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In Aug. 2008, the 29th Olympic Games were held in Beijing, China. It had been the largest international sporting spectacle in China to date. More than 10,500 athletes, 40,000 media workers, 80,000 volunteers, and over one million tourists from 204 countries came to Beijing for this sporting event. The 29th Olympic Games were held during the summer, the peak time for intestinal disease outbreaks. Previous surveillance data showed that incidences of dysentery and infectious diarrhea ranked top among national notifiable infectious disease in the month of Aug. This sporting spectacle created more opportunities for spectators to have dinner together, increasing the risk of food-borne diseases, water-borne diseases, and food poisoning.

Due to the rapid increase in population density, the risk of outbreak or the dissemination of respiratory infectious diseases (such as measles, meningococcal meningitis, Legionellosis, etc.) should never be neglected. Summer is also the peak period for heightened vector activities such as those of rats, mosquitoes, flies, cockroaches, etc. This provided the necessary basis for the transmission of infectious diseases via vector which facilitated their transmission. In addition, the risks of transmission and dissemination of infectious diseases were also increased by the frequent travel of people across different provinces or countries.

Meanwhile, the probability of importation of an infectious disease continued to grow, such as dengue fever, Ebola hemorrhagic fever, yellow fever, etc. Therefore, the international mass gathering posed unprecedented challenges for maintaining public health security. For a huge city with 16.33 million regular residents, the prevention and control of infectious diseases was the single greatest challenge to the work of public health for Beijing Olympic Games.
The goal for health protection during the 29th Beijing Olympic Games in 2008 was to ensure that there would be no major outbreaks, epidemics, or transmission of communicable diseases in Beijing. Sporadic and newly imported cases of infectious diseases could be under timely control in order to prevent secondary infection. The Olympic Games were held successfully and meanwhile it was also intended that the capacity and management level of the host cities and venues in prevention, control and management of infectious diseases be comprehensively upgraded (Jin et al., 2010).

For the goal of the Games, based upon a suite of different traditional infectious disease surveillance, Beijing introduced a new syndromic surveillance system to establish an integrated surveillance system: Beijing Olympic Games Infectious Disease Surveillance System (BOG-IDSS). From Aug. 8 to 24, 2008, as required by the security of the public health during the Olympic Games, Beijing implemented the surveillance and monitoring work of infectious diseases with BOG-IDSS. The system carried out timely early warning analysis on the data collected, identified aberrations and controlled the risk of the outbreak or epidemic at the lowest level, effectively ensuring the safety of the public health during Beijing Olympic Games.

8.1 OBJECTIVES OF BOG-IDSS

BOG-IDSS was designed to meet the need for infectious disease surveillance during mass gatherings. The objectives of the system included: systematically and continuously collecting in real-time; analyzing data in a timely manner; estimating the location, size, trend and hazard of potential outbreaks or epidemics; detecting aberrations as early as possible; generating early warning prior to real infectious disease outbreaks or epidemics; ensuring timely and effective control of sporadic cases and imported infectious disease cases; ensuring no major outbreaks or epidemics during the Games; and ensuring the success of the 29th Beijing Olympic Games.

8.2 FRAMEWORK OF BOG-IDSS

In general, BOG-IDSS consists of two major components: disease surveillance targeted at notifiable infectious diseases as defined by the State, and syndromic surveillance targeting health-related symptoms. Specifically, four subsystems for infectious disease surveillance were integrated in BOG-IDSS, including three routine surveillance and one newly established system: the Syndromic Surveillance System for Beijing Olympic Games (SSSBOG). See Table 8.1 for the components of BOG-IDSS.

Based on various subsystems for infectious disease surveillance, the collection, transmission, summarization, analysis, and integration of multisource data could be achieved by BOG-IDSS, which facilitated the early detection of aberrations related to infectious diseases, enabling the timely containment of outbreaks or epidemics. The basic elements of the system included: determination of subjects...
of surveillance, collection of data, early warning analysis, identification of aberrations, verification of diagnosis, generation of early warning signals, early warning response, and early warning effectiveness evaluation, etc. See Fig. 8.1 for the overarching framework of BOG-IDSS.

