Public Health Surveillance for Mass Gatherings

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Mass gatherings represent specific challenges for public health officials because of the health risks associated with crowd size and duration of stay. In addition, population movement requires public health departments to interact across jurisdictional boundaries to identify risks and disease-management solutions. However, federal privacy laws restrict the sharing of patient data among public health departments in multiple jurisdictions. This article examines previous disease surveillance practices by public health officials in planning for mass events and describes a simple approach for sharing health-risk information that was employed in 2007 during Super Bowl XLI by the health departments of Indiana, Marion County, Cook County, and Miami-Dade County.

INTRODUCTION

Mass gatherings are defined as preplanned public events that are held for a limited time period and attended by more than 25,000 people.[1] The length of stay can be for several hours to several days. The Fourth of July celebration held annually in the nation's Capital draws approximately 500,000 attendees to the city for several hours. The Hajj in Mecca, Saudi Arabia, can attract 2.5 million pilgrims who stay for an average of 40 days. Figure 1 provides three examples of public gatherings based on crowd size and duration of stay.

The Centers for Disease Control and Prevention (CDC) suggests that public health surveillance should be implemented at mass gatherings to facilitate early detection of outbreaks and other health-related events and to enable public health officials to respond in a timely manner.[2]

The health implications surrounding events of this magnitude provide specific challenges for public health officials. There are many factors that can affect the health of each individual at the event, factors such as weather; crowd size, density, age, and mood; event duration and type; whether the event is indoor or outdoor; whether the participants are seated or mobile; and whether there is alcohol or drug use. Some of the health problems

Figure 1. Concentrated crowds created by temporary population movements.

associated with mass gatherings include heat-related illness, drug- or alcohol-related illness, lacerations, trampling, head injury, musculoskeletal injury, asthma exacerbation, viral syndrome, and gastrointestinal illness.[3] Individuals can efficiently transmit communicable diseases to many others, who then return to their homes. Gatherings also provide opportunities for terrorist activities. Explosives detonated at the event have the potential for causing many immediate casualties, and an intentional exposure to a deadly pathogen, especially one that results in a highly contagious infectious disease, has the potential for greater fatalities if not recognized and controlled early. This article examines previous practices of disease surveillance during mass gatherings and describes a practical exercise that was conducted in 2007 during Super Bowl XLI to share surveillance data among health departments in multiple jurisdictions.

HEALTH RISKS

For infectious diseases, there are two primary health risks associated with mass gatherings.[4] The first is the increase in population and population density with the associated increase in number of diseased persons present. Those diseased persons have the opportunity for close interpersonal contact with a greater number of persons than would normally occur. The second health risk is caused by population movement. The visitors' disease is spread to the local population, the visitors are exposed to the local population's diseases, and the visitors carry the disease back to their homes. Returning travelers have the potential to infect those they come in contact with across a wide geographic area. Figure 2 provides a visualization of the potential transmission paths resulting from population movement for mass gatherings.

Secondary aspects of large events concern the need for new services and changes in behaviors, the strain on the infrastructure, and the potential to be a target for terrorism. Temporary facilities are usually created to supplement existing food distribution, which can result in poor hygiene practices. Public health safeguards can be easily neglected in the effort to satisfy the increasing need for services such as water quality and public toilets. For some mass events, there is also the concern over an increase in risky sexual behaviors as well as terrorists using the opportunity to obtain media attention. Table 1 presents a list of variables and their possible causal relationships for mass-gathering medical care. Causes of increases in illness are represented by a plus (+) and causes of decreases in illness are represented by a minus (–) in the outcomes column.[1,5]

As a result of the 1972 massacre of the Israeli Olympic team in Munich, security has been heightened at mass gatherings. The national conventions of the major political parties, Summer and Winter Olympics, the World Cup, and the Super Bowl are just a few of the events receiving additional surveillance. Table 2 shows the surveillance efforts for the six previous Summer/Winter Olympics, Super Bowls, and World Cups. The most recent Super Bowl (2007) is included for comparison.

SURVEILLANCE PRACTICES

Previous surveillance practices considered several important factors such as the amount of effort required for enhanced surveillance during mass gatherings, which data/information is shared, and in which format and to whom the data/information is shared during the event.

