information: "Can you trust that the criteria have truly been met based on the observed available information?"

2. Support or reject each alternative explanation in the list.

Different techniques are described in Box 3. Additionally, logic or discussions with key persons, such as laboratory directors, can help to support or reject alternative explanations.

An alternative explanation may sometimes justify some of the trend, even after it is rejected. For example, increasing cases of syndromic illness may have the alternative explanation that increased health-care seeking is causing the observed trend. To reject this explanation does not mean that increased health-care seeking is not responsible for some of the increase. Instead, it means that even though health-care seeking has increased, there is supporting evidence that the disease has truly increased.

3. Review the list.

If the same alternative explanations appear for multiple items and cannot be rejected, then limitations or biases may be hiding the true situation. The chances of misinterpreting the information are high, which will lead to the wrong decision option. If time permits, continue obtaining and analysing information (return to Step 3 to build the list), especially information that does not have the same alternative explanations. If there is no time, move to Step 6. For some situations, the epidemiological situation may be too complicated to conclude with confidence.

If alternative explanations have been rejected and the list includes enough multi-source information, proceed to Step 6.

The key is having information from sources that do not suffer from the same bias so that the possibility of alternative explanations can be addressed.

HOW MUCH IS ENOUGH?

Sufficient information and analyses depend on the time available, the information available and the level of confidence required by decision-makers. The timeline should have been clarified with decision-makers in Step 1 (at the beginning of ERD). If time permits, continue obtaining and analysing information.

BOX 3 Methods for addressing alternative explanations (limitations and biases)

Complementary and supplementary information

Consider how alternative explanations for one source of information relate to those of another. Try to complement and supplement the limitations and biases of one source with information from a source that has different limitations and biases. *Be careful when information from different sources has the same alternative explanations.* For example, an increase in reported syndromic case number may be due to increased health-care-seeking behaviour, and an increase in school absenteeism may also be due to the same. Therefore, these sources do not complement one another. Seek data from a source without that alternative explanation (for instance, increase in deaths). As another example, daily aggregate syndromic reports can account for (complement) the limitation of delayed reporting that often occurs in indicator-based surveillance (IBS), such as case-based and laboratory positives when case load increases.

Restriction

Consider groups within the data that might be less influenced by the limitations and biases of concern. Review patterns in those groups separately. For example, universal syphilis testing of pregnant women means their data are not affected by fluctuations in health-care-seeking behaviour, clinical suspicion or testing behaviours. Restricting analysis to pregnant women allows for an assessment of syphilis trends that is not affected by such fluctuations.

Positivity

The number of laboratory tests influences the number of positive results. The number of laboratory tests can change for many reasons, for instance, changes in health-care-seeking behaviours, clinical suspicion or laboratory procedures. Because positivity is a proportion of positive results over the number of tests, positivity trends can help to account for changes in testing intensity. Looking at positivity alone without understanding how testing intensity has changed can lead to misinterpretation. Thus, look at trends in the numerator or trends in the denominator, as well as trends in the proportion. Some combinations are easier to interpret than others (see examples on page 16). Consider the test performance characteristics, for example, sensitivity, specificity and testing criteria. When possible, restrict assessment of positivity to patients with the same clinical signs and symptoms to reduce the influence of changes in health-care-seeking behaviours and clinical suspicion. For more, see Kato et al. (2018)*.

Qualitative information

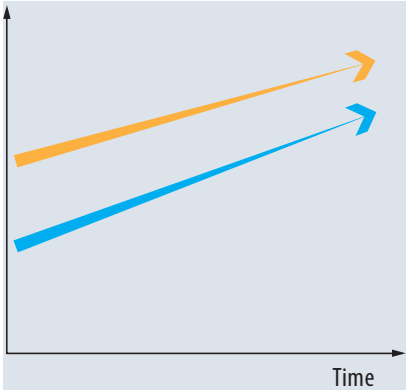
Qualitative information can support, account for or weaken observed trends. Use written reports, interviews and anecdotal evidence from sources such as field teams, clinicians, nurses, surveillance officers, community members and traditional healers.

* Kato H, Kanou K, Arima Y, Ando F, Matsuoka S, Yoshimura K et al. The importance of accounting for testing and positivity in surveillance by time and place: an illustration from HIV surveillance in Japan. Epidemiol Infect. 2018 Dec;146(16):2072–78. doi:10.1017/S0950268818002558.

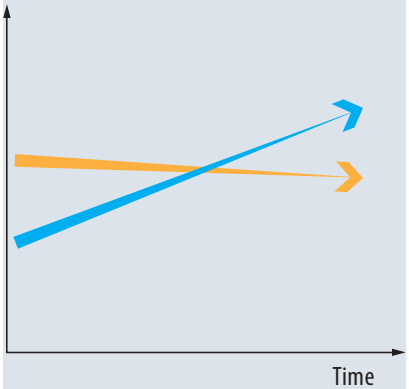
Different interpretations of positivity are illustrated in Fig. 4.

Table 1 shows example outputs for ERD Steps 3, 4 and 5.

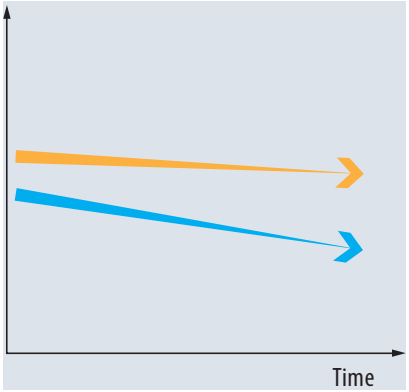
FIG. 4 Interpretations of positivity



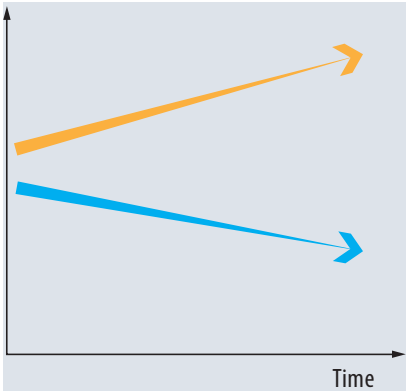
Increasing positivity (blue) and number of specimens tested (orange) strongly imply a worsening situation. This is because you are testing more (suspecting more) and, proportionately, more of those are testing positive.



Increasing positivity (blue) and decreasing number of specimens tested (orange) could be the result of improved sampling or testing. Alternatively, the laboratory could have restricted the criteria for specimens or testing. This situation is harder to interpret, but if the number of positives is increasing, that would imply a worsening situation as you are detecting more cases even though you are testing less.



Decreasing positivity (blue) and number of specimens tested (orange) imply an improving situation, because you are testing less (suspecting less) and, proportionately, fewer of those are testing positive. Confirm that there are no issues with laboratory capacity (chain of specimen collection to testing and reporting).



Decreasing positivity (blue) and increasing number of specimens tested (orange) can be hard to interpret. It is common for positivity to decrease when there is increased testing due to higher awareness because more people less likely to be infected request testing or because clinicians test more patients who were previously not considered. When possible, restrict positivity to patients with the same clinical signs and symptoms to reduce such bias. Also, if the number of positives is declining, that would imply an improving situation – detecting fewer cases while testing more. Confirm that sampling procedures have not changed and false negatives are not an issue.

TABLE 1 Example outputs for ERD Steps 3, 4 and 5
(All information indicates a decrease in occurrence except for positivity)

STEP 3	STEP 4	STEP 5	
If disease occurrence is declining, we expect…	**Observed info shows…**	**But the trend could be due to…**	**…which we REJECT or SUPPORT because…**
Reported cases in IBS ↘	↘	Delayed reporting	• REJECT – Syndromic case number is also down.
Laboratory positivity ↘	↗	Restricted testing criteria	• SUPPORT – Laboratory staff restricted on X date because of high testing requests.
		Increase in false positives (FPs) due to change in test or staff	• REJECT – Laboratory staff reports no changes to testing or staff; no reason to suspect false positives.
Daily suspected syndromic case number ↘	↘	Reduced reporting Decrease in health-care seeking	• REJECT – Severe disease (hospitalizations) is also down.
Field teams report disease ↘	↘	Missed areas where disease is occurring Political pressure to report improvements	• REJECT – Syndromic case number is decreasing in most areas. • NEITHER – No information to support or reject.
Relevant EBS signals ↘	↘	Change in media priorities Decreased EBS staff capacity	• NEITHER – No information to support or reject, but syndromic case number is decreasing. • REJECT – EBS chief reports no changes in staff.
Hospitalizations ↘	↘	Change in hospital policies/priorities	• REJECT – Three major hospitals report no changes have occurred.

EBS: event-based surveillance; IBS: indicator-based surveillance

In this example, the alternative explanation for positivity that testing criteria were restricted is supported by communications with laboratory staff. Although not every alternative explanation could be rejected, most were. We move to Step 6.

STEP 6

Synthesize the information and inform decision-makers of the conclusion

– Which decision option is supported by the available multi-source information?

Objective: To inform decision-makers of the epidemiological considerations based on the assessment of multi-source information.

Output: A recommended action with justification and level of confidence.

Example: The available multi-source epidemiological information indicates that disease is truly decreasing, so additional control measures are not supported. Our conclusion is based on an assessment of multi-source information from indicator-based surveillance, laboratories, field teams, event-based surveillance, hospitalizations and mortality, which makes alternative explanations unlikely and our confidence in this assessment high.

Compare the assessed information from Step 5 with the expected epidemiological situations from Step 2 to clarify which situation is most likely true. Based on the most likely true situation, answer the decision question.

