Strengthening Early Warning Systems and Surveillance for Public Health Events of International Concern

The International Health Regulations (IHR) 2005, recently adopted by the World Health Assembly, provides the international legal framework for the global response to any public health event of international concern. Member States are required to build, strengthen and maintain the capabilities stipulated under IHR 2005, and to mobilize resources necessary for that purpose. One of the minimum core capacity requirements for national preparedness and response include: at community and primary public health level to detect illnesses and deaths above expected levels and to report information to appropriate local health personnel. This paper describes and evaluates current national infectious disease surveillance systems and outlines what will be needed to strengthen and improve national capabilities for early detection and reporting of specific disease cases and/or outbreaks.

Current Public Health Surveillance Systems for Communicable Diseases

Public health surveillance is defined as: the routine collection, analysis, and dissemination of all data that may be relevant for the prevention and/or control of a public health problem. Public health surveillance of infectious diseases has traditionally relied primarily on a passive system of disease reporting. Most countries have established by law or regulation a list of diseases that are required to be reported by the medical community or other care providers. However, it is common knowledge that most reportable diseases are not well reported. The accuracy and completeness of communicable disease reporting may vary from a few percent for most reportable diseases to over 90 percent for some diseases in developed countries. Much lower levels of reporting are generally found in developing countries.

Traditional disease reporting systems are dependent on (1) the recognition and diagnosis of a disease by a health care provider, and (2) the timely reporting of that disease case(s) to local public health authorities. Many studies have been carried out documenting the major delays and incompleteness of disease reporting. However, it has not been fully realized that the prevailing system of disease reporting does not measure the extent of ascertainment or detection of infections that actually occur. Most of the delays from initial infection to a possible report of a disease are related to the specific epidemiology and natural history of infectious disease agents. The time interval from infection to the development of any signs or symptoms of illness (the incubation period) varies for each infectious disease agent, but for most acute infectious diseases, this incubation period is usually a few days or at most a week or so. From the development of illness, the clinical spectrum of disease can range
from very mild or almost no disease to very severe disease and death. As a result, for any specific infectious disease agent, only a variable percent of infected and diseased persons might seek any medical care. Finally, the time from admission to a health care office or facility to the time that a specific diagnosis is made can range from a day or so up to a few weeks. Thus, all confirmed and diagnosed cases of a reportable disease may not get to the attention of local public health authorities for up to a week or several weeks *after infection*. In a review of the timeliness of detection of paralytic polio cases, the median interval from onset of paralysis in the 1st case to laboratory confirmation of wild polio virus (WPV) was 51 days (range: 24-123 days).\(^2\) Clearly, it should not take, on average, up to a couple of months for such detection and verification!

**Development of more reliable and sensitive detection systems for new, unusual, or epidemic disease occurrence**

Early or earlier *detection* and *verification* of an emerging disease outbreak requires the receipt of, or some awareness of, early or earlier “*signals*” of an epidemic or any unusual disease occurrence. The “business as usual” approach would be to maintain the current passive reporting system and to constantly exhort health care providers to do what they have always been required to do – report promptly any and all reportable diseases as well as any usual disease occurrences. Even if this were always well carried out, this would not, in most instances significantly reduce the time lag from *infection* to the *diagnosis* and *reporting* of a disease. What is needed to be more responsive for the implementation of IHR 2005 is development of more *sensitive* surveillance systems. Instead of waiting to receive reports of disease occurrence that may take up to weeks to be diagnosed and then reported, earlier signals should be routinely and actively sought and promptly acted upon to begin the verification process.

Such improved or strengthened surveillance systems could easily be developed along the lines of annual influenza surveillance where the primary objectives are rapid early warning of an epidemic and not the reporting of all diagnosed cases of influenza. Influenza surveillance systems have utilized the concept of *sentinel surveillance*, defined as: *the use of well defined subsets of the population for routine collection of data that may be useful or relevant for early detection and monitoring of a potential public health problem.*

Influenza surveillance systems have included:

1. Routine collection and analysis of school absenteeism data. The first visible indication of an influenza epidemic may be a sudden increase of acute respiratory
illnesses in children. In addition, many influenza surveillance systems also collect absenteeism data from large employers such as government offices, etc.

2. Weekly sampling of patients hospitalized with influenza like illnesses (ILI) for laboratory study for influenza or other respiratory disease agents.

3. Routine collection and analysis of daily or at least weekly outpatient visits for ILI from sentinel clinics and hospitals.

4. Routine collection and analysis of pneumonia and influenza deaths from sentinel cities or populations.

5. Routine collection and analysis of daily or weekly sales or distribution of both prescription and over the counter medicines for acute respiratory illnesses.