8.3 DETERMINING THE SUBJECTS OF SURVEILLANCE

Risks of infectious disease outbreaks or epidemics during the Olympic Games were identified and evaluated by ways of empirical judgment, Delphi expert consultation, expert review and risk analysis matrix, with reference to management science, sociology and epidemiology theories. The likelihood, severity and hazards of each risk were assessed from four perspectives: biological factors (sources of infection, transmission routes, and susceptible populations), behavioral factors (psychological factors, and culture), environmental factors (natural environment and ecological environment), social factors (laws and regulations, standards and codes, capacity of service delivery, strategies and actions for prevention and control, and management capacity, etc.). The adverse outcome of risks was evaluated with integrated consideration on the disease transmission capacity, the ability of diagnosis and control, the attention from the public and socio economic impact. Finally, the target of surveillance for BOG-IDSS was determined, which included two main categories: cases of infectious diseases and cases with related symptoms.

According to epidemic reports on major infectious diseases in Beijing and across the world, data on public health events in previous mass gatherings, the level of current public health response and the feature of it being summer time during the Olympic Games, a total of 22 infectious diseases were finally selected as the surveillance subjects (Table 8.2). Among them, 19 diseases were notifiable infectious diseases defined by the State laws, and three other ones had never been reported yet in China but might have the risk of importation from other counties (including West Nile fever, Ebola hemorrhagic fever, and yellow fever) (Jin et al., 2010).

Based on the result of risk assessment of the above 22 infectious diseases and their typical symptoms (Table 8.3), patients with fever, diarrhea, jaundice, rash, or conjunctivitis were finally determined as subjects of SSSBOG.
8.4 DATA COLLECTION

The data source of BOD-IDSS mainly included CIDARS, SSSBOG, Early Warning Surveillance System for Influenza of Beijing and Early Warning Surveillance System in Intestinal Outpatients of Beijing. See Table 8.4 for the types and data sources of surveillance subjects of BOG-IDSS.
| No. | Disease                                         | Risk level                                                                 | Likelihood               | Consequences | Risk rating |
|-----|------------------------------------------------|---------------------------------------------------------------------------|--------------------------|--------------|-------------|
| 1   | Cholera                                        | Level 4 (high)                                                            | B (likely to occur frequently) | E (extreme)  |             |
| 2   | Plague                                         | Level 4 (high)                                                            | C (possible and likely to occur at some time) | E (extreme)  |             |
| 3   | Human infection of avian influenza A (H5N1)    | Level 4 (high)                                                            | D (may occur but only in rare and exceptional circumstances) | H (high)     |             |
| 4   | Anthrax                                        | Level 4 (high)                                                            | D (may occur but only in rare and exceptional circumstances) | H (high)     |             |
| 5   | Ebola hemorrhagic fever                        | Level 4 (high)                                                            | D (may occur but only in rare and exceptional circumstances) | H (high)     |             |
| 6   | Severe acute respiratory syndromes (SARS)      | Level 4 (high)                                                            | D (may occur but only in rare and exceptional circumstances) | H (high)     |             |
| 7   | Bacillary dysentery                            | Level 3 (moderate)                                                       | B (likely to occur frequently) | H (high)     |             |
| 8   | Acute hemorrhagic conjunctivitis               | Level 3 (moderate)                                                       | B (likely to occur frequently) | H (high)     |             |
| 9   | Sexual transmitted diseases                    | Level 3 (moderate)                                                       | B (likely to occur frequently) | H (high)     |             |
| 10  | Hepatitis A                                    | Level 3 (moderate)                                                       | C (possible and likely to occur at some time) | H (high)     |             |
| 11  | AIDS                                           | Level 3 (moderate)                                                       | C (possible and likely to occur at some time) | H (high)     |             |
| 12  | Influenza                                      | Level 3 (moderate)                                                       | C (possible and likely to occur at some time) | H (high)     |             |
| 13  | Legionellosis                                  | Level 3 (moderate)                                                       | C (possible and likely to occur at some time) | H (high)     |             |
| 14  | Epidemic hemorrhagic fever                     | Level 3 (moderate)                                                       | C (possible and likely to occur at some time) | H (high)     |             |
| 15  | Measles                                        | Level 3 (moderate)                                                       | C (possible and likely to occur at some time) | H (high)     |             |
| 16  | Meningococcal meningitis                       | Level 3 (moderate)                                                       | C (possible and likely to occur at some time) | H (high)     |             |
| 17  | West Nile fever                                | Level 3 (moderate)                                                       | D (may occur but only in rare and exceptional circumstances) | M (moderate) |             |
| 18  | Poliomyelitis                                  | Level 3 (moderate)                                                       | D (may occur but only in rare and exceptional circumstances) | M (moderate) |             |
### Table 8.2 Results of Risk Assessment for Infectious Diseases During the 29th Olympic Games in Beijing—cont’d