Communicate the recommended action(s) to the decision-makers and state the level of confidence in the assessment. Maintain credibility by responding within the timeline, even if that means not answering some questions that remain about the observed trends or alternative explanations. State the limitations and biases of the information and clarify the EDR team's caveats, assumptions and uncertainties. Overstating confidence could damage the ERD team's credibility.

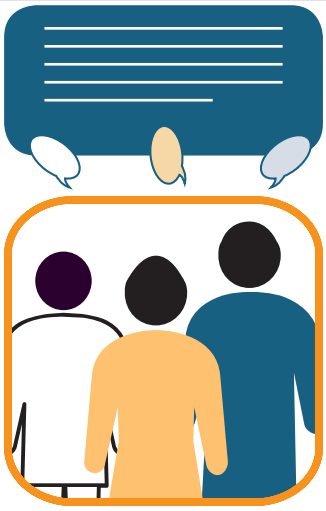
Decision-makers may decide against the recommendation. They consider many aspects (for instance, financial, political and sociocultural) when deciding how to respond. The epidemiological input is one component. If ERD was completed rigorously, accept that other considerations have outweighed the epidemiological ones this time. Complete Step 7 to improve ERD for next time.

Continue to monitor the information. ERD organizes existing information to inform decisions. That information will change. Monitor it. Alert decision-makers if the information changes. A new decision may become necessary, as well as another ERD.

Fig. 5 shows how confidence is determined.

Determining confidence in an assessment is difficult and mostly subjective. The ERD team needs to communicate to decision-makers how much it believes the assessment conclusion reflects the true situation. Because confidence is highly subjective, the ERD leader should facilitate a discussion with the ERD team to reach consensus on the level of confidence. The following questions can guide the ERD team's discussion.

FIG. 5 Determining confidence

How much information was available for conducting this assessment?	**How clear were the trends?**	**How well was the ERD team able to address alternative explanations?**
Multi-source information is key to understanding the true epidemiological situation. Generally, as the number of available sources of information increases, so does confidence.	Trends that are easy to interpret (for example, clearly rising or clearly falling) increase confidence in the conclusion, but trends that are more complicated to interpret or unclear decrease confidence in the conclusion.	Addressing all alternative explanations for the observed trends increases confidence. As the number of alternative explanations that cannot be addressed increases, confidence decreases.
After considering alternative explanations, how consistent is the pattern in the multi-source information?		**After considering alternative explanations, which sources of information contradict the general pattern?**
If all trends point to the same conclusion (for instance, decreasing disease), confidence increases. As the number of trends that contradict the pattern increases, confidence decreases.		Some sources are more important than others (for instance, laboratory data versus pharmaceutical sales). The relative importance will differ for each country and epidemic. An important source contradicting the pattern should decrease confidence more than a less important source contradicting the pattern.

Assign **Very high, High, Low** or **Very low** confidence levels to the conclusion. If assigning "Very low", consider concluding instead that the available multi-source information could not answer the decision question at this time.

STEP 7

Evaluate multi-source information and ERD as a system for informing response decisions

– How can we improve multi-source information for ERD?

Objective: To improve multi-source information for response decision-making for a disease and improve ERD generally for future events.

Output: Findings and conclusions of the evaluation and recommendations for improving ERD, including the process, personnel and information that could strengthen ERD.

Example: ERD for deciding whether to increase support to a provincial measles response produced an answer within three hours. Noted gaps in ERD included the lack of recent near-real-time syndromic data, a lack of understanding of Internet search trend tools, and difficulty accessing and interpreting subnational immunization coverage data. Therefore, to improve ERD for measles, we recommend:

- establishing procedures/systems for obtaining daily fever-and-rash syndromic surveillance data from sentinel clinics in each district as soon as a measles outbreak is declared;
- training surveillance staff on analysing and interpreting Internet search trend tools; and
- establishing agreements with representatives from the immunization division to join the ERD team quickly and access subnational immunization data.

Evaluate the process, including the multi-source information and how it was used to answer the decision question, using the following procedure:

1. Set the ERD objective as providing an epidemiology-based answer to the decision question with very high confidence and within the allotted time.

2. Describe the system of multi-source information used to answer the decision question, including the sources of information and the processes and persons involved in obtaining, reviewing, assessing, interpreting and synthesizing the information.

» To complete this, brainstorm a list of the activities and people involved. Flow charts and logic models can also help to visualize the system.

3. Compare the expected information from Step 3 with the available information from Step 4.

» Note any information that was unavailable, challenging to obtain, difficult to interpret or not useful.

4. Review the alternative explanations.

» Note any that were difficult or impossible to address.

5. Interview the team or conduct an open discussion with teammates to identify additional challenges and potential solutions.

» The timing of Step 7 is important. Aim to complete it soon after communicating the decision answer, while the ERD team is still together and memories are still strong. Also, the situation may change quickly, which may require another ERD. Completing Step 7 will identify the areas to improve ERD.

6. Review the information (1–5).

» Was ERD able to meet its objective? Why or why not?

» Draw conclusions based on the information obtained (1–5). Ensure the conclusions are supported by the information.

7. Make concrete recommendations for improving ERD and the information used in it.

» List the sources that should be obtained for similar events. Identify mechanisms for accessing the information from those sources.

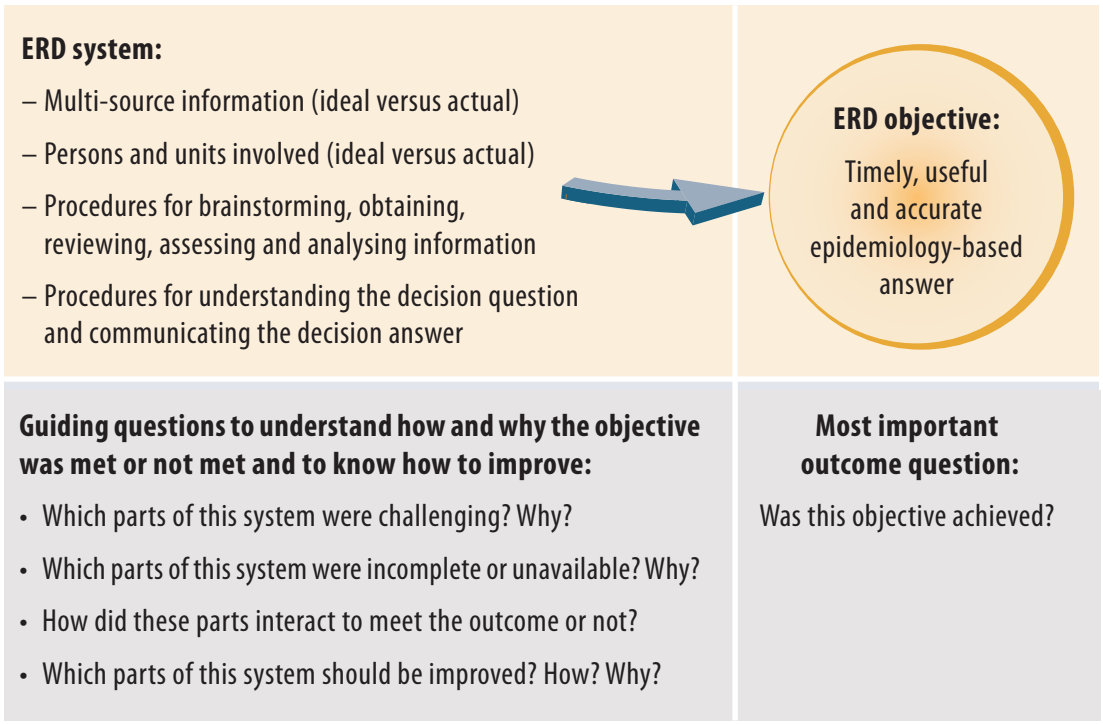
» Identify the people and processes that were important for this ERD and those that should be included in the future. Formulate strategies to include these people and processes.

» Ensure recommendations are communicated to stakeholders who can implement necessary changes.

» Disseminate the findings of the ERD assessment, for example, through publications, to share lessons with international colleagues.

Step 7 essentially asks whether the objective – a timely, useful and accurate epidemiology-based answer – was achieved, and why or why not. Visualizing ERD as a system with an objective helps to identify the components that need improvement. Fig. 6 depicts the process of how to evaluate ERD.

FIG. 6 Evaluating ERD



2. ACTIVITIES TO STRENGTHEN ERD

This section describes activities to complete during epidemiological "peacetime" to improve ERD.

ERD can be strengthened through preparation and practice before an event occurs.

The three main ways are:

1. improving access to information;

2. understanding the strengths, weaknesses, limitations and biases of existing information sources; and

3. developing the public health workforce for ERD.

Improve access to information

For each priority disease, brainstorm the potential information that could be useful for ERD (Annex D).

1. List the information and its sources.
2. Review the list and remove any that are not appropriate.
3. For the remaining items on the list, state whether the information is currently available. Consider accessibility as well as availability – that is, how quickly the information could be obtained during an event.
4. For any information that is not readily available, list the reasons and begin to address those reasons to improve access. Consider:
    a. writing procedures for quickly collecting information during an event,
    b. cultivating relationships with data owners and data shepherds, and
    c. writing memoranda of understanding (MOUs) to facilitate sharing of information.

Conduct systematic multi-source surveillance system evaluations for prioritized diseases

For each priority disease, document the strengths, weaknesses, limitations and biases of existing information sources by conducting a surveillance system evaluation. Knowing, for example, the average number of days between onset of symptoms and report of the case can help to interpret the trends in the observed data. Another example is documenting the representativeness of a surveillance system, which can help with interpretation of the validity of the observed information on geographical spread of disease. Incorporate this information into a table or matrix so that it is easily accessible during ERD (Table 2).