Effort

During mass-gathering events, public health agencies should coordinate and ensure adequate disease surveillance across multiple local jurisdictions; adequate surveillance should include notifiable disease surveillance,

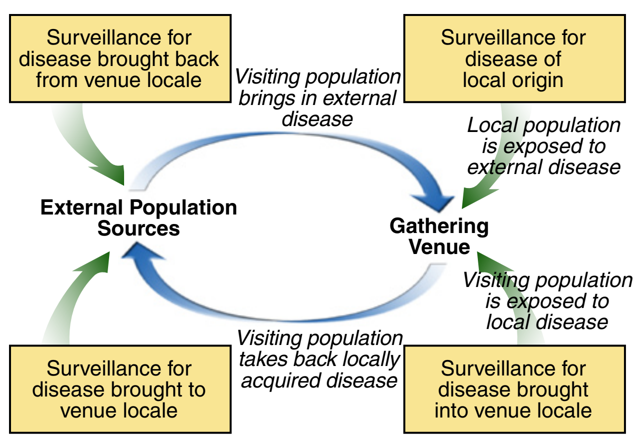

Figure 2. Potential disease-transmission paths due to mass gatherings.

Table 1. Variables and their possible causal relationships to mass gathering medical care.

Variable	Possible causal factors	Outcome (+ or –)*	References
Weather	Heat and cold exposure Lightning Precipitation	+ with heat +/– with cold	3, 6–9, 12, 18, 24, 30, 33, 39–41, 49, 50, 55, 67
Attendance	Dilutional effect Staffing levels Fixed location events, may anticipate attendance by past events or ticket sales Crowd size predictions for one-time events is haphazard	+/– to mild –	3, 46, 64
Duration of event	Extended exposure Incubation periods elapse Increased exhaustion Cumulative morbidity	Mild +	4, 7–9, 12, 14, 15, 30, 34, 39, 40, 49
Outdoor vs. indoor	Exposure to temperature extremes Exposure to sun and geographical objects Crowd mobility	+ for outdoor	3, 7, 8, 12, 40, 49, 50, 55
Seated vs. mobile	Exposure to hazards when mobile Increased crowding when mobile Risky behavior	+ for mobile	7–9, 12–14, 40, 41, 55
Event type	Music: drugs, alcohol, duration, mobility, age Sports: alcohol, hazards of sport	+ for rock concerts + for papal masses – for classical music +/– for sporting events	3, 7, 8, 14, 34, 39, 40, 41, 50, 85
Crowd mood	Music type Revival aspect Team rivalry	+/–	9, 13, 39, 40, 48, 49
Alcohol and drugs	Toxicological effects of polysubstance abuse Misrepresentation of drugs Drug–drug interactions Dose and route—binging at the gate Decreased coordination and judgment Increased violence Direct physiologic effects	+	7, 9, 12, 14, 39, 40, 41, 49, 55
Crowd density	Increased exposure to microbes Effects on mood Decreased access to patients Decreased access to water, family, and bathrooms	+/–	9, 12, 33, 34, 39–41, 49
Locale/physical plant	Barriers to ingress and egress Protection from the elements Exposure to hazards	+/–	4, 6–8, 13, 14, 48, 55
Age	Behavior and judgment Frailty and vulnerability	+/–	8, 24, 30, 55

*+ represents an increase in illness; – indicates a decrease in illness.

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Table 2. Use of enhanced surveillance at selected mass gatherings.*

	Event			
Year	Olympics, Summer	Olympics, Winter	Super Bowl	World Cup
1984	**Los Angeles County, CA**			
1986				Mexico
1988	Seoul, Korea	Calgary, Canada		
1990				Italy
1992	*Barcelona, Spain*	Albertville, France		
1994		Lillehammer, Norway		USA
1996	*Atlanta, GA*			
1998		Nagano, Japan		*France*
2000	*Sydney, Australia*			
2001			**Tampa, FL**	
2002		**Salt Lake City, UT**	New Orleans, LA	**Korea and Japan**
2003			San Diego, CA	
2004	*Athens, Greece*		Houston, TX	
2005			**Jacksonville, FL**	
2006		**Torino, Italy**	Detroit, MI	*Germany*
2007			**Miami, FL**	

Events using enhanced surveillance are shown in *italics*; events using enhanced surveillance including syndromic surveillance are shown in **boldface**.

*As reported in literature found in PubMed, *MMWR Morb. Mortal. Wkly. Rep.*, *Eurosurveillance*, or Google Scholar. Publications were sought on the past six events of each type: Summer Olympics, Winter Olympics, Super Bowl, and World Cup.[4,6–19]

syndromic surveillance, sentinel site surveillance, and injury surveillance. Multijurisdictional disease-trend analysis should also be conducted, and coordinating and ensuring adequate epidemiological event investigation and outbreak response is important.[20] The amount of effort required is based on which surveillance systems are currently in place. The least amount of effort would consist of using disease surveillance systems that are routinely used in the communities hosting the events. Establishing drop-in surveillance systems or new systems could require a much greater effort. Which data, and which forms of data, are shared depends on the level of effort.