| No. | Disease       | Risk level | Likelihood                  | Consequences       | Risk rating |
|-----|---------------|------------|-----------------------------|--------------------|-------------|
| 19  | Rabies        |            | D (may occur but only in rare and exceptional circumstances) | Level 3 (moderate) | M (moderate) |
| 20a | Yellow fever  |            | D (may occur but only in rare and exceptional circumstances) | Level 3 (moderate) | M (moderate) |
| 21  | Dengue fever  |            | D (may occur but only in rare and exceptional circumstances) | Level 3 (moderate) | M (moderate) |
| 22  | Brucellosis   |            | D (may occur but only in rare and exceptional circumstances) | Level 2 (low)      | L (low)     |

*Note: No cases of those diseases were reported in China before Beijing Olympic Games. However, these diseases have the potential risk of importation from other countries into China.*

### Table 8.3 Targeted Diseases and Their Primary Syndromes

| No. | Syndrome     | Targeted disease                                                                 |
|-----|--------------|----------------------------------------------------------------------------------|
| 1   | Fever        | Plague, human infection with highly pathogenic avian influenza, anthrax, SARS, acute hemorrhagic conjunctivitis, AIDS, influenza, legionellosis, epidemic hemorrhagic fever, measles, meningococcal meningitis, West Nile fever, poliomyelitis, yellow fever, dengue fever, brucellosis |
| 2   | Diarrheal    | Cholera, bacillary dysentery, hepatitis A, Ebola hemorrhagic fever                 |
| 3   | Rash         | Measles, dengue fever, AIDS, sexual transmitted diseases (gonorrhea, syphilis, genital herpes, chlamydia infection) |
| 4   | Conjunctival redness | Plague, acute hemorrhagic conjunctivitis                                       |
| 5   | Jaundice     | Hepatitis A, yellow fever                                                        |

### Table 8.4 Types of the Subjects of BOG-IDSS and Their Data Sources

| Types     | Subjects                                                                 | Data source                                                                 |
|-----------|--------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| Diseases  | Cases of 19 national notifiable diseases                                 | CIDARS                                                                      |
|           | Cases of three infectious diseases which have the potential importation risk from other countries |                                                                             |
| Syndromes | Cases who have one of five defined syndromes                             | SSSBOG                                                                      |
|           | Influenza-like illness cases                                             | Early Warning Surveillance System for Influenza of Beijing                   |
|           | Diarrheal cases                                                         | Early Warning Surveillance System in Intestinal Outpatients of Beijing       |
8.4.1 CIDARS

Targeting notifiable report infectious diseases, CIDARS was established in 2006, and in Apr. 2008 the pilot work of CIDARS was launched in Beijing. The system could simultaneously implement the functions of data processing and analysis, generating and releasing early warning signals, give feedback of response to signals, signal inquiry and sharing, etc. See Chapter 7 for details.

8.4.2 SSSBOG

SSSBOG was mainly targeting five symptoms: fever, diarrhea, jaundice, rash and conjunctivitis. It was a computer-aided electronic surveillance system specifically designed and developed by Beijing CDC for Beijing Olympic Games. This surveillance system was designed to facilitate the early detection and screening of suspected clusters of infectious diseases. It aimed at the early/rapid containment and prevention of the spread of epidemics by conducting surveillance on cases who exhibited/presented with the syndromes of fever, diarrhea, jaundice, rash, or conjunctivitis. The system included stadium-based surveillance and sentinel hospital-based surveillance (city-level surveillance of cases with suspected cluster).