Traditional surveillance system evaluations often consider each information source in isolation. To strengthen ERD, consider surveillance systems from a decision-making perspective by evaluating all sources of information for a given disease as one system. Identify gaps in information and additional sources that are needed to inform response decisions. The key is having information sources that do not suffer from the same potential bias so that the possibility of alternative explanations can be addressed.

(See Guidance for epidemiological surveillance system evaluation, 2nd ed. Field Epidemiology Training Program – Japan. Tokyo: National Institute of Infectious Diseases; 2018.)

Develop the public health workforce for ERD

No guidance document can clarify all possibilities. A workforce that is confident and skilled can identify problems and develop solutions on its own.

Develop the public health workforce to identify, gather and assess multi-source information to inform response decisions. Specifically, aim to strengthen:

» staff understanding of surveillance, especially the limitations and biases;

» staff skills with descriptive epidemiology, epidemiological concepts and data visualization; and

» staff confidence in conducting ERD (Table 3).

TABLE 2 Examples of existing information sources, advantages, biases and limitations for measles

Source of information	Advantages	Biases and limitations
INDICATOR-BASED SURVEILLANCE		
	Trend of case notifications (including confirmed) based on established surveillance system; maps of notifications; baseline and historic data (15 years); epidemiological characteristics.	Delayed reporting; affected by changes in health-care-seeking behaviours; clinical suspicion and reporting behaviours (and testing behaviours if confirmed case reporting); may not capture evacuee camps.
PATHOGEN (LABORATORY-BASED) SURVEILLANCE		
	Information on causative agent; trends in number of tests and proportion positive able to account for changes in testing intensity that may occur due to changes in health-care seeking and clinical suspicion behaviours.	Delayed reporting; tends to be timelier in areas with more resources and infrastructure; sensitivity and specificity of the testing procedures affect detection but not trend assessments; however, need to be aware of changes in tests or testing criteria.
ENHANCED SYNDROMIC SURVEILLANCE		
	Real-time data (daily); simple and sensitive as not dependent on clinician's index of suspicion/differential diagnosis (not confirmed).	Not laboratory confirmed and not specific (also affected by occurrence of other diseases with similar clinical signs/symptoms); not representative (select sites); affected by changes in health-care seeking and reporting behaviours; delayed adoption/mastery of system.
SCHOOL ABSENTEEISM		
	Near-real-time data (daily); simple counts and proportions; representative (if schools participate); historical comparisons.	Not specific to measles; subject to public fears and anxieties and may not indicate true disease trends; depends on school participation.
EVENT-BASED SURVEILLANCE		
	Real-time sensitive information; public and clinical perceptions (capacity); new areas or hotspots and spreading of outbreak; contextual information for interpreting data.	Unverified, unconfirmed information; difficult baseline comparisons; not necessarily representative.
INTERNET SEARCH TRENDS		
	Simple, no-cost, real-time trends on where, when and how disease may be occurring; public perception information.	Not directly related to symptoms or infection with pathogen; subject to public fears and anxieties; may not represent those who cannot afford or access an Internet connection.

TABLE 3 Activities to develop the public health workforce for ERD

WHY	WHAT	HOW
TO BUILD AWARENESS OF SURVEILLANCE SYSTEM STRENGTHS, WEAKNESSES, LIMITATIONS AND BIASES		
	Improve knowledge of surveillance systems beyond IBS, e.g. event-based, syndromic, pathogen, pharmaceutical sales.	⩥ Shadow data operators and data managers of unfamiliar systems. ⩥ Participate in international and regional training programmes and fellowships. ⩥ Conduct a surveillance system evaluation of a non-IBS system. ⩥ Read surveillance system evaluation publications.
TO STRENGTHEN SKILLS FOR INTERPRETING INFORMATION FROM MULTIPLE SOURCES		
	Improve descriptive epidemiology skills, especially methods for summarizing, interpreting trends and suggesting next analysis steps.	⩥ Review and understand epidemiological concepts and thinking. ⩥ Assign individuals and groups: Reports of surveillance data that include descriptive summaries, interpretations and next steps (So? So what? So what now?). ⩥ Watch video training online (e.g. on YouTube) that demonstrates descriptive epidemiology skills. ⩥ Attend trainings and fellowships that emphasize descriptive epidemiology. ⩥ Read about descriptive epidemiology, summarization and interpretation.
	Improve data visualization skills.	⩥ Watch free video training tools online (e.g. YouTube, TED Talks) that demonstrate data visualization. ⩥ Attend training programmes and fellowships that address data visualization. ⩥ Read textbooks and online resources on theory and practice of data visualization. ⩥ Convene periodic workshops in which participants translate a published article into a visual (no text) presentation and provide feedback.
TO BUILD PROBLEM-SOLVING ABILITIES DURING ERD		
	Improve confidence for leading and participating in ERD.	⩥ Review and understand epidemiological concepts and thinking. ⩥ Attend training programmes and fellowships that emphasize and use ERD. ⩥ Review this ERD guidance as a team (including the scenarios), identify challenges and questions that arise, and brainstorm solutions. ⩥ Observe ERD in action and summarize what happened, what challenges occurred, what steps were taken to overcome them and what to improve. ⩥ Use the scenarios in this ERD guidance to facilitate discussion-based exercises. ⩥ Develop simulation exercises in which participants must use ERD to answer a decision question for senior officials, and then review the exercise as a group to identify challenges, solutions and improvements.

ANNEXES

ANNEX A.
SCENARIO 1 – INFLUENZA: NATIONAL OUTBREAK

Should we send additional funds to the provinces to support influenza response activities?

ANNEX B.
SCENARIO 2 – MEASLES: NATIONAL OUTBREAK

Do we request additional support from the Prime Minister?

ANNEX C.
SCENARIO 3 – CHOLERA: PROVINCIAL OUTBREAK

Do we declare a state of emergency?

ANNEX D.
STRUCTURED BRAINSTORMING

A method for obtaining a comprehensive list of information (Step 3)

ANNEX E.
Template for completing ERD Steps 1–6

ANNEX A. SCENARIO 1

INFLUENZA

NATIONAL OUTBREAK

Reported cases of influenza-like illness (ILI) have been increasing nationally and a proportion of these have been confirmed to be influenza. Standard public health hygiene messages have been disseminated since week 16, but reported ILI has continued to increase. The Director of the National Disease Control and Prevention Centre is considering whether to send additional funding to the provinces to support control efforts.

The Director of the Epidemiology Bureau, which is within the National Disease Control and Prevention Centre, has pulled a team together to conduct ERD to inform the Director's decision.

STEP 1. WHAT IS THE DECISION THAT NEEDS TO BE MADE?

State the decision question and its options.

- Should the National Disease Control and Prevention Centre send additional funding to the provinces to support control efforts?
- Options are **YES** or **NO**.
  - Additional funding will enhance the provinces' abilities to detect, investigate, manage and control influenza, which should reduce transmission and the number of new cases of disease; however, doing so will reduce the amount of funds available for efforts needed for other diseases.
  - If the funds are sent unnecessarily, they may be wasted, which could result in negative public perception.
  - If no funds are sent, the disease may continue to occur, and the public may ask why nothing has been done.
- After engaging the stakeholders, we have learnt that they would like to make a decision within the next three days.

STEP 2. WHAT EPIDEMIOLOGICAL SITUATIONS JUSTIFY THE DECISION OPTIONS?

Restate the options as epidemiological situations.

If influenza disease is still truly increasing, additional funding could help reduce transmission and is therefore justified.

AND

If influenza disease is no longer truly increasing, additional funding may not be justified.

STEP 3. IF THE SITUATION WERE TRUE, WHAT SHOULD THE INFORMATION SHOW?

Brainstorm and list information that would support one situation.

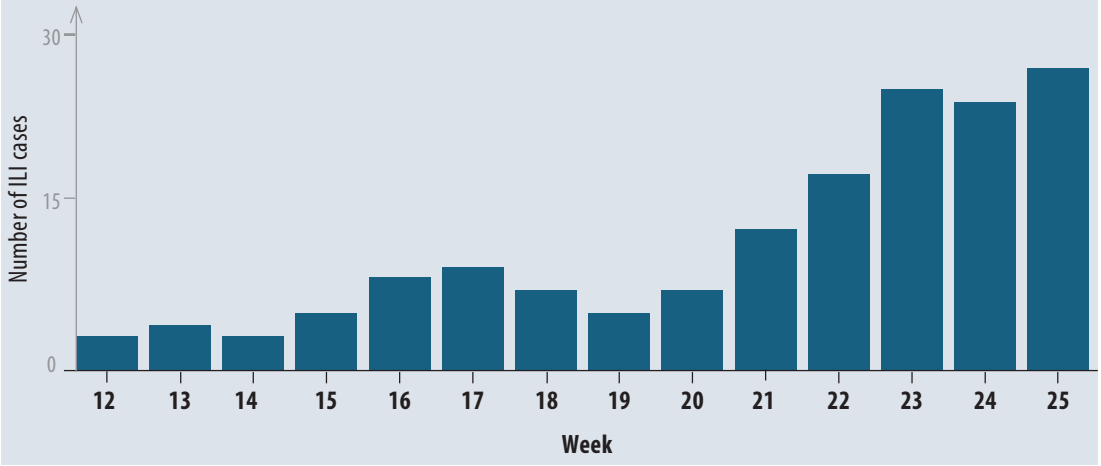
If influenza disease were still truly increasing, then the information would show increases in…

- ILI cases
- ILI specimens tested
- % ILI specimens that are positive
- Severe acute respiratory infections (SARI) cases
- SARI specimens tested
- % SARI specimens that are positive
- School absenteeism
- Pharmaceutical sales for ILI symptom treatment
- Workplace absenteeism