Figure 3 presents a comparison of effort for the setup and operation of enhanced disease surveillance for the events described in Table 2. The 2004 Summer Olympics took the greatest amount of effort to set up and operate because all of the reporting was done manually. In comparison, the 2006 World Cup took the least amount of overall effort because the surveillance was accomplished with extensions to an existing automated surveillance system.[5] For future mass events, the cost of enhancing surveillance should be reduced markedly because of the increase in operational automated surveillance systems.

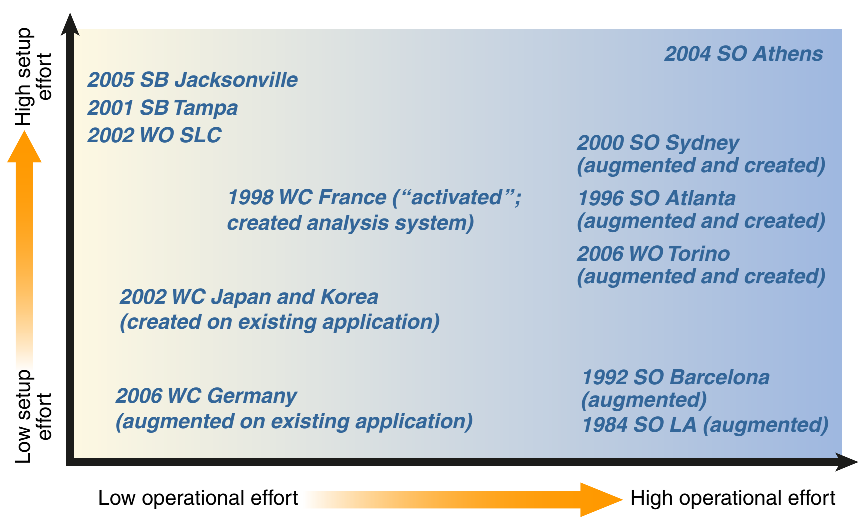

Figure 3. Effort needed to set up and operate enhanced surveillance for selected events. LA, Los Angeles; SB, Super Bowl; SLC, Salt Lake City; SO, Summer Olympics; WC, World Cup; WO, Winter Olympics.

Sharing of Surveillance Products

Data and information are the products generated from automated disease surveillance systems. The term data is defined as the uninterpreted facts or values that are independent of any assigned meaning. Traditionally, health-indicator data include hospital emergency department chief complaint records, nurse call center data, laboratory and radiology orders, pharmacy sales data, and school absenteeism records. Information is defined as interpreted data that describe the past or present situation. Sharing products of the enhanced surveillance effort presents challenges because of existing privacy laws. In the United States, these concerns can fall under The Health Insurance Portability and Accountability Act of 1996 (HIPAA) or mandated disease-reporting requirements at the state level.[21] The data collected may contain the identifiers of the individuals seeking care. Under the HIPAA privacy standards, these identifiers are considered protected health information.[21] Although this information can be collected by local health departments for operational surveillance purposes, public health agencies must adhere to any privacy policies and procedures for their jurisdictions, and they must obey any data-use agreements they have entered into with data providers. Alternative products of an automated surveillance system, such as interpreted data or information, may be shared more easily because they do not involve data elements that are restricted by HIPAA. Figure 4 presents a hierarchy of products collected or generated within disease surveillance systems. The raw data collected from emergency departments or clinics supporting the event are at the base of the pyramid. The second level contains the cleansed data, which includes all of the processing needed to remove variances in reporting such as misspellings, duplicate records, etc. The third level aggregates the data into groupings. Examples of these groupings can be infectious disease syndromes, injuries, chronic diseases, or ages. The remaining three levels of the pyramid refer to data that have been interpreted. Univariate analysis refers to processing of a single data stream, whereas multivariate refers to multiple data streams. At the very top level are interpretations by one or more analysts or epidemiologists after review of selected products in the lower levels.

Raw data and aggregated data counts are structured, whereas information can be free-text outbreak reports and alert interpretations, which are unstructured. Figure 5 shows the form in which the data or information can be shared. Products on the upper half of the pyramid from Fig. 4 are usually void of any information that could be used to identify specific individuals unless these identifiers are specifically added by the epidemiologist performing the surveillance monitoring. As a result, the products from the upper half are more easily shared among jurisdictions and agencies.