STADIUM-BASED SURVEILLANCE

From Jul. 20 to Aug. 24, 2008, doctors working in the 157 medical stations within Olympic venues were required to complete infectious disease syndromic surveillance cards once they identified one case presenting with fever, diarrhea, jaundice, rash, or conjunctivitis among various staff for Olympic Games (i.e., athletes, coaches, media workers, stadium staff, and volunteers), and immediately were required to report to the public health security team inside of the venues. The public health security team would then report online through SSSBOG, and conduct an epidemiological investigation; meanwhile, they would take prevention and control measures within a certain range to avoid the spread of infectious disease in Olympic stadiums and guarantee the smooth progress of the Olympic Games.

SENTINEL HOSPITAL-BASED SURVEILLANCE (CITY-LEVEL SURVEILLANCE OF SUSPECTED CLUSTERS)

China health institutions are classified into three levels according to scale, functions, infrastructure, professional level, health service quality, and scientific management capacity and class III is the highest. From Aug. 1 to 24, 2008, 125 Class II and Class III hospitals in Beijing were designated as sentinel hospitals. Once doctors at outpatient and emergency departments in the sentinel hospitals identified any patient with the symptom of fever, diarrhea, jaundice, rash, or conjunctivitis, they were required to ask about whether patients’ close contacts in the past 3 days had similar symptoms.

Experts specializing in clinical medicine, epidemiology, biology and other areas determined the early warning thresholds for the surveillance of the five symptoms based on several factors, including the clinical characteristics of the
diseases, the rate of transmission, level of diagnosis and control and others. These thresholds were: three or more persons with fever; three or more persons with diarrhea; two or more persons with jaundice; two or more persons with rash; three or more persons with conjunctivitis. If the number of cases (including the attendees and their close contacts) surpassed the threshold, the attending physicians must complete the infectious disease syndromic surveillance cards (Fig. 8.2), and report via Internet within 4 h through the computer-aided SSSBOG (see Fig. 8.3).

Record card for SSSBOG in sentinel hospitals during Olympic game

1. Name: __________
2. Gender: Male or Female
3. Age: ___________ Years of Age
4. Workplace: __________________________________________________________
5. Residence Address: ____________________________________________
6. Telephone No.: _______________
7. Mobile Phone No.: _______________
8. Close Contact:
   Fever Cases 3 and Above Yes or No
   Diarrheal Cases 3 and Above Yes or No
   Jaundice Cases 2 and Above Yes or No
   Rash Cases 2 and Above Yes or No
   Conjunctival Redness Cases 3 and Above Yes or No
9. Onset Time: _____ yy _____ mm _____ dd
10. Reporter: _____
11. Report Date: _____ yy _____ mm _____ dd
12. Report Agency: ______________

FIG. 8.2
Record card for SSSBOG in the whole city during Olympic Games.

Syndromic Surveillance System for Beijing Olympic Games

FIG. 8.3
User interface to input information in SSSBOG.
The designated staff working in county/district CDCs in Beijing browsed through the report system real-time on a daily basis, and would conduct epidemiological investigation immediately to verify each of the reported suspected clusters, and upload epidemiological investigation report through network to the surveillance system. If the suspected cluster was confirmed, the close contacts of the index case would be traced and managed and appropriate actions would be taken to control the further spread of the cluster.

### 8.4.3 Early Warning Surveillance System for Influenza of Beijing

Early Warning Surveillance System for Influenza of Beijing mainly included surveillance on influenza-like illness (ILI) and influenza virological cases. ILI case surveillance provided real-time integration and statistics of the reports and data, analyzing the distribution and epidemiological patterns of ILI cases; while influenza virological surveillance served to understand and grasp the dominant strains of influenza virus and the intensity of their activities through laboratory testing. During the Olympic Games, the system was strengthened and expanded in the scope of surveillance.