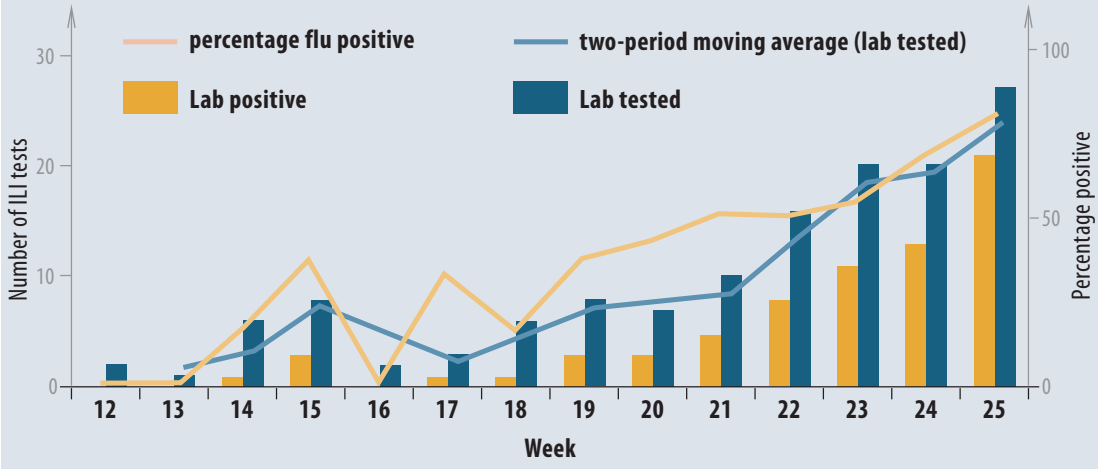
STEP 4. WHAT DOES THE ACTUAL MULTI-SOURCE INFORMATION SHOW?

Describe the patterns in the available information.

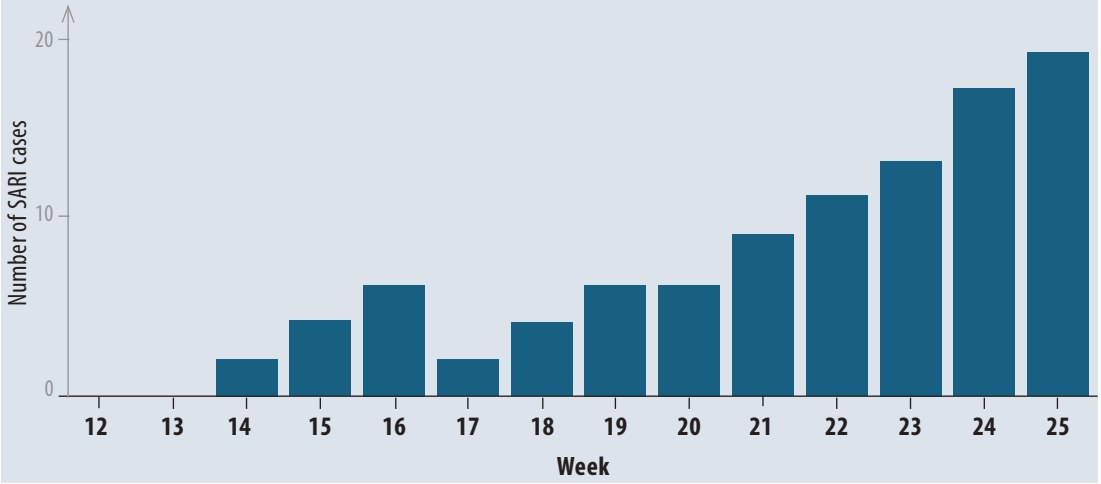
ILI cases, by week of report



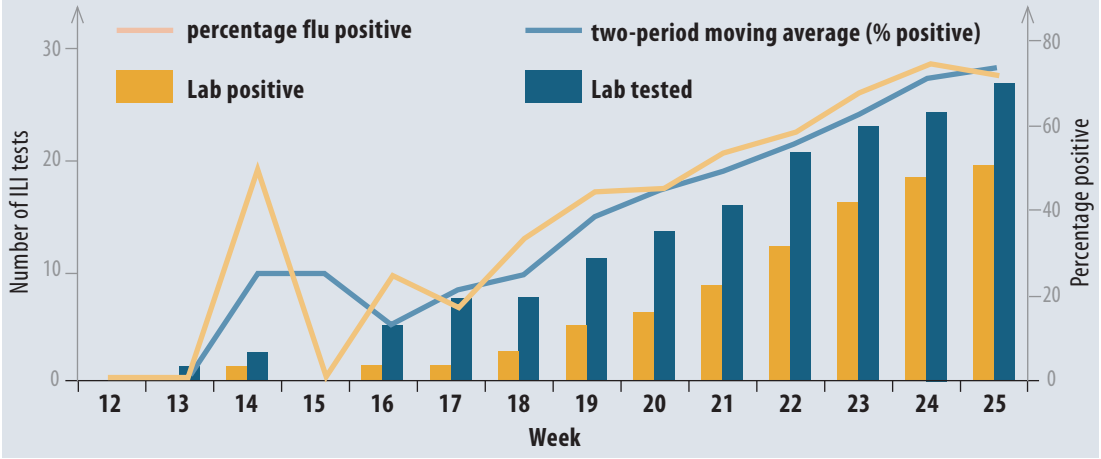
ILI tests, influenza positive and positivity, by week of test (national)



SARI cases, by week of onset (national)



SARI tests, influenza positive and positivity, by week of test (national)



After reviewing the available information, the team conducting this ERD has summarized the actual observed information in this way:

- ILI cases ↗ since week 19
- ILI specimens tested ↗ since week 18
- % ILI specimens that are positive ↗ since week 19
- SARI cases ↗ since week 18
- SARI specimens tested ↗ since week 18
- % SARI specimens that are positive ↗ since week 18
- School absenteeism ⊘ unavailable
- Pharmaceutical sales for ILI symptom treatment ⊘ unavailable
- Workplace absenteeism ⊘ unavailable

STEP 5. WHAT ELSE COULD EXPLAIN THE OBSERVED TRENDS?

List alternative explanations and then reject or support them.

See Table 4 for an example.

TABLE 4 Summarized observed information, alternative explanations and reasons for rejecting or supporting the alternative explanation – national influenza outbreak scenario (1)

Observed…	Information	Alternative explanation	Reject or support alternative
… since week 19 	ILI cases	Increased health-care seeking and clinical suspicion	• REJECT – Although there may be increased health-care seeking and suspicion, severe infections (SARI) and influenza positivity among ILI cases are also increasing.
… since week 18 	ILI specimens tested	Increased health-care seeking and clinical suspicion	• REJECT – Severe illness and influenza positivity among ILI cases are also increasing.
… since week 19 	% ILI specimens that are positive	Improved testing or restricted testing criteria	• REJECT – According to the Director of the National Reference Laboratory, no substantial changes have occurred.
… since week 18 	SARI cases	Increased non-influenza severe diseases with similar presentations	• REJECT – Influenza positivity among SARI cases is also increasing.
… since week 18 	SARI specimens tested	Increased non-influenza severe diseases with similar presentations or increased capacity to test	• REJECT – Laboratory influenza positivity among SARI cases is also increasing.
… since week 18 	% SARI specimens that are positive	Improved testing or restricted testing criteria	• REJECT – According to the Director of the National Reference Laboratory, no substantial changes have occurred and because changes in health-care seeking for severe acute respiratory infections (SARI) is less likely to occur.

ILI: influenza-like illness; SARI: severe acute respiratory infections

STEP 6. WHICH DECISION OPTION IS SUPPORTED BY THE AVAILABLE MULTI-SOURCE INFORMATION?

Synthesize the information and inform decision-makers of the conclusion.

The Director of the Epidemiology Bureau is communicating the following to the Director of the National Disease Control and Prevention Centre:

> Based on the available multi-source epidemiological information, the National Disease Control and Prevention Centre **should send additional funding to the provinces to support influenza control efforts.** Our recommendation is based on an assessment of multi-source information from ILI cases, ILI laboratory testing, SARI cases and SARI laboratory testing, which indicate that influenza disease and severe influenza disease are increasing. Because these sources are the country's strongest sources of influenza data and because the information in them consistently indicated that occurrence of influenza and severe influenza is increasing, which makes alternative explanations unlikely, our confidence in this assessment is high.

STEP 7. HOW CAN WE IMPROVE MULTI-SOURCE INFORMATION FOR ERD?

Evaluate multi-source information and ERD as a system for informing response decisions.

The objective of this ERD was to provide – within three days – an epidemiology-based answer with very high confidence to the Director of the National Centre for Disease Control and Prevention on whether to send additional funding to the provinces to support influenza control efforts. This ERD was able to provide an epidemiology-based answer within two days with high confidence.

The ERD team decided that "high" confidence was most appropriate because the data sources were strong and consistent and because alternative explanations were reasonably addressed. Nevertheless, we only used information from five sources. The ERD team discussed whether to wait an additional day to obtain more information and finally decided that "high" confidence was sufficient and that a quicker response would serve the Director better.

Noted gaps in the ERD included unavailable data on school absenteeism, pharmaceutical sales for ILI symptom treatment and workplace absenteeism. Although we requested information on absenteeism, which was available from several school districts and worksites, the managers of those data were not authorized to share them with our team. With respect to pharmaceutical sales, the ERD team did not know where to find the information. Such data could have strengthened understanding of the spread of influenza, especially mild influenza, beyond sentinel sites. Additionally, we encountered a delay in completing ERD due to our difficulty in obtaining information about changes to laboratory procedures from the Director of the National Reference Laboratory. He was out of the country at an international laboratory meeting.