Figure 1 was adapted from a paper published in the mid-1970s on the detection and reporting of *Shigella* infections.³ This figure illustrates the high specificity but poor sensitivity of routine public health surveillance systems that rely primarily on the passive reporting of diagnosed disease cases. For every 1,000 *Shigella* infections that may occur, it was estimated that the US surveillance system may only receive reports on about 50 cases or 5 percent! In reviewing the surveillance profile for *Shigella* – from infection to the report of a *Shigella* case, it is clear that there are multiple potential sources of earlier signals of a *Shigella* outbreak.

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**Surveillance Profile of *Shigella* Infections**

The vast majority (76%) of *Shigella* infections are symptomatic with diarrhea, nausea, vomiting, and abdominal cramps ranging from mild to very severe. This is in marked contrast to an agent such as polio virus where the vast majority of infections (up to 90%) are asymptomatic.

A majority (over 60%) of ill persons do not require or seek out any medical care. Only about a third of patients have stool specimens collected. *Shigella* found in close to 80% of specimens tested.

Laboratory tests may be ordered upon admission or a few days after admission. Laboratory findings may be reported back in a few days or up to a week or more.

Reporting can be immediate or delayed a few days or a few weeks after a diagnosis is made.

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³ Shigella infections

Asymptomatic

Symptomatic

Home care only

Medically Attended

No laboratory tests

Laboratory tests

Tests negative or inconclusive

Laboratory confirmed

Not reported

Reported

Incubation period is about 2-3 days - can range from 0.5-7 days

From onset of illness to seeking medical care varies from a few days to a few weeks, but usual duration of illness is less than a week.

Increased drug use

Latest
The first potential signal is an increase in persons with diarrheal illness and the first reflection of this may be absenteeism from school or work. The next potential signal may be a sudden increase in the sales or distribution of drugs used for the treatment of diarrhea. This drug signal may be detected or reported by an increase in persons/patients seen in medical clinics, offices, and/or hospitals for severe diarrhea. Around this time, there may also be increased reports of laboratory tests being ordered for *Shigella*-like illnesses. All of these earlier potential warning signals occur up to weeks prior to the final or latest warning signal – reports of laboratory confirmed *Shigella* cases received by local public health authorities.

As shown in the following table, the potential sources of these earlier warning signals can range from the routine and active collection of data regarding these specific signals to a reliance on *ad hoc* reports of such signals. If the first signal detected by the local health department is a news media report that there may be a *Shigella* outbreak in community X, then it is clear that the public health system for early detection of illnesses and death, above expected levels, needs improvement and strengthening.

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<tr>
<th>Early to Late Signals</th>
<th>Potential Source(s) of Signals</th>
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<tr>
<td>1 Increase in diarrheal illness</td>
<td>Routine, daily or weekly absenteeism data from schools and large business or government offices; <em>ad hoc</em> reports of absenteeism; rumors and/or news media reports</td>
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<td>2 Increase in drug sales for treatment of diarrhea</td>
<td>Routine, daily or weekly reports of different types of drug sales or distribution; <em>ad hoc</em> report of increased diarrheal drug sales; rumors and/or news media reports.</td>
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<td>3 Increase in medical patients with diarrhea</td>
<td>Routine, daily or weekly reports of medical patients by type of clinical disease; <em>ad hoc</em> reports of increase in diarrheal patients; rumors and/or news media reports.</td>
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<tr>
<td>4 Increase in patients hospitalized for diarrheal illness</td>
<td>Routine, daily or weekly reports of hospital patients by type of clinical disease; <em>ad hoc</em> reports of increase in diarrheal patients hospitalized; rumors and/or news media reports.</td>
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<td>5 Increase in laboratory tests ordered for Shigella</td>
<td>Routine, daily or weekly reports from laboratories by type of tests ordered; <em>ad hoc</em> reports of increase in stool tests for <em>Shigella</em>; rumors and/or news media reports.</td>
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<td>6 Increased reports of Shigella cases</td>
<td>Currently required to be reported by those who make the diagnosis to the local health authorities</td>
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To increase the early “signals” of disease emergence will require the active collection of sentinel surveillance type data. The cost of continuing and expanding collection of the sentinel surveillance datasets that are now used for influenza surveillance should not be large. There may be some objections from some employers for providing absenteeism data and some hospitals and medical offices may not want to regularly report their patient data without being paid, but these obstacles can be overcome. Some type of incentives may need to be developed to encourage sentinel sites to routinely provide regular weekly reporting of both positive and negative data. Collection and analysis of all general sentinel surveillance datasets (absenteeism, drug distribution, medical/hospital visits or admissions), all need to have at least a year or two of baseline data available before “normal” or expected levels of absenteeism, etc., can be determined to develop specific algorithms for public health action.