#### ILI CASE SURVEILLANCE

In 2007, ILI case surveillance was expanded from five national-level surveillance sentinel hospitals to 125 sentinel hospitals. With reference to the WHO's case definition, an ILI case in Beijing was defined as a patient developing fever (axillary temperature $\geq 38^\circ C$) with cough or sore throat. The surveillance sites involved fever clinics, respiratory departments, pediatrics department and emergency departments across Beijing. Each of them were required to collect and upload the number of ILI cases, outpatients/emergency care visits by department and age group (0–4, 5–14, 15–24, 25–59, and 60 or more years) the day before into Early Warning Surveillance System for Influenza of Beijing by 12:00 a.m. The district/county CDCs were responsible for data review and medical workers would conduct a statistical summary on the data gathered and analyzed the distribution and trend of those reported ILI cases (Yang et al., 2009).

#### INFLUENZA VIROLOGICAL SURVEILLANCE

Based on the ILI case surveillance, Beijing established an influenza pathogen surveillance network consisting of sentinel hospitals and infectious disease network laboratories. During the Beijing Olympic Games, a total of 11 sentinel hospitals and 7 network laboratories participated in influenza virological surveillance. The healthcare workers at the surveillance departments of sentinel hospitals collected throat swab specimens from ILI cases and completed the “Beijing Influenza Surveillance Sampling Information Form” which contained basic information of the cases, their contact information, symptoms, whether or not they used vaccine and antiviral drugs, etc. The form and the collected specimens were then delivered to the predefined influenza surveillance network laboratories for influenza virus isolation and identification. The subjects for sample collection were ILI
cases who presented with symptoms in the last 3 days and never took antiviral
drugs. Each sentinel hospital was required to collect at least 20 specimens weekly,
avoiding cluster sampling. Specimens collected were delivered to influenza viro-
logical surveillance network laboratories within 24 h for testing. Each network
laboratory was required to report the test results of the specimens to the Beijing
CDC by 12:00 a.m. of each Friday. The test results offered information about the
prevalent strains of influenza virus and the intensity of their activities. This served
as the golden standard to for the verification and evaluation of the overall effec-
tiveness of influenza early warning through ILI case surveillance.

8.4.4 Early Warning Surveillance System in Intestinal
Outpatients of Beijing

Early Warning Surveillance System in Intestinal Outpatients of Beijing was estab-
lished in Beijing for the purpose of facilitating the timely identification of enteric
infectious disease cases, such as cholera, dysentery, and other infectious diarrhea.
Its overall aim was to play a role in early outbreak detection, reporting, diagnosis,
isoaltion, and treatment of diarrhea cases. The system began at a probationary or
trial stage in 2006 and was officially launched throughout the city in Apr. 2008.
According to the regulations of Beijing with regard to the prevention and control
of enteric infectious diseases, all diarrhea cases presenting in hospitals must
undergo triage to understand the specific enteric disease clinics they needed to
be referred to, and be included as the targets for surveillance in the Early Warning
Surveillance System in Intestinal Outpatients of Beijing. Diarrhea cases were
defined as three or more stools per day. The surveillance sites were situated in
the 335 enteric disease clinics in hospitals at different levels across Beijing.
The enteric disease clinics open on Apr. 1 of each year, providing 24-h service.
Except for a few enteric disease clinics operating in winter, other enteric disease
clinics close on Oct. 31. From Nov. to the following Mar. (low-epidemic period
of enteric infectious diseases), only one or two enteric disease clinics continue
working in each district/county. The health care workers at the enteric disease
clinics are asked to record the information about each diarrhea case, covering
the general demographics, clinical symptoms, laboratory tests, diagnosis and
treatment, and reported via network through Early Warning Surveillance System
in Intestinal Outpatients of Beijing. The district/county CDCs are responsible for
the review of the input information every day to ensure the accuracy and com-
pleteness of information input. In order to detect suspected cholera cases, attend-
ing doctors were required to collect stool specimens from each diarrhea case for
routine stool examination, vibrio cholera-suspension tests, stool vibrio cholera
culture, and other tests. If the cases were determined as cases requiring medical
observation for cholera (suspected cases or confirmed cases), field investigation
and management would be conducted according to the management protocol
for cholera cases. In Early Warning Surveillance System in Intestinal Outpatients
of Beijing, a CUSUM algorithm was applied to conducting temporal and geo-
ographical analysis. And the system would generate early warning signals in
real-time for clustering diarrhea cases or suspected outbreak that are correlated
by time or region.
8.5 EARLY WARNING ANALYSIS AND VERIFICATION