Therefore, to improve ERD for influenza, we recommend the following:

- Identify existing sources of workplace and school absenteeism and set up MOUs that facilitate exchange of data and information during influenza (and other) public health events.
- Establish a weekly reporting system for aggregated influenza-confirmed hospitalizations in all provinces that can be activated during influenza seasons.
- Train staff from the National Reference Laboratory on ERD and include a representative of that laboratory on the ERD team.
- Identify potential partners in the private pharmaceutical retail industry to develop reporting systems or MOUs to facilitate data sharing.

ANNEX B.
SCENARIO 2

MEASLES

NATIONAL OUTBREAK

We are members of the Division of Infectious Diseases, Surveillance and Response at the National Institute for Public Health. Our country experiences increased notifications in measles every three to four years. After many years of observing the overall burden decrease, cases rose last year. This year, the number of reported cases exploded in February. Our country is also experiencing a 71% increase in reported dengue cases compared to last year.

It is now 8 April. Of the 12 health districts in the country, six have reported more than 100 laboratory-confirmed measles cases this year. Nationally, approximately 22 cases per 100 000 population have been reported through the National Reportable Diseases Surveillance system, including cases that are laboratory confirmed (< 1%), epidemiologically linked (< 1%), clinically compatible (63%) and pending laboratory test results (35%). Approximately 1.3% of these patients have died.

The age distribution of the patient cases is: 11% aged less than 6 months old; 23% between 6 and 11 months; 32% from 1 to 4 years old; 15% from 5 to 19 years old; and the remaining 18% aged 20 years or more. Patients whose age is unknown account for less than 1%. Ethnic minorities represent approximately 35% of the population and approximately 57% of the measles cases.

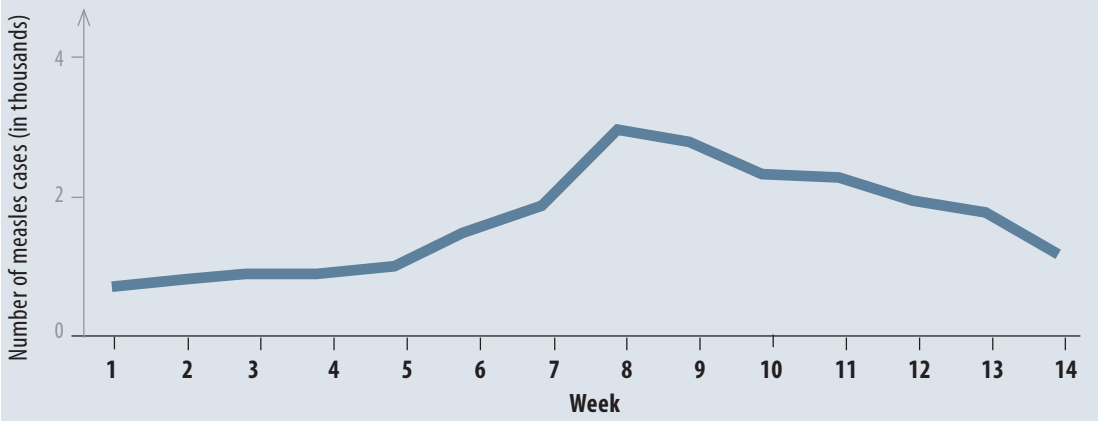
Approximately 60% of these reported patient cases were not vaccinated, with another 8% vaccinated with only one dose of measles-containing vaccine and 32% with unknown vaccination status. National immunization coverage for children aged from 6 to 59 months last year was 79%, and health district coverage ranged from 26% to 128%.

Surveys of mothers have indicated that the major reasons for not vaccinating children include being too busy, facing difficulties in accessing health services and fearing adverse effects. Four years ago, the country suffered a national incident with a non-measles vaccination campaign in which many children became critically ill and several died.

Although the Government has invested in efforts to correct the issue, explaining the unfortunate incident and addressing misconceptions about vaccines, the incident has left many mothers and fathers with doubts about the safety of vaccines in general.

Immunization activities were enhanced in mid-February in response to the current outbreak, including school-based immunizations and outbreak response immunizations in prioritized areas. Almost 2 million children have been vaccinated since the start of this campaign. In late March, reported cases of measles began to decline.

Reported measles cases by week of onset (national)



This morning, our supervisor, the Director of the Division of Infectious Diseases, Surveillance and Response, called an emergency meeting with our team. She was tense. She told us how the Vice-Minister of Health called her at home late last night to say that the Prime Minister would be in the office tomorrow morning and would probably offer additional support to control this outbreak.

The Director told the Vice-Minister that the WHO country office has been providing technical assistance and that cases have been decreasing, but the Vice-Minister said, "We cannot miss the opportunity for additional support if we need it. Neither can we waste time and resources if this thing is ending. I need to know how confident your team is that this outbreak is ending."

Our Director wants to know how to respond before 14:00 today.

STEP 1. WHAT IS THE DECISION THAT NEEDS TO BE MADE?

State the decision question and its options.

- Should we accept additional support from the Prime Minister to control this outbreak?
- Options are **YES** (accept) or **NO** (decline).
  - To decline means no additional funding, personnel or immunizations. It also means that the country has successfully controlled the outbreak without such support.
  - To accept means additional funding, technical support, personnel and immunizations. Although receiving additional support is beneficial, we would have to invest time and effort in managing that support, diverting our attention from all the other diseases and projects we are managing. It also might look as though we are not able to control the outbreak on our own, which could further decrease the population's confidence in the public health system.
- After engaging the stakeholders, we have learnt that they would like to make a decision within the next six hours.

STEP 2. WHAT EPIDEMIOLOGICAL SITUATIONS JUSTIFY THE DECISION OPTIONS?

Restate the options as epidemiological situations.

If occurrence of measles disease is truly decreasing, we should decline the offer of support.

AND

If occurrence of measles disease is not truly decreasing, we should accept the offer of support.

We know that reported cases have been decreasing for almost a month. Does the decline in reported cases represent a true decrease in disease?

STEP 3. IF THE SITUATION WERE TRUE, WHAT SHOULD THE INFORMATION SHOW?

Brainstorm and list information that would support one situation.

If occurrence of measles disease were truly decreasing, then the information would show decreases in:

- Reported cases of measles
- Frequency of EBS reports (e.g. in media)
- Laboratory positivity
- Number of fever-and-rash patients reported
- Number of hospital admissions due to measles
- Number of measles-confirmed deaths
- School absenteeism
- Internet search terms related to measles

Additionally,

If occurrence of measles disease were truly decreasing, we expect to observe:

- Field-team investigation reports from the past 2–3 weeks suggesting reduction in disease occurrence.
- Supplemental immunization activity (SIA) vaccination coverage increasing (or having reached its target).

STEP 4. WHAT DOES THE ACTUAL MULTI-SOURCE INFORMATION SHOW?

Describe the patterns in the available information.

After reviewing the available information, the team conducting this ERD has summarized the actual observed information in this way:

- Reported cases of measles  since week 9
- Relevant media articles from EBS  since week 10
- Internet searches for terms related to measles  since week 7
- Measles laboratory test positivity  since week 9
- Reported fever-and-rash patients  unavailable

- Measles-confirmed deaths ↘ since week 9
- Measles-confirmed hospitalizations ⊘ unavailable
- SIA vaccination coverage ☺ 78% at week 12
- School absenteeism ⊘ unavailable
- Field visits to provinces and municipalities find supporting evidence that disease has declined in the past four weeks ↘ since week 10

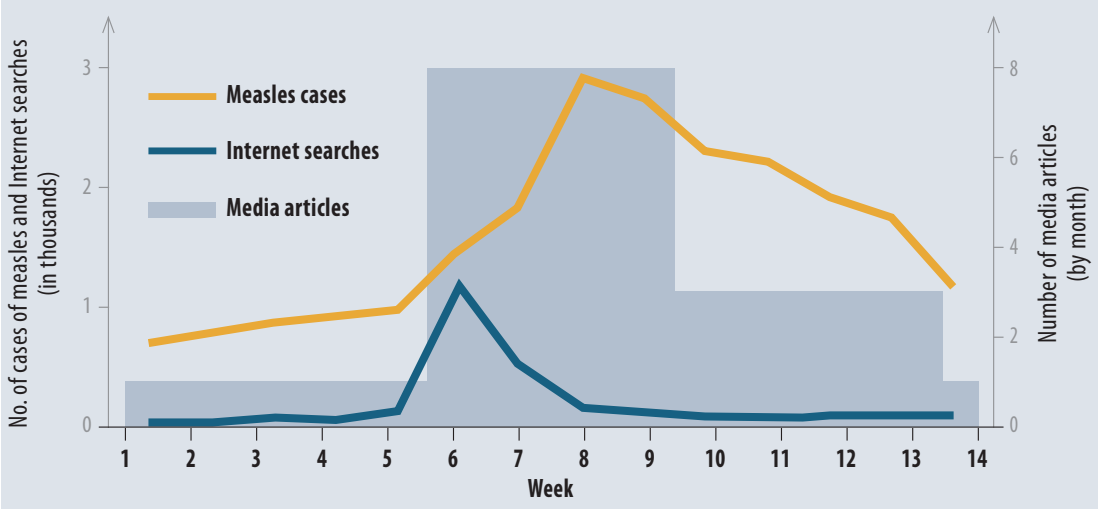
STEP 5. WHAT ELSE COULD EXPLAIN THE OBSERVED TRENDS?

List alternative explanations and then reject or support them.

