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Testing a symptom-based surveillance system at high-profile gatherings as a preparatory measure for bioterrorism

K. OSAKA[1,2]*, H. TAKAHASHI[1] AND T. OHYAMA[1]

[1] *Infectious Disease Surveillance Center, National Institute of Infectious Diseases, Tokyo, Japan*
[2] *Department of Population and International Health, Harvard School of Public Health, 665 Huntington Avenue, Boston, MA 02115-6021, USA*

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SUMMARY

We tested symptom-based surveillance during the G8 conference in 2000 as a means of detecting outbreaks, including bio-terrorism attacks, promptly. Five categories of symptoms (skin and haemorrhagic, respiratory, gastrointestinal, neurological and unexplained) were adopted for the case definition of the surveillance. The surveillance began 1 week before the conference, and continued until 1 week after the conference ended. We could not detect any outbreaks during this surveillance. Compared to the existing diagnosis-based surveillance system, symptom-based surveillance has the advantages of timeliness and simplicity. However, poor specificity and difficulties in determining epidemic threshold were important limitations of this system. To increase the specificity of surveillance, it is essential to incorporate rapid laboratory diagnoses into the system.

INTRODUCTION

With recent terrorist attacks, the need for strategies to detect and respond rapidly to nuclear, biological and chemical (NBC) disasters has taken on new urgency. While the delivery of anthrax-tainted mail in the days following the 11 September 2001 terrorist assaults on the US has focused worldwide attention on this threat, earlier episodes have shown the potential for this type of attack by many different types of terrorist groups all over the world [1]. In addition, there is the ever-present risk of unintentional exposures of populations to toxic chemicals and pathogens through industrial accidents and food contamination.

Japan has experienced several of these types of disasters in recent years. The chemical agent Sarin gas was used by the *Aum-shinrikyo*, a cult group, in the Tokyo subway in 1995 [2]. A nuclear accident occurred at a nuclear fuel processing facility at Tokaimura village in 1999 [3]. As for bioterrorism, the *Aum* cult tried to obtain and develop biological weapons such as the Ebola virus and anthrax. They confessed that they used anthrax bacillus as a weapon in Tokyo but failed to cause any cases of the disease [4]. In addition to the intentional spread of infectious agents, there have been many large-scale outbreaks due to inadvertent contamination of food during processing. Vero-toxin producing *Escherichia coli* (VTEC) O157 affected more than 6000 children through radish sprouts served in a school lunch programme in 1996 [5]. Diffuse outbreaks at Sushi bars in multiple prefectures were shown to be associated with salmon roe contaminated with VTEC [6]. Consumption of snacks made of *S.* Oranienburg-contaminated semi-dry squid affected as many as 1505 people throughout Japan [7].

Preparation for these types of disasters is particularly crucial during large high-profile events such as

* Author for correspondence.

Table 1. *Disease classification used as part of the surveillance for the G8 summit*

(1)	Haemorrhagic/dermatological symptoms (e.g. measles, hand-foot-mouth disease, cutaneous anthrax)
(2)	Respiratory symptoms (e.g. pharyngitis, pneumonia)
(3)	Gastrointestinal tract symptoms, including nausea, vomiting and diarrhoea (e.g. staphylococcal infection and Norwalk-like virus infection)
(4)	Neurological symptoms as part of an infectious disease (e.g. botulism)
(5)	Unexplained (or non-specific) symptoms as part of an infectious disease (e.g. brucellosis)

international conferences. Security concerns are naturally heightened during such events. In addition, large events create challenging logistics for the safe handling of food, increasing the risk of unintentional food poisoning.

Although there have been a number of reports on the public health response to outbreaks and bioterrorism at mass gatherings [8–13], few have dealt with the development of an appropriate surveillance system that can be used during large high-profile events. Under the current national surveillance system in Japan, the national epidemiological surveillance of infectious diseases (NESID) [14], notifiable diseases were categorized from I to IV according to their impact on the public health. Most notifiable diseases are reported by physicians after laboratory diagnoses, and take several days to be reported. Therefore, we recognized the need to implement additional surveillance during the Kyusyu-Okinawa G8 conference in 2000 to detect infectious disease outbreaks promptly. The surveillance was carried out for the meeting of finance ministers at Fukuoka and the meeting of Foreign Ministers at Miyazaki city. Both cities are located on Kyusyu Island in southwestern Japan.