During the Beijing Olympic Games, different early warning analysis methods were applied, depending on the characteristics of surveillance data from the various subsystems of BOG-IDSS and the requirements for infection prevention and control. Since the surveillance data collected by SSSBOG (a subsystem of BOG-IDSS) represented events of suspected epidemiological clusters, rather than information about single cases, an absolute value method was applied for early warning. For the early warning thresholds, see Table 8.5, the 157 medical stations inside of the Olympic venues required attending physicians to send early warning signals once they identified one case with fever, diarrhea, jaundice, rash, or conjunctivitis among any Olympic Games related staff members and to immediately report to the public health security team within the stadiums. The public health security team would then conduct an initial epidemiological investigation to trace contacts and verify the diagnosis. Outside the Olympic stadiums, whenever outpatient/emergency care physicians at the 125 sentinel hospitals in Beijing detected any patients or close contacts fitting the case definition (i.e., three or more persons with fever; three or more persons with diarrhea; two or more persons with jaundice; two or more persons with rash; three or more persons with conjunctivitis), they were asked to report this online, prompting the local CDCs to conduct an epidemiological investigation and confirm the existence of the cluster.

Early warning methods which require long-term historical baseline data (e.g., Serfling seasonal regressive models, ARIMA models, etc.) are not applicable for subsystems of BOG-IDSS, as these subsystems have a short-term historical baseline data. Finally, the CUSUM model, which does not require long-term historical data, was used for early warning analysis. Different methods of early warning were used in different subsets of BOG-IDSS. See Table 8.6 for details.

### Table 8.5 Thresholds of SSSBOG During the Beijing Olympic Games

| Syndromes            | Olympic stadium (case) | City (case/3 days) |
|----------------------|------------------------|--------------------|
| Fever                | 1                      | 3                  |
| Diarrheal            | 1                      | 3                  |
| Rash                 | 1                      | 2                  |
| Conjunctival redness | 1                      | 3                  |
| Jaundice             | 1                      | 2                  |

*Study subjects include athletes, coaches, media workers, volunteers, and staff working in stadiums.*

### Table 8.6 Early Warning Algorithms of Each Subset of BOG-IDSS

| Algorithms      | Subset of surveillance system                                           |
|-----------------|-------------------------------------------------------------------------|
| Absolute value  | SSSBOG                                                                  |
| CUSUM           | CIDARS; Early Warning Surveillance System for Influenza of Beijing; Early Warning Surveillance System in Intestinal Outpatients of Beijing |
Once a suspected aberration was identified by CUSUM, the signal would then be verified in a timely manner and confirmed by staff working in district CDCs. The verification would cover the accuracy of personal information of the cases, date of the onset of illness, contact information, the number of cases with suspected correlations, and other information; inquiry about any change to the methods and standards for clinical and laboratory diagnosis; investigation into any clustered reports by health facilities. After excluding the above conditions that may lead to an abnormal rise in the number of cases, early warning signals would then be triggered and an epidemiological investigation conducted immediately to further verify any epidemiological associations among the cases. If the initial field investigation is unable to exclude the possibility of any epidemiological associations (history of joint exposure), corresponding public health actions would be then taken in a timely manner to contain any potential further spread of the epidemic.

8.6 SYSTEM OPERATION RESULTS
8.6.1 Early Warning Analysis in CIDARS
During the Beijing Olympic Games, CIDARS detected one signal. However, after subsequent epidemiological investigation, the cluster was excluded.