Information	Alternative explanation
↘ Reported cases of measles	Delayed reporting, decreased health-care seeking or decreased clinical suspicion.
↘ Number of relevant media articles from EBS	Change in reporting priorities by media or change in the EBS system (e.g. a new, less experienced surveillance officer).
↘ Internet search terms related to measles	Decreased interest because of low media attention or decreased Internet access.
↗ Measles laboratory test positivity	Restricted testing (i.e. decreasing denominator) or change in testing; data entry or reporting that allowed previously non-positive results (e.g. indeterminate) to be classified positive.
☺ SIA vaccination coverage	Change in formula for calculating coverage, decrease in target population size, increased coverage in non-essential areas, or wrong target population.
↘ Field visits to find evidence that cases have declined in the past four weeks	Lack of representativeness in the investigation or improper investigation methods.

Exploring the trends in case-based data and media attention

Reported cases of measles by week of onset, number of significant media articles by month of publication and number of Internet searches in the country for measles terms by week (national)



An analysis of a subset of cases revealed that on average, there is a three-week delay from symptom onset to reporting the case. The decrease in reported cases of measles (dark blue line), however, began five weeks ago.

The decrease could be due instead to decreased clinical attention, but the number of deaths (not shown) began to decrease in week 9. We would not expect reported deaths to be influenced as much by decreased clinical attention.

The decrease could be due to decreased health-care-seeking behaviour because of decreased media attention, but the number of significant media articles was still high in February, when the number of cases began to fall.

The number of weekly Internet searches for terms related to measles (orange line) peaked two weeks before cases of measles did, meaning interest had already declined while occurrence of cases was increasing.

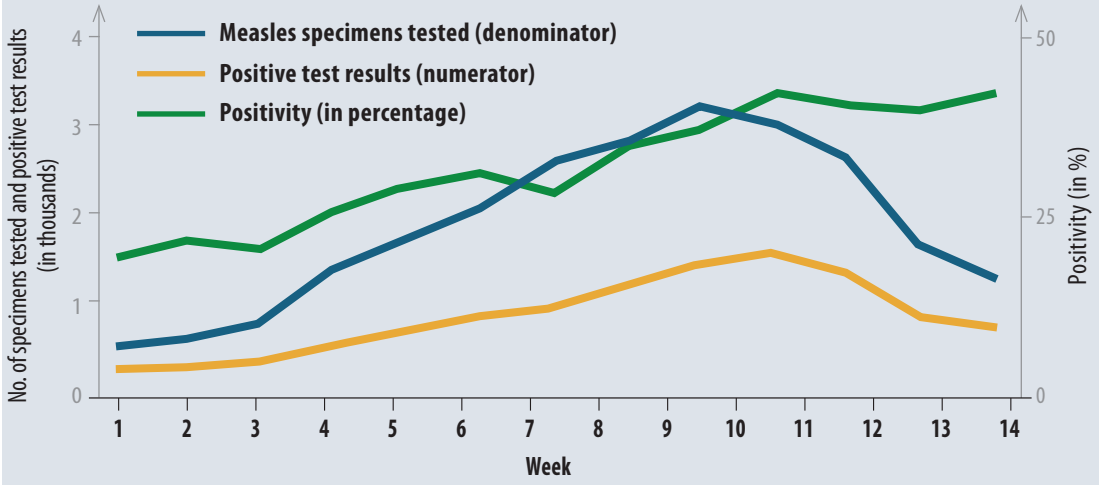
Exploring the increase in laboratory positivity

The increase in positivity could be due to a true increase in disease. Alternatively, a change may have occurred in the testing, data entry or reporting procedures that allowed specimens that were previously classified as not positive (for instance, indeterminate specimens) to be reclassified as positive. These specimens may have already been in the

denominator because they were tested but not in the numerator because they were not positive. An example could be that the laboratory decided to raise the cycle threshold (CT) value for positive reverse transcriptase polymerase chain reaction (rt-PCR), thus classifying results that were previously indeterminate or negative now as positive. Or the increase could be due to a change in testing criteria, which limited the patients or specimens that the laboratory would test (denominator), and these criteria identified patients or specimens that were more likely to test positive.

After discussions with the National Reference Laboratory, we learnt that due to the large number of specimens the laboratory was receiving, the Director had changed the criteria in week 8 to test specimens of only suspected cases from new subdistricts and only if they met strict collection, transportation and labelling guidelines. Thus, the Laboratory restricted the patients and specimens being tested to those that were more likely to test positive, which caused positivity to increase. Our colleagues in the National Reference Laboratory provided data to construct the following graph.

Measles specimens tested, positive test results and positivity (National Reference Laboratory)



After looking at the laboratory data, we observed a decrease in both the numerator and the denominator, but a sharper decrease in the denominator. The number of laboratory specimens tested had decreased since week 9, whereas the decrease in the numerator began in week 11. The increase in positivity was due to changes in the protocol that made it more probable to test specimens that were likely to be positive. We would suspect a true increase in measles occurrence if the denominator were increasing and positivity were increasing (assuming the number of tests was proportional to the number of suspected cases); this was not what happened.

TABLE 5 Summarized observed information, alternative explanations and reasons for rejecting or supporting the alternative explanations – national measles outbreak scenario (2)

Observed…	Information	Alternative explanation	Reject or support alternative
… since week 9 	Reported measles cases	Delayed reporting, decreased health-care seeking or decreased clinical suspicion	• REJECT – Decrease began five weeks ago (> typical three-week delay) when media attention was high, and because deaths are also decreasing.
… since week 10 	Number of relevant media articles from EBS	Change in reporting priorities by media or change in the EBS system (e.g. a new less-experienced surveillance officer)	• REJECT – No major news event has occurred. • REJECT – No changes in the system have occurred.
… since week 7 	Internet search terms related to measles	Decreased interest because of a lack of media attention (change in priorities) or decreased Internet access	• REJECT – Media attention was still high when searching decreased and no Internet access changes have been reported.
… since week 9 	Measles laboratory test positivity	Restricted testing (decreasing denominator) or change in testing, data entry or reporting that allowed previously non-positive results to be classified as positive (e.g. indeterminate results)	• SUPPORT – Testing restriction was confirmed by laboratory colleagues.
… at week 12 78% 	SIA vaccination coverage	Change in formula for coverage, decrease in target population, increased coverage in non-essential areas, wrong target population	• REJECT – Immunization colleagues report no changes in formula or populations; target population is geographically appropriate and age appropriate.
… since week 10 	Field visits to find evidence that cases have declined in the past four weeks	Lack of representative-ness in the investigation or improper investigation methods	• REJECT – Supported by national decreases in reported cases and deaths.

EBS: evidence-based surveillance; SIA: supplementary immunization activity

Note the different alternative explanations in the table. Including sources that are susceptible to different alternative explanations is one key to an effective ERD.

STEP 6. WHICH DECISION OPTION IS SUPPORTED BY THE AVAILABLE MULTI-SOURCE INFORMATION?

Synthesize the information and inform decision-makers of the conclusion.

Based on the available multi-source information, additional support is not warranted at this time. Our recommendation is based on an assessment of multi-source information that indicates the occurrence of measles is truly decreasing nationally. The assessment included information from case-based surveillance, National Reference Laboratory tests, measles deaths, significant EBS reports, SIA coverage, field visits and Internet search trends, which makes alternative explanations unlikely and our confidence in this assessment high. Although cases will continue to occur, the national situation has improved and will likely continue to improve with current response efforts.

STEP 7. HOW CAN WE IMPROVE MULTI-SOURCE INFORMATION FOR ERD?

Evaluate multi-source information and ERD as a system for informing response decisions.

The objective of this ERD was to provide – within six hours – an epidemiology-based answer with very high confidence to the Vice-Minister on whether to accept additional support from the Prime Minister to control this national measles outbreak. This ERD was able to provide an epidemiology-based answer within four hours with high confidence.

The team decided that "high" confidence was most appropriate because, although we used strong data sources (case-based surveillance, deaths and national reference laboratory testing), these sources are all potentially limited by delayed reporting. Recent field visits, EBS reports and Internet search trends are not susceptible to this limitation, and their trends are also declining. In the team's view, however, these sources are not the strongest sources of data.

Noted gaps in this ERD included unavailable data on school absenteeism, hospital measles admissions and fever-and-rash reports, which would counter the concerns with delayed reporting and strengthen the validity of the interpretation. We requested such data from two major hospitals, but have yet to receive them. Absenteeism is likely available from school districts, but due to the very short time allotted for this ERD, we could not identify those districts to reach out to them. The same could be said for hospital measles admission data. Fever-and-rash reports are not collected systematically in the country.

Delays in providing the ERD answer came from two challenges. First, the team struggled to interpret Internet search trend data, especially regarding which terms are most valid and reliable. Second, the team struggled to interpret the positivity data until it was able to communicate with a knowledgeable person at the National Reference Laboratory.

As with all ERDs, the key to reaching an answer with high confidence was having information sources that did not have the same potential bias so that the alternative explanations could be addressed.

Therefore, to improve ERD for measles, we recommend the following:

1. Improve staff skills and understanding in epidemiology to support analysis and interpretation of multiple information sources, considering biases, and alternative explanations and approaches in ruling them out.
2. Design and implement a syndromic surveillance system early in large measles outbreaks, including daily or weekly numbers of fever-and-rash cases from sentinel clinics in each district.
3. Design and implement surveillance for admitted patients with suspected measles early in large measles outbreaks, including recording daily or weekly numbers of fever-and-rash cases from major hospitals in each province.
4. Improve staff skills and knowledge to analyse and interpret Internet search term trends for ERD.
5. Introduce ERD and invite representatives or experts in epidemiology, immunizations, the national laboratory, and online data and analytics to join the ERD team.