METHODS

Organization and education

A governmental task force developed a comprehensive plan for dealing with health issues during the G8 conference and set up task teams at the conference venue. Many clinical experts were appointed to stand by at the major hospitals near the venue. In addition, medical epidemiologists specializing in infectious diseases were dispatched, and they coordinated the additional surveillance during the conference. The government also started a field epidemiology training programme (FETP) in collaboration with the US Centers for Disease Control and Prevention (CDC) in September, 1999. The trainees in the programme were also dispatched to respond to any outbreaks that might occur. For additional surveillance, sentinel clinicians were chosen according to their past experiences in infectious disease surveillance and the location of the clinics (near to the venue of the conference).

A total of 14 medical facilities in Fukuoka city and 5 clinics in Miyazaki city participated in the surveillance. Prior to the beginning of the surveillance, sentinel clinicians were given instruction on the reporting procedure by the coordinator of the surveillance. A 24 h hot-line was set up during the surveillance period for the sentinel clinician to be able to report unexpected incidents at anytime.

System and case definition

To create an effective surveillance system, timeliness was top priority. Case definitions and the reporting system were designed to be simple and fast. To assemble a list of infectious diseases that would likely occur, we considered the incubation period, seasonality of the disease, probability of occurrence, and impact on the public. The conferences were scheduled for only 1–2 days at three venues, and diseases with long incubation periods were considered to be the least likely to occur during the conference as a result of mass gathering. Cases were defined by symptoms, rather than by disease, to reduce the time for confirmatory diagnosis, and to be able to cover highly prioritized diseases. We modified the tentative case definitions of the revised International Health Regulation by WHO [15], deleting jaundice symptoms and adding skin diseases in order to detect important conditions such as cutaneous anthrax and measles (Table 1). Sentinel clinicians marked a column of the form (see Fig. 1) to indicate the symptom category whenever the patients' clinical symptoms fit the case definition, and then filled in additional details, such as provisional clinical diagnoses and the name of the

Reporting Form – Surveillance during the G8 summit

Date: .... July 2000 No. .... Name .... No. outpatients/day

No.	Sex	Age	1 Haemorhagic/skin lesion	2 Respiratory	3 Gastrointestinal	4 Neurological	5 Non-specific (unexplained)	Details
	M(male) or F(female)		Acute onset, symptom of erythema, rash, purpura, vesicular or ulcer lesion or haemorrhagic symptom such as nasal bleeding, petechiae	Acute onset, cough or respiratory tract disorders (excluding chronic diseases)	Acute onset, vomitting, diarrhoea (excluding malignancy/ chronic disease)	Neurological disorder (excluding cerebro-vascular disease)	Not adopted 1–4, unexplained or non-specific symptom	Detailed symptoms, suspect duration, location etc.
1	M F	5y	O					Generalised rash, Measles susp., **daycare centre
2	M F							
3	M F							
4	M F							

Fig. 1. Details of the form used in the surveillance system for the G8 summit. Sentinel practitioners place a mark (1–5) in the column and then write detailed clinical information in the last column. The form was then faxed to public health centers.

school or office to which the patient belonged in the last column. Multiple marks were allowed when the patients' symptoms could not be defined within one category. At the end of the daily practice, the form, along with information about the total daily number of outpatients, was faxed to both the local health centre and the local public health laboratory. When laboratory confirmation of disease was indicated, clinical specimens were submitted to the public health laboratory without delay. The data were assembled and reviewed by epidemiologists on site. If an epidemiologist detected unusual incidents or an increase in any disease category, they called the clinicians and laboratory staff members to determine whether the incidents were associated with each other. Summary reports were distributed to all sentinels and health authorities on a daily basis. Surveillance covered the period from 1 week prior to the conference to 1 week after the conference.

RESULTS

The daily reported numbers of cases at Miyazaki city are shown in Figure 2. A total of 1081 patients were reported, 536 males and 545 females. Nine hundred and nine cases (83 %) were classified as respiratory, 108 cases (10 %) were gastrointestinal, 71 cases (6 %) were haemorrhagic/dermatological, 50 cases (5 %) were non-specific, and 16 cases (1 %) were neurological. The commonly reported provisional diagnoses in the respiratory category were acute bronchitis and other upper respiratory infection. In the haemorrhagic/ dermatological symptom category, clinical diagnoses of hand-foot-mouth disease and suspected enterovirus infection predominated, followed by chicken pox, staphylococcal skin disease and measles. In the gastrointestinal tract symptom group, the most prominent provisional clinical diagnoses was infectious gastroenterocolitis (not specified), followed by acute colitis, abdominal pain and diarrhoea.

The mean number of daily reports and 95 % confidence intervals calculated by the data before and after the conference periods for each category are shown in Table 2. The reported numbers in each category on the G8 conference days were within the upper limit of the 95 % confidence interval and no unusual increases were detected. On the Monday after the conference ended, reported cases of respiratory symptoms seemed to be elevated and we tried to investigate the associations between them. However, we could not detect any outbreaks. We also analysed the association of cases according to the location of the patient's school or office and could not find any accumulation of diseases. We could not detect any outbreaks in Fukuoka (data not shown).