8.6.2 Early Warning Analysis in SSSBOG
During the Olympic Games, surveillance in Olympic venues covered a total of 244,000 people, including 8000 registered athletes and coaches, 21,000 media workers, 5000 Olympic Games officers, and 210,000 registered volunteers who directly participated in service provision during the Games. At the clinics inside of the Olympic venues, no cases with jaundice symptoms were found. As for the other four symptoms included in the syndromic surveillance see Table 8.7, total of 515 Olympic Games related staff members with four targeted symptoms were reported, with an incidence of 211.93/100,000; among them, volunteers took the largest part, accounting for 71.07% (366/515), followed by media workers, accounting for 20.19% (104/515); and then officers, athletes and coaches. The incidence of the four symptoms among media workers was the highest (495.24/100,000), significantly higher than other populations. The difference showed a statistical significance \((P<0.01)\). According to the confirmatory

| Table 8.7 | Distribution of Five Syndromes During the Olympic Games |
|-----------|--------------------------------------------------------|
| Syndromes | Cases  | Proportion (%) | Incidence (1/100,000) | Male/female |
|-----------|--------|----------------|-----------------------|-------------|
| Diarrheal | 257    | 49.90          | 105.76                | 1.38:1(149/108) |
| Fever     | 176    | 34.17          | 72.43                 | 1.63:1(109/67)  |
| Rash      | 29     | 5.63           | 11.93                 | 0.53:1(10/19)  |
| Conjunctival redness | 53  | 10.30          | 21.81                 | 1.41:1(31/22)  |
| Total     | 515    | 100.00         | 211.93                | 1.38:1(299/216) |
diagnosis of health care workers, 10 Olympic Games related staff members were identified as infectious disease cases, including two varicella cases, four malaria cases, one bacillary dysentery case, one dengue fever case, and one melioidosis case (Li et al., 2010).

From Aug. 8 to 24, through the syndromic surveillance system, 83 events of suspected association were reported by 125 sentinel hospitals throughout Beijing, involving 377 people, averaging 4.5 (1–45). See Fig. 8.4; of these events, 11 were fever (42 cases), 64 were diarrhea (316 cases), 5 rashes (11 cases), and 3 conjunctiva redness (8 cases). Of the 83 events, 67 were confirmed with clear association by epidemiological investigations and the others were confirmed sporadic events.

The 67 events of association were mainly of diarrhea caused by contaminated food—49 clusters, 276 cases involved. Other clusters were also finally identified, including a scabies cluster (2 cases), 1 varicella cluster (2 cases), 1 measles cluster (2 cases), 2 hand, foot, and mouth disease clusters (6 cases), 2 acute hemorrhagic conjunctivitis clusters (7 cases), 8 upper acute respiratory infection clusters (38 cases), 2 bacillary dysentery clusters (6 cases), and 6 other noninfectious disease clusters (21 cases).

8.6.3 Early Warning Analysis in Early Warning Surveillance System for Influenza of Beijing

Before the Beijing Olympic Games, CUSUM algorithm was used to identify the onset of influenza season. CUSUM triggered continuous signals at the 48th week of 2007. This week was then considered as the onset of 2007–2008 seasonal influenza circulation by CUSUM algorithm (Yang et al., 2009), 1 week earlier than the gold standard (the 49th week). See Fig. 8.5. CUSUM algorithm was proved suitable for early warning of influenza.

During the Olympic Games, a total of 17,563 ILI cases were reported, and the total number of visits reached 845,218, of which 2.08% were ILI cases. A total of 8029 ILI cases were under the age of 5, accounting for the largest part
(45.72%), followed by age group of 5–14 years (29.02%); however 615 ILI cases aged 60 years and above, accounted for the smallest part (3.50%). See Fig. 8.6 for details. Using the CUSUM model, real-time early warning analysis had been conducted in Early Warning Surveillance System for Influenza of Beijing since Aug. 1, 2008, and no early warning signal was generated at Olympic Games-time.

### 8.6.4 Early Warning Analysis in Early Warning Surveillance System in Intestinal Outpatients of Beijing

From Aug. 8 to 24, a total of 15,491 diarrhea cases were reported all around Beijing; among which 24.32% were diagnosed as “other infectious diarrhea,” followed by dyspepsia (11.89%), bacterial dysentery cases (10.96%). No typhoid
fever and cholera cases were reported (Fig. 8.7). By using CUSUM model, real-time early warning analysis had been conducted in Early Warning Surveillance System in Intestinal Outpatients of Beijing since Aug. 1, 2008, and four aberration signals were generated (Figs. 8.8 and 8.9), mainly during the period of Aug. 8–10. After verification diagnosis, all the suspected diarrhea clusters were finally excluded.