ANNEX C.
SCENARIO 3

CHOLERA

PROVINCIAL OUTBREAK

Today is 25 May. You are a member of the surveillance team for the provincial Department of Health (DOH).

Cholera is endemic in our country, and an outbreak was declared six weeks ago. Notified cases are up 98% this year compared to the six-year average. The pathogen has been identified as toxigenic *V. cholera*e O139. As of 24 May, the case-fatality rate (CFR) is 0.9% in the province.

The outbreak began 11 weeks ago in an impoverished area on the outskirts of the provincial capital. Then, seven weeks ago, heavy rains and landslides forced many people in the area into makeshift evacuee settlements. Notifications increased rapidly after that, which led to adoption of the WHO epidemic case definition: "acute watery diarrhoea with or without vomiting in any patient".

The DOH has worked with local health authorities to institute disease prevention-and-control measures, including improved access to water, sanitation and hygiene (WASH), enhanced education on hygiene and food safety, reinforced clinical case management, and increased distribution of oral rehydration solution. Resources have been sufficient but not abundant. Health-care facilities (treatment centres, clinics, hospitals) in the province are full every day. Staff are working long hours.

Politicians have been on television saying we must declare a state of emergency because the situation is getting worse, and a state of emergency will release resources to control the outbreak, close facilities that may be contributing to the caseload and improve the country's chances of receiving oral cholera vaccines.

Politicians from the majority party, however, have said that declaring a state of emergency is unnecessary and a waste of resources. They say the DOH is very capable and can manage the situation. They also point to a decline in case notifications in the most recent weeks.

The Governor wants advice from the provincial Health Director tomorrow morning. The Director wants our advice by the end of the day.

STEP 1. WHAT IS THE DECISION THAT NEEDS TO BE MADE?

State the decision question and its options.

Should the DOH declare a state of emergency?

- Options are **YES** (accept) or **NO** (decline).
  - To declare a state of emergency means more resources from the central government, including money and health-care personnel, which could be used in the evacuee camps, improve WASH and reinforce staff at health-care facilities. A declaration means additional funding to support field teams and laboratories and the likely receipt of oral cholera vaccines, which would benefit the population in the future too.
  - A declaration also means that we are admitting we cannot handle this outbreak on our own. It looks bad for our team, our health department, the majority political party and the Governor, if later we should learn that the outbreak was already ending and the resources were unnecessary.
  - To not make a declaration means no extra resources, no cholera vaccines, but no political trouble, as long as the outbreak is under control or subsiding. Also, it could make the public question why we did not respond more strongly.
- After engaging the stakeholders, we have learnt that they would like to make a decision within the day.

STEP 2. WHAT EPIDEMIOLOGICAL SITUATIONS JUSTIFY THE DECISION OPTIONS?

Restate the options as epidemiological situations.

If the number of people with cholera disease is truly increasing, then we declare a state of emergency;

AND

If the number of people with cholera disease is not truly increasing, then we do not declare a state of emergency.

STEP 3. IF THE SITUATION WERE TRUE, WHAT SHOULD THE INFORMATION SHOW?

Brainstorm and list information that would support one situation.

If the number of people with cholera disease is truly increasing, then the information would show increases in:

- Case notifications from indicator-based notifiable disease surveillance
- Case notifications from enhanced syndromic hospital surveillance
- Pathogen surveillance positivity and number of specimens tested
- School absenteeism
- EBS signals
- Sales of pharmaceutical products related to diarrhoea and rehydration
- Internet searches for terms related to cholera
- Environmental sampling positivity with increasing number of positive tests

We would also expect to see recent field-team investigation reports suggesting a worsening situation.

A discussion among the team conducting this ERD led to the removal of "Internet searches for terms related to cholera" from the list. The team agreed that the affected population has very limited access to the Internet, so any changes in trends would reflect public curiosity as opposed to occurrence of symptoms.

STEP 4. WHAT DOES THE ACTUAL MULTI-SOURCE INFORMATION SHOW?

Describe the patterns in the available information.

After reviewing the available information, the team conducting this ERD has summarized the actual observed information in this way:

- Case notifications from indicator-based surveillance ↘ in the past 3 weeks
- Case notifications from enhanced syndromic hospital surveillance ↗ in the past 6 weeks
- Pathogen surveillance positivity ↗ in the past 4 weeks
- School absenteeism ⊘ unavailable
- EBS signals ↗ in the past 6 weeks
- Sales of pharmaceutical products related to diarrhoea and rehydration ⊘ unavailable

- Environmental sampling positivity with increasing number of positive tests ↘ in the past 3 weeks
- Field visits to two affected districts ▬; one is unchanged and may be worsening in the other

STEP 5. WHAT ELSE COULD EXPLAIN THE OBSERVED TRENDS?

List alternative explanations and then reject or support them.

A review of the environmental sampling data shows that the number of tests (denominator – blue line) dramatically increased from week 16, while the number of positives (numerator – orange line) increased less rapidly. These patterns caused positivity to decline. It is common for positivity to decrease when higher awareness results in increased testing because more specimens that are less likely to be positive are being tested. Through discussions with colleagues from the environmental sampling team, we learnt that the sampling strategy changed around week 15 to identify new potential hotspots. Collection of specimens intensified to cover more geographical areas and increase the number of collection sites, including those that are not typically associated with presence of the pathogen.

Environmental sampling: tests, positive results and positivity (Province)

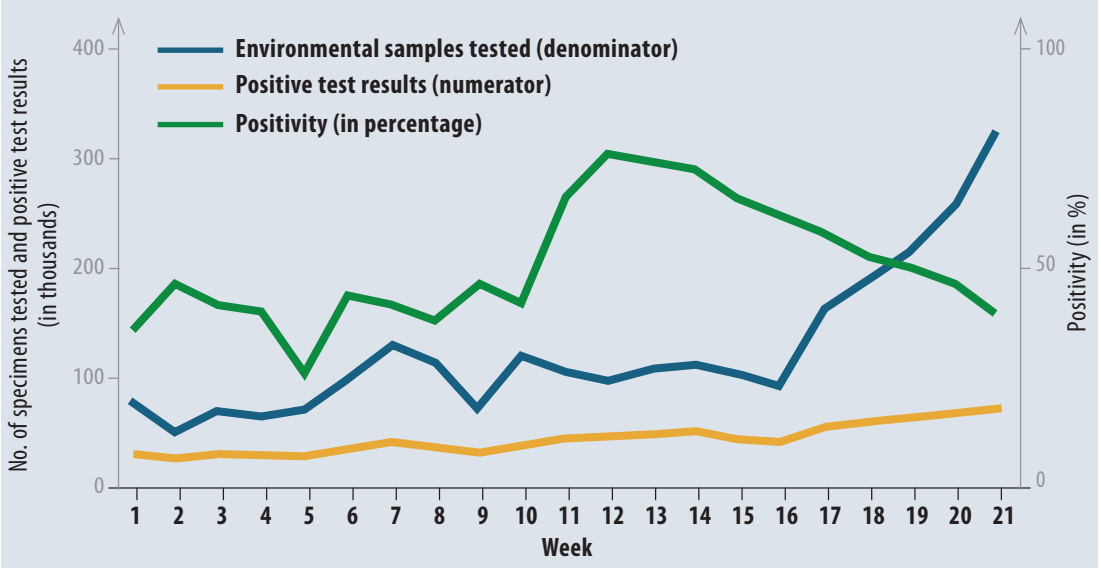


TABLE 6 Summarized observed information, alternative explanations and reasons for rejecting or supporting the alternative explanations – provincial cholera outbreak scenario (3)

Observed…	Information	Alternative explanation	Reject or support alternative explanations?
… since week 18 	Cases in IBS	Delayed reporting (e.g. overwhelmed capacity to report), decreased health-care seeking, or decreased clinical suspicion	• REJECT – Reported syndromic case number is increasing and laboratory tests are increasing. • SUPPORT – Surveillance officers confirmed a backlog of cases to report due to overwhelmed capacity.
… since week 15 	Cases in enhanced syndromic hospital surveillance	Increased health-care seeking, increased clinical suspicion, improved reporting	• REJECT – Despite increased laboratory tests, cholera positivity is increasing.
… since week 17 	Pathogen surveillance positivity	Improved sampling or restricted criteria for testing	• REJECT – Number of tests (i.e. denominator) is increasing.
… since week 15 	EBS signals	Change in EBS system that resulted in more sensitive criteria for picking up signals	• SUPPORT – The EBS team was strengthened by adding two persons, and wider criteria were implemented.
… since week 18 	Environmental sampling positivity	Increased testing or reduced capacity to identify true positives	• SUPPORT – Increased testing because the number of tests (denominator) is increasing rapidly and, per the environmental sampling team, the collection increased.
… reported situation in one is unchanged and may be worsening in the other	Field visits to two affected districts	Lack of representativeness in the investigation or improper investigation methods	• REJECT – The observed findings support the above evidence, which points to a worsening situation.

EBS: evidence-based surveillance; IBS: indicator-based surveillance

STEP 6. WHICH DECISION OPTION IS SUPPORTED BY THE AVAILABLE MULTI-SOURCE INFORMATION?

Synthesize the information and inform decision-makers of the conclusion.

Based on the available multi-source epidemiological evidence, a declaration of a state of emergency is supported. Our recommendation is based on an assessment of multi-source information indicating that the occurrence of cholera is truly increasing in the province. The assessment included information from case-based surveillance, syndromic hospital surveillance, pathogen surveillance, EBS, environmental surveillance and field investigations, which makes alternative explanations unlikely and our confidence in this assessment very high. Only the observed trend in case-based surveillance indicates an improving situation; however, that observed decreasing trend is due to the district surveillance officers being overwhelmed with response efforts and thus not able to complete case reporting on time.