The diagnostic laboratory tests, carried out on selected samples by the sentinels, showed the presence of common pathogens such as enterovirus (echo 9, echo 25 and coxsackievirus A16) and herpes semiflex virus-1 virus from patients with dermatological symptoms.

Table 2. *Mean and 95% confidence intervals of reported cases in each category during the study period, excluding conference days*

Category	Mean	95% CI	Day 1	Day 2
1. Haemo./derma.	5·9	[3·9, 7·9]	3	4
2. Respiratory	70·7	[60·6, 80·8]	71	55
3. Gastroint.	8·8	[6·2, 11·4]	6	5
4. Neurological	1·6	[0·4, 2·7]	0	2
5. Non-specific	3·7	[2·0, 5·3]	5	4
No. outpatients	504·9	[471·4, 538·4]	511	424

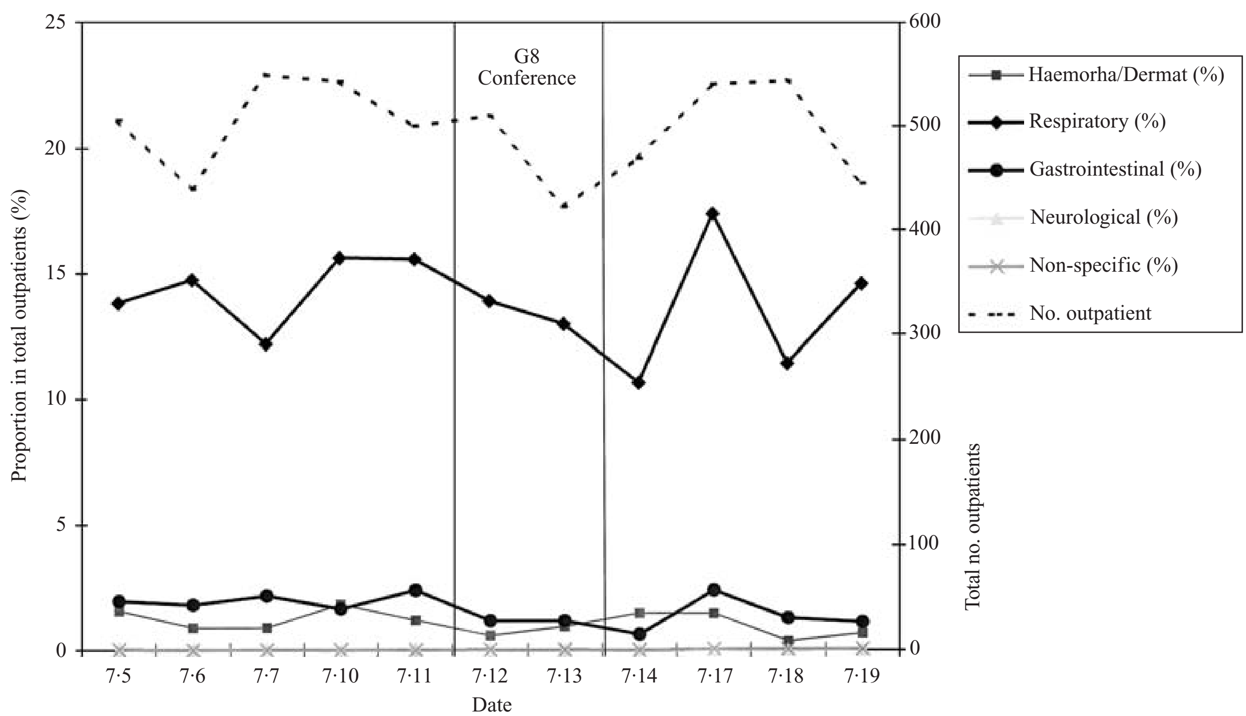

Fig. 2. Results obtained from Miyazaki city during the study period (from 5 July to 19 July 2000). The proportions of reported numbers in each category for the total number of outpatients are shown.

A few enterobacteria, such as salmonella and enteropathic *E. coli* (EPEC), were found in sporadic cases.

DISCUSSION

We evaluated the performance of the surveillance system by comparing it to the pre-existing national epidemiological surveillance of infectious diseases (NESID), based on the criteria below [16].