8.7 SYSTEM EFFECTIVENESS EVALUATION

No major outbreak or epidemic spread of infectious disease occurred during the Beijing 2008 Olympic Games. Sporadic or newly imported infectious disease
cases were under timely control and no secondary cases occurred. The goal for infectious disease control and security during the Olympic Games as proposed in the 2008 Urban Operation Guidelines for Beijing Olympic Games was achieved.

To ensure public health security during the Beijing Olympic Games, considering the unique needs of the Olympic Games, Beijing integrated and enhanced the existing infectious disease surveillance systems and on such basis established a novel system—SSSBOG. CUSUM algorithm which had been commonly used for short-term surveillance data internationally was applied for real-time analysis of daily reported ILI cases and diarrhea cases. During the Olympic Games, Early Warning Surveillance System for Influenza of Beijing detected no aberration; Early Warning Surveillance System in Intestinal Outpatients of Beijing detected four aberrations. Field investigations revealed that there was no shared exposure history among those cases and finally excluded the possibility of epidemiological association while in fact were just irrelevant sporadic events. The results were consistent with the fact that there was no major outbreak or epidemics during the game-time, indicating that the BOG-IDSS in Beijing was sensitive and effective.

Compared to the other three subsystems, the newly established SSSBOG had its unique advantages. The early warning thresholds in SSSBOG were lower, and attending physicians were required to ask about similar symptoms among close contacts of case-patients and thus suspected joint exposure history among patients and their close contacts were identified earlier. Therefore, the system exhibited that it could detect more aberrations, with higher sensitivity and timeliness. Regular or traditional infectious disease early warning surveillance (i.e., CIDARS, Early Warning Surveillance System for Influenza of Beijing and Early Warning Surveillance System in Intestinal Outpatients of Beijing) are based on analysis of cases who visited hospitals. When the level actually observed exceeds the upper threshold, early warning signals are triggered.
However, not all cases with joint exposure history visit hospitals and even if patients attend hospitals, they visited different hospitals. When the magnitude of the outbreak is small, it is hard to detect this kind of minor aberration using summarized case numbers. Additionally, even if CUSUM model detects an abnormal rise in case numbers through summarized data, CDC staff members still have difficulties in determining the exact region and period of the cluster, something that requires further exploration. For diarrhea cases visiting enteric disease clinics, the basic and diagnostic information of the cases are collected, which is mandatory. However, the present addresses, working places and other information of the cases were a challenge to code in a uniform manner. If cases with joint exposure history lived or visited hospitals in different areas, or worked in different agencies or studied in different schools, traditional surveillance systems could hardly detect this cluster in a timely manner. Therefore, SSSBOG can be an important supplement and complement to CIDARS, Early Warning Surveillance System for Influenza of Beijing and Early Warning Surveillance System in Intestinal Outpatients of Beijing.

In the syndromic surveillance used during Beijing Olympic Games, the actions for cases with suspected associations could be considered an innovation to the traditional theoretical framework of infectious disease surveillance. Such surveillance makes up the weakness identified in the existing traditional surveillance systems. Based on the traditional surveillance systems, a new innovative measure was introduced, i.e., the attending doctors conduct preliminary epidemiological investigation into patients with syndromes like fever, diarrhea, conjunctival swelling, rash and jaundice, actively asking about whether they had any close contacts with similar symptoms within the last 3 days. Meanwhile, medical staff in CDC’s jurisdiction would verify that information further and screen suspected related cases based on the clues about the current epidemic situation. This innovation can enable timely warning and prompt control of public health incidents in response to mass gatherings.

During the execution, the overall surveillance of infectious disease may put more workload on the workers in CDCs but considering the challenge to public health brought by the high density population gathering and the condition of hot weather in summer time during the Olympic Games, we believe such surveillance was necessary.

BOG-IDSS has been reserved as an important Olympic legacy and continues to serve its purpose for the security of public health in Beijing; most especially contributing to the prevention and control work during the period of pandemic influenza A (H1N1) in 2009 and the 60th National Day celebration event. We believe, in future practice, the operational mechanism of the system will be gradually improved and perfected. For future mass gatherings or large-scale social events, BOG-IDSS will continue to play a crucial role in the prevention and control of infectious disease.
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