STEP 7. HOW CAN WE IMPROVE MULTI-SOURCE INFORMATION FOR ERD?

Evaluate multi-source information and ERD as a system for informing response decisions.

The objective of this ERD was to provide – within eight hours – an epidemiology-based answer with very high confidence to the Governor on whether to declare a state of emergency to control this provincial cholera outbreak. This ERD was able to provide an epidemiology-based answer within six hours with very high confidence.

The team decided that "very high" confidence was appropriate because we used strong data sources (case-based surveillance, syndromic surveillance, pathogen surveillance, EBS, environmental surveillance and field investigations) that were susceptible to different limitations and biases.

Noted gaps in this ERD included unavailable data on school absenteeism and pharmaceutical sales, which could strengthen understanding of real-time illness and geographical distribution. Absenteeism is likely available, but due to the short time allotted for this ERD, we could not reach out to the schools. Pharmaceutical sales may also be available, but we did not have time to identify stakeholders to request those data.

As with all ERDs, the key to reaching an answer with very high confidence was having multi-source information with different biases affecting each source so that the alternative explanations could be considered.

A second key strength of this ERD was having an epidemiologist on the team with strong skills in analyses. She was able to explain the trends in laboratory positivity quickly and with clarity. A key challenge for this team was identifying the reasons for the backlog in case-based surveillance, as surveillance officers were hesitant to discuss the issue.

Therefore, to improve ERD for cholera, we recommend the following:

1. Improve other staff skills and understanding in epidemiology to support analysis and interpretation of multiple information sources, considering biases, alternative explanations and approaches in ruling them out.
2. Identify existing school absenteeism systems and set up memoranda of understanding (MOUs) that facilitate exchange of data and information during cholera (and other) public health events.
3. Identify potential partners in the private pharmaceutical retail industry to develop reporting systems or MOUs to facilitate data sharing.
4. Introduce ERD to the district surveillance officers so that they understand why we are requesting information from them and do not feel as though they are being evaluated for their performance.

ANNEX D.
STRUCTURED BRAINSTORMING

Brainstorming aims to stimulate thought and creativity. If done correctly, it generates ideas quickly and boosts energy to move forward and solve problems. Brainstorming is most helpful for Steps 3 and 4. It should not take more than two hours. It works best for a group of three to eight people.

1. *Make space for the ERD exercise*

Prepare whiteboard or flip-chart paper so that you do not have to stop the creative flow of ideas. For Steps 3 and 4, you will need three columns (information that would support a situation, alternative explanations and considerations).

Assign a writer – either a co-facilitator or a volunteer.

2. *Clarify the ground rules for brainstorming*

- All ideas will be accepted for the ERD exercise.
- No idea should be discussed or criticized.
- Discussion will occur only after the brainstorming session finishes.
- Clarify the order: "popcorn style" – everyone speaks when they want; "go-around" – in order clockwise or counterclockwise; point to people, etc.

3. *Warm up and focus the group by asking about past experiences*

Ask everyone to talk about a recent outbreak or response in which they were involved. After they tell their brief story, ask them to name something challenging and something interesting from the experience.

Write the interesting and challenging words in the considerations column. These words can help trigger thinking later during the session.

4. *Clarify the decision question* (Step 1) *and the epidemiological situation* (Step 2)

Ensure participants understand these two points. Answer any questions and address any confusion.

5. *Start with the first column and ask for ideas and suggestions, write them in the appropriate column as they come*

To keep the pace going, validate ideas and help the writer capture every comment, repeat key phrases back to the teammates as they give their ideas.

Write the ideas in the participants' words to prevent repetition, validate participation and keep people focused. Write in block letters. Keep the board organized. Alternate marker colours.

6. *Encourage participation*

Restate a question often to remind participants.

Review the ideas on the list and ask: *"What else?"*

Allow silence – after the first round of ideas, participants get quiet. Give them time to think and generate another round of ideas.

Use effective facilitation techniques (for instance, engaging body language, active listening, paraphrasing) to encourage participation.

If comments or questions arise that threaten to slow down the session, put them in the third column (considerations) and promise to return to them later. If the question is crucial for advancing, address it at that point.

7. *Alert when time is running out*

Let participants know when five and two minutes remain.

8. *Review the final list before discussion*

Thank participants for their active participation.

Review the list without judgement or commentary.

Ask if any ideas need to be clarified. If so, ask for clarification.

Ask if any need to be removed. If so, solicit the group's approval.

9. *Repeat No. 4–8 for* ERD Step 4

WHO Regional Office for the Western Pacific Field Epidemiology Fellowship Programme fellows participate in a brainstorming session for ERD.

ANNEX E.

TEMPLATE FOR COMPLETING ERD STEPS 1–6, WITH INSTRUCTIONS

Decision question	*(Write the decision question here)*			
Decision options	Option 1:		Option 2:	
Epidemiological situation that would justify the option	Option 1:		Option 2:	
Expected information if situations 1 or 2 were true	Actual observed information	Alternative explanation(s)	Reject, support or neither?	Why reject, support or neither?
(Write expected information sources and their direction in this column)	*(In this column, describe the observed information, if available, for the expected information on the left)*	*(Write the alternative explanations for the observed information on the left in this column)*	*(In this column, state whether the alternative explanations can be rejected, supported or neither)*	*(Explain why the alternative explanation can be rejected, supported or neither in this column)*
Conclusion statement	*(Write the conclusion here, including which option, if any, is supported and why. State any uncertainties. This statement can be used to communicate back to the decision-makers)*			
Confidence level	*(State whether the team's confidence in the conclusion is very low, low, high or very high, and explain why)*			

TEMPLATE FOR COMPLETING ERD STEPS 1–6

Decision question				
Decision options	Option 1:		Option 2:	
Epidemiological situation that would justify the option	Option 1:		Option 2:	
Expected information if situations 1 or 2 were true	Actual observed information	Alternative explanation(s)	Reject, support or neither?	Why reject, support or neither?
Conclusion statement				
Confidence level				

TEMPLATE FOR COMPLETING ERD STEPS 1–6, WITH EXAMPLE DECISION OF EOC ACTIVATION FOR AN INFLUENZA-LIKE ILLNESS OUTBREAK

Decision question	*(Write the decision question here)* Do we activate the Emergency Operations Centre (EOC) to coordinate response to the influenza-like illness (ILI) outbreak?			
Decision options	Option 1:	*(Write one of the decision options here)* Yes, activate.	Option 2:	*(Write the second decision option here)* No, do not activate. We can manage the outbreak response with current efforts and procedures.
Epidemiological situation that would justify the option	Option 1:	*(Describe the epidemiological situation that would justify option 1)* Increasing ILI.	Option 2:	*(Describe the epidemiological situation that would justify option 2)* Decreasing ILI.

Expected information if situations 1 or 2 were true	Actual observed information	Alternative explanation(s)	Reject, support or neither?	Why reject, support or neither?
(Write expected information sources and their direction in this column) Increasing ILI outpatient visits	*(In this column, describe the observed information, if available, for the expected information on the left)* Decrease in the last two weeks	*(Write the alternative explanations for the observed information on the left in this column)* Delayed reporting or over-whelmed capacity (stopped reporting)	*(In this column, state whether the alternative explanations can be rejected, supported or neither)* Neither (reject?)	*(Explain why the alternative explanation can be rejected, supported or neither in this column)* Possibly reject because of increases in all other sources, but need to contact reporting sites to determine if delayed or stopped reporting
Increasing no. of facilities throughout the country with clusters or outbreaks	Increasing compared to previous two weeks	Another pathogen	Reject	Increasing laboratory positives for influenza
Increasing no. of severe acute respiratory infections (SARI)	Increasing in the last 3 weeks	Increased reporting	Reject	Increasing laboratory positives for influenza among SARI cases

TEMPLATE FOR COMPLETING ERD STEPS 1–6, WITH EXAMPLE DECISION OF EOC ACTIVATION FOR AN INFLUENZA-LIKE ILLNESS OUTBREAK (CONTINUED)

Expected information if situations 1 or 2 were true	Actual observed information	Alternative explanation(s)	Reject, support, or neither?	Why reject, support or neither?
Increasing no. of positives for the same pathogen	Increasing influenza positives	Increased testing or increased health-care seeking	Reject	Positivity is also increasing
Increasing pharmaceutical sales	NO DATA			
Increasing absenteeism	NO DATA			
Worsening situation reported by rapid response team in the field	Worsening	Not representative or generalizable	Reject	Worsening situation is also reflected in other geographical areas through increasing laboratory positives, hospitalizations and ILI
Worsening situation reported by clinicians	Worsening in two hospitals	Not representative or generalizable	Reject	Worsening situation is also reflected in other geographical areas through increasing laboratory positives, hospitalizations and ILI
Conclusion statement	*(Write the conclusion here, including which option, if any, is supported and why. State any uncertainties. This statement can be used to communicate back to the decision-makers)* Option 1 – Yes – activating the EOC is supported because increases have been observed in the number of facilities reporting increased cases, the number of SARI and the number of positive laboratory tests for influenza despite increased testing, and because the field investigation team and clinicians report worsening situations. Only ILI reports are decreasing, which may be due to delayed or reduced reporting. We suggest following up with ILI reporting sites to reject or support these alternative explanations.			
Confidence level	*(State whether the team's confidence in the conclusion is very low, low, high, or very high, and explain why)* High – The four principal sources of information point toward a worsening situation. Only ILI reports, which are also a principal source of information, contradict this trend. Nevertheless, we have experienced delayed ILI reporting in the past, especially for the most recent reporting weeks. Qualitative field-team and clinician reports also point towards a worsening situation.			

CONTRIBUTORS

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