Regardless of what system is developed to improve or strengthen the earlier detection of disease outbreaks or the unusual occurrence of specific diseases, it needs to be stressed that any and all potential signals have to be investigated and verified as soon as possible so that surrounding populations can be alerted to the disease outbreak and appropriate public health measures can be implemented for prevention and control of any epidemic spread. A standard national surveillance manual should be developed by WHO and this surveillance manual should be adapted and modified as needed by different regions and countries to best fit with the specific diseases that need to be routinely included for regional and national surveillance and early detection and to be technically within the capabilities of national and/or local laboratory facilities.

Standard protocols should be developed to routinely “investigate” any statistically significant increase or change in absenteeism – if there is an increase, some indication as to the primary disease(s) involved, i.e., respiratory or enteric illness, etc., should be obtained so that the laboratory component of sentinel surveillance can be alerted as to the potential disease(s) that may need to be tested for. These “standard” surveillance protocols should be developed as algorithms in a clear and simple IHR 2005 Surveillance Manual. These standard protocols will need to be developed for the most likely disease agents in different areas and populations and for the different levels of sophistication of laboratory resources.

For example, the first steps in the investigation of an increase in school absenteeism should be to: (1) verify with the school that there is indeed a significant increase in absenteeism; (2) obtain any information available as to the primary cause(s) of absenteeism; (3) contact surrounding schools to determine if there may also be increased absenteeism and if not to
ask these schools to immediately report any possible increase in absenteeism; (4) contact medical clinics and hospitals to determine if there is any increase in patient visits, etc; and (5) alert the intermediate public health level that a stage 1 alert is in progress. The surveillance manual should specify when a stage 1 alert can be cancelled as a probable false alarm and what criteria are needed for increasing the stage 1 alert to the next level (stage 2, etc.) when specific laboratory studies and wider alert notices are needed.

It should be realized that for infectious disease cases that have become rare or uncommon, such as paralytic polio, that the traditional passive reporting system may be sufficiently sensitive compared to any sentinel type surveillance. However, epidemic prone diseases like influenza, viral encephalitis, SARS-like epidemics, and enteric disease epidemics can be detected at a much earlier stage using sentinel surveillance type data. Complete records need to be kept as to whether any action(s) were taken to verify any and all potential signals. These records should be systematically reviewed to assure that the national surveillance system is operating according to the standards and general timelines recommended in the IHR 2005 surveillance guidelines.

The timely and appropriate national response to potential disease outbreaks requires the proper functioning of the basic interrelationships between local, intermediate and national health units. This situation is no different than periodically reviewing the capability of fire departments to receive the earliest warning of a fire that they need to respond to. Fire department staffs are used to the need for continuous training and for participation in periodic “fire drills.” Disease control staff at the national, intermediate and local levels also need continuous “on the job” training and periodic mock exercises to test out their training and communications capabilities. With IHR 2005 as the impetus, now is the time to review and revitalize the capability of health department staffs, from the local levels up through the intermediate and national levels to receive or detect an early signal and then to as rapidly as possible, according to some clear protocol/algorithm detailed in a National Surveillance Manual, verify the need for continued action and alert.\(^a\)

\(^a\) The development of a National Surveillance Manual, essential for the effective implementation of IHR 2005, is similar to the WHO’s development of guidelines for HIV sentinel surveillance during the late 1980s.
Strengthening Early Warning Systems and Surveillance for Disease Outbreaks

1. Requirement for reports of all reportable diseases and all outbreaks or suspect outbreaks. This is the primary surveillance system present in virtually all countries and it should be retained and improved and strengthened to the extent possible.

2. System of stimulated passive reporting with routine checks for negative reports -- a report that there were no reportable diseases to report. Stimulated passive reporting is present in virtually all countries, but not many, if any, carry out routine checks for negative reports. This should be made a requirement for strengthening an early detection and reporting system.

3. System of sentinel surveillance sites with routine collection of specified data on a daily or weekly basis. Most countries carry out sentinel surveillance type collection of data for a few specific diseases (HIV/AIDS and influenza). Routine sentinel surveillance protocols (for ILI, CNS type illnesses, enteric illnesses, etc.) need to be developed for all diseases that are of importance and concern for IHR 2005.

4. Development of a IHR 2005 Surveillance Manual that would provide detailed step by step procedures for investigating any “signal” of any increase in disease from what is expected or any unusual disease occurrence. This manual will need to be tailored to be region and country specific and include all of the recommended and required methods for data collection and analysis to meet the objectives of IHR 2005.

5. Countries should consider the development of a monthly (or bi-weekly) Surveillance Bulletin Report that provides information as to the status of disease outbreak reporting throughout the country. This bulletin should include specific recommendations for increased alert for different diseases at different time periods – influenza and ILI surveillance during the respiratory season, enteric disease surveillance in the summer months, etc.

6. Continuous training and review of standardized procedures for detecting and verifying infectious disease threats should be implemented in all Member States with periodic mock exercises to maintain a high level of alertness to the emergence of any public health event of international concern.

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