Simplicity, flexibility and acceptability

The NESID involves several intermediate steps between the first report by the physician and the final analysis of the data. When a physician diagnoses a patient with an infectious disease that is on the national notifiable disease list, this information, along with laboratory confirmation, is reported to the local health centre by telephone or fax. The staff of the local health centre then sends the data in electronic form to the municipal government and the Ministry of Health and Welfare. The data are analysed at the National Institute of Infectious Disease, which then edits a weekly report that is distributed through its website and by post in hard copy form. Multiple forms are used for the system, because national notifiable diseases consist of four disease categories, each requiring reporting of different data sets. Precise information on the patient and the disease, such as the birth date of the patient and the dates of disease onset, first consultation, diagnosis and reporting, are required to be documented in this system. NESID is regulated by national law, and guidelines for reporting are provided by the Ministry of Health and Welfare. The surveillance budget is provided by the government. Although the surveillance system is subject to revision every 5 years, more frequent changes in the system would be advantageous.

On the other hand, our surveillance during the G8 conference was simple in terms of case definition and the reporting procedures. The sentinels just had to complete a simple form and send it by fax to the local health institutes at the end of each day. The data were analysed and further confirmation was sought if the data were not clear. A daily summary report was delivered the following morning. Our system was simple, and the sentinels were experienced and actively interested in contributing to the surveillance, meaning that the system could be adjusted with relative ease. In fact, on the starting day, we asked that name of school or office of patient should be added to the last column and sentinels readily followed our requests.

Data quality/sensitivity/predictive value positive

There is no comparative analysis of NESID and our surveillance system with respect to data quality, sensitivity and predictive value. However, in NESID, most notifiable diseases are diagnosed by laboratory tests, so the reporting cases have high predictive value for positive cases. However, the systems used are complicated and require the input of many data items, so errors in data entry are common (unpublished data of NIID). Our system relies on a symptom-based case-definition so there is no need to thoroughly describe the data. Therefore data entry errors are unlikely to occur. However, predictive value of our surveillance for target diseases likely to result from bio-terrorism is low, especially, when the target disease prevalence is very low.

Timeliness

The greatest strength of the surveillance system used during the G8 conference was its timeliness. In this system, data analyses and communication of the diagnosis were completed within 24 h. In NESID, the mean time from the first consultation to the final report was 6·8 days in malaria cases and 3·9 days for VTEC infections (unpublished data).

Representativeness

In the NESID, the total number of sentinel health facilities was carefully calculated to minimize selection bias. For the NESID as many as 5000 sentinels were chosen on the basis of local population size, and geographical distribution. Our surveillance during G8 conference was less representative, because the number of sentinels was much smaller than the NESID, and sentinels were not chosen by population size.

Conclusions

Infectious disease surveillance using symptom-based reporting has previously been used to detect abnormal incidents during routine surveillance as part of a comprehensive surveillance programme in continuous preparation for bio-terrorism [17]. When we implemented this approach during the high-profile mass gatherings associated with the G8 Conference, we found several problems. One difficulty in applying the symptom-based surveillance system is uncertainty in determining the threshold for reporting an abnormal finding. In mass gatherings, the number of outpatients in nearby clinics naturally increases with the increase in the size of the population. It was estimated more than 6000 people, including members of the media, bureaucrats and guards visited Miyazaki city during the conference. This made it difficult to distinguish between natural increases in clinic visits and an epidemic. Therefore, rapid laboratory diagnosis of diseases that show increased incidence is important. This would mean that the criteria for detecting an outbreak would include results of analysis of clinical specimens, rather than setting up an epidemic threshold based on the number of patients with a particular set of symptoms. When symptom-based case reporting, specimen delivery and reporting of laboratory results are well coordinated, the surveillance system is both sensitive and fast.

Another problem with symptom-based surveillance is in defining the area of surveillance and the number of sentinels required. In fact, our study missed an outbreak of *Vibrio parahaemolyticus* in policemen who ate food from prepared lunch boxes. These policemen went to a physician who was not part of the sentinel surveillance system of our study. If we want to cover the whole area without missing any cases or target diseases, including rare diseases that are more likely to be associated with bioterrorism, such as anthrax, viral haemorrhagic fever and smallpox, all medical practitioners in the area should be involved to increase the sensitivity. However, if all the physicians participated and submitted the specimens from patient with symptoms of these disease, this would overload and epidemiologists and laboratory staff, making them unable to analyse the data and samples promptly and accurately. Narrower case definitions or disease-specific definitions of reporting is preferable in this setting. The introduction of rapid test kits for the detection of pathogenic agents, such as influenza and VTEC, would greatly help in reducing the amount of work for the diagnostic laboratories.

Ideally, routine surveillance should be able to detect an outbreak immediately and with good accuracy. Symptom-based surveillance is one option to that increases the timeliness of diagnoses, allowing for more rapid recognition of outbreaks. In collaboration with sufficient laboratory support, we can apply this type of surveillance effectively in mass gatherings such as the Olympic Games and Football World Cup, as well as other international events.

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