Intrajurisdictional and Interjurisdictional Sharing

The people/agencies with whom the data/information are shared depends on venue and population sources. A single-jurisdiction venue (intrajurisdictional) would have single-jurisdiction population sources, whereas multiple-jurisdiction venues (interjurisdictional) could have

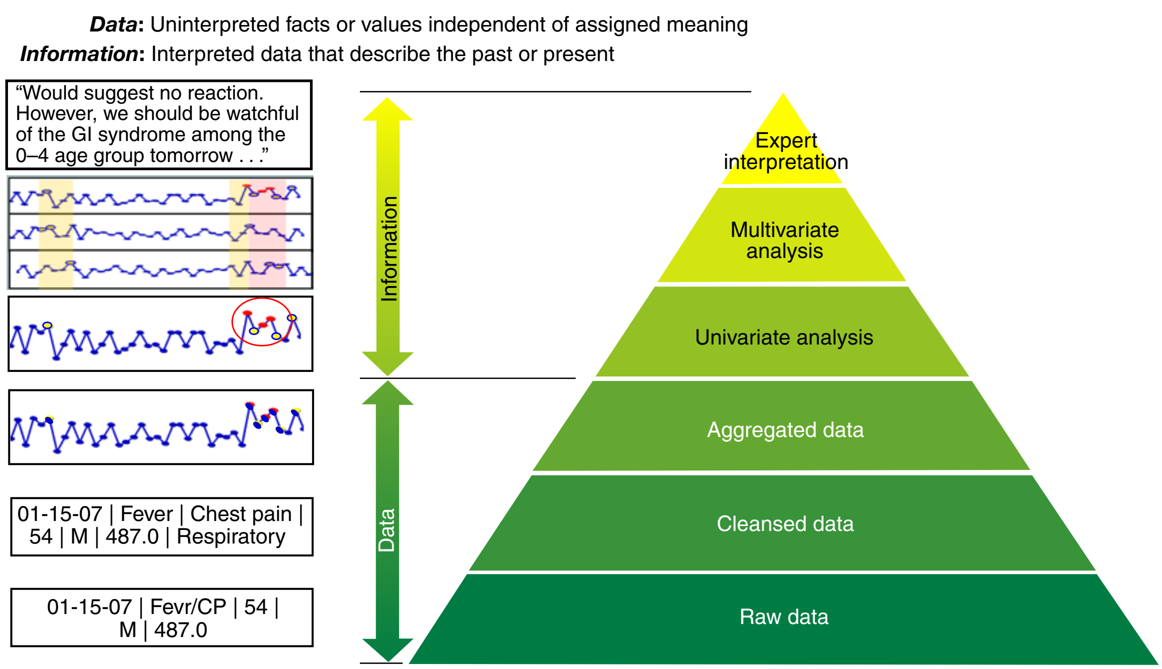

Figure 4. Classes of data and information used in automated disease surveillance systems.

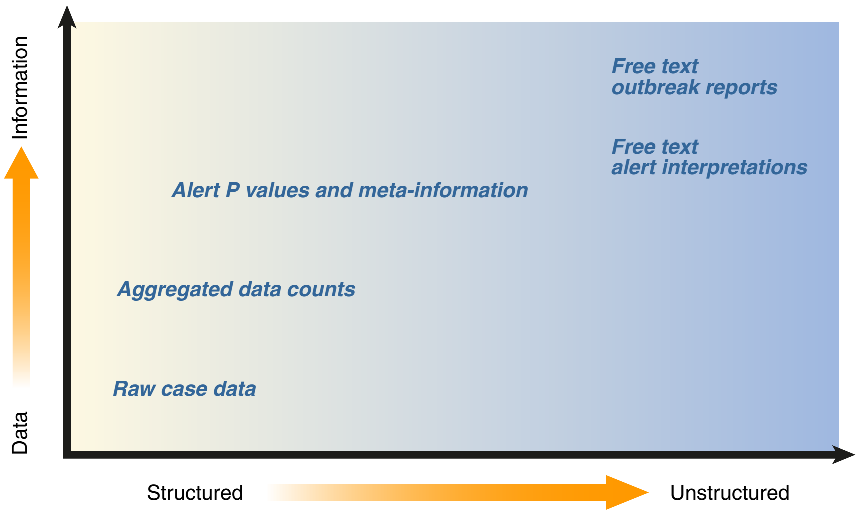

Figure 5. Forms of structured and unstructured data and information shared.

dispersed population sources (e.g., the Summer Olympics) or focused sources (e.g., National Mall Fourth of July).

As an example, for the 1984 Summer Olympics in Los Angeles County, the following disease surveillance practices were implemented. The setup required little effort with the modification of the existing reportable disease system. The operational effort involved the collection of data via phone calls, three times a week, by public health officials from the county health departments at each event venue. The events were held in Los Angeles County and the four surrounding counties. This effort involved an interjurisdictional sharing of structured data. Case counts for four syndromes by age groupings and notifiable diseases were shared among the counties where the events were being held.

ENHANCED SURVEILLANCE AND SUPER BOWL XLI

Since the 1980s, enhanced surveillance practices at sporting events with more than 25,000 attendees have been planned by considering the four factors discussed above: how much effort, what is shared, with whom, and in what form. Setup and operation of the disease surveillance system could require minimal effort or take years of planning to implement. For the events discussed in this article, many health departments in the event locale augmented existing reportable disease or surveillance systems by increasing the frequency of reporting or including additional diseases more susceptible to poor hygiene practices. The significance of Super Bowl XLI in 2007 was that this was the first time that health departments in all three Super Bowl-related regions already practiced daily disease surveillance by using different instances of the same biosurveillance information system. Use of the same system permitted surveillance to be performed at the home location of the people as well as at the event locale.[22]

2007 Super Bowl

Super Bowl XLI was played in Dolphin Stadium located in Miami, Florida, on 4 February 2007. The Indianapolis Colts played the Chicago Bears. For a full week before the game, fans participated in pregame events in the Miami area. Many more fans than just the number of game-day ticketholders traveled to the Miami area to participate in these events.[23] The Cook County Department of Public Health, from the home of the Chicago Bears, the Marion County Health Department, from the home of the Indianapolis Colts, and the Miami-Dade County Health Department, from the location of the Super Bowl game, all have versions of the Electronic Surveillance System for the Early Notification of Community-based Epidemics (ESSENCE), an automated disease surveillance system. This system was developed by APL in conjunction with several Department of Defense and civilian public health organizations. The APL ESSENCE team realized that Super Bowl XLI provided an opportunity to explore ways in which separate surveillance systems could be coordinated for effective, short-term, multijurisdictional surveillance.[20] The Miami-Dade and Cook County health departments normally produce routine daily summary reports of their surveillance activities, making it possible to share these reports among the three public health departments to enhance surveillance for the Super Bowl. The APL ESSENCE team consulted with the regional public health departments to determine their interest in sharing surveillance data surrounding Super Bowl activities. Cook County Department of Public Health, Marion County Health Department, the Indiana State Department of Health, and the Miami-Dade County Health Department all agreed to participate. One week before the Super Bowl, each public health department was consulted by the APL ESSENCE team to determine the additional surveillance activities that were required for the event. The setup and operational efforts to augment existing biosurveillance systems/practices for the Super Bowl period were minimal and were completed in 24 hours. The modifications involved event-specific visualization and information sharing. To better identify Super Bowl fans from Illinois and Indiana residents seeking care in the Miami area, the ZIP code groupings from those areas were added to the Miami version of ESSENCE. Another addition was a pick list that enabled Miami surveillance monitors reviewing emergency department records in Miami to separately group, view, and analyze persons coming from the homes of the Super Bowl teams. Emergency department records were not shared, so no additional rerouting of data was needed. The Miami health department agreed to share its daily surveillance summary report with the other three health departments. Cook County Department of Public Health agreed to share its daily reports with the other health departments if any unusual disease activity was observed. The Marion County and Indiana health departments agreed to include the other health departments in their standard notification process if unusual disease activities were observed. The process is presented in Fig. 6.

Results

Super Bowl surveillance activities began 4 days before the event and extended through 14 days after it was over. Although there were no unusual disease activities observed in the three regions during the surveillance period, each health department participated as agreed, and records of the information that was shared were kept. This exercise showed that it was possible to leverage off existing biosurveillance systems and practices to support surveillance for mass gatherings. With very short notice, it was possible to arrange interjurisdictional information sharing among four public health departments. No formal data-sharing agreements were needed and, aside from introducing new ZIP code groupings, no technical work was required. Because the disease surveillance systems were fully operational in all three regions, the only requirement was the willingness of each health department to participate. If an unusual disease activity had been observed, the procedures established in each of the jurisdictions by the local health departments working with the local authorities would have been implemented.

CONCLUSION

Mass gatherings represent many challenges for public health officials. One of the biggest challenges is the movement of infected persons across jurisdictional boundaries to propagate disease. Federal privacy laws in the past have limited the exchange of data among jurisdictions performing disease surveillance. One solution that was considered was processing results that do not contain information on individuals. An enabling factor for this solution is that the processes should be the same among the health departments sharing the data/information. Installation of the JHU/APL ESSENCE system among the three jurisdictions participating in the Super Bowl XLI surveillance provided a de facto standard by which to share surveillance information in an efficient manner and with minimal preplanning and cost.

Figure 6. Process for exchange of data by health departments for the 2007 Super Bowl.

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