

# Infectious disease surveillance for the London 2012 Olympic and Paralympic Games

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The London 2012 Olympic and Paralympic Games will be one of the largest mass gathering events in British history. In order to minimise potential infectious disease threats related to the event, the Health Protection Agency (HPA) has set up a suite of robust and multi-source surveillance systems. These include enhancements of already established systems (notification of infectious diseases, local and regional reporting, laboratory surveillance, mortality surveillance, international surveillance, and syndromic surveillance in primary care), as well as new systems created for the Games (syndromic surveillance in emergency departments and out-of-hours/unscheduled care, undiagnosed serious infectious illness surveillance). Enhanced existing and newly established surveillance systems will continue after the Games or will be ready for future reactivation should the need arise. In addition to the direct improvements to surveillance, the strengthening of relationships with national and international stakeholders will constitute a major post-Games legacy for the HPA.

## Introduction

Few sports events match the scale of the Olympic Games, and few mass gatherings capture such international attention. The London 2012 Olympic and Paralympic Games run from 27 July to 9 September, and involve the participation of 15,000 athletes, 70,000 volunteers, 20,000 journalists and over 10 million ticketed spectators. Games events are taking place across England, Scotland and Wales, with the majority of venues based in the Olympic Park in Stratford, east London (Figure 1) [1].

Although the Games last just a few weeks, long-term health aspirations are on a grand scale. London organisers anticipate that the Games will result in economic and social regeneration of East London and a wider health legacy, predicting 'the nation will be healthier, happier and more active' [2]. A more immediate Olympic public health legacy will be the enhancement of communicable disease surveillance systems [3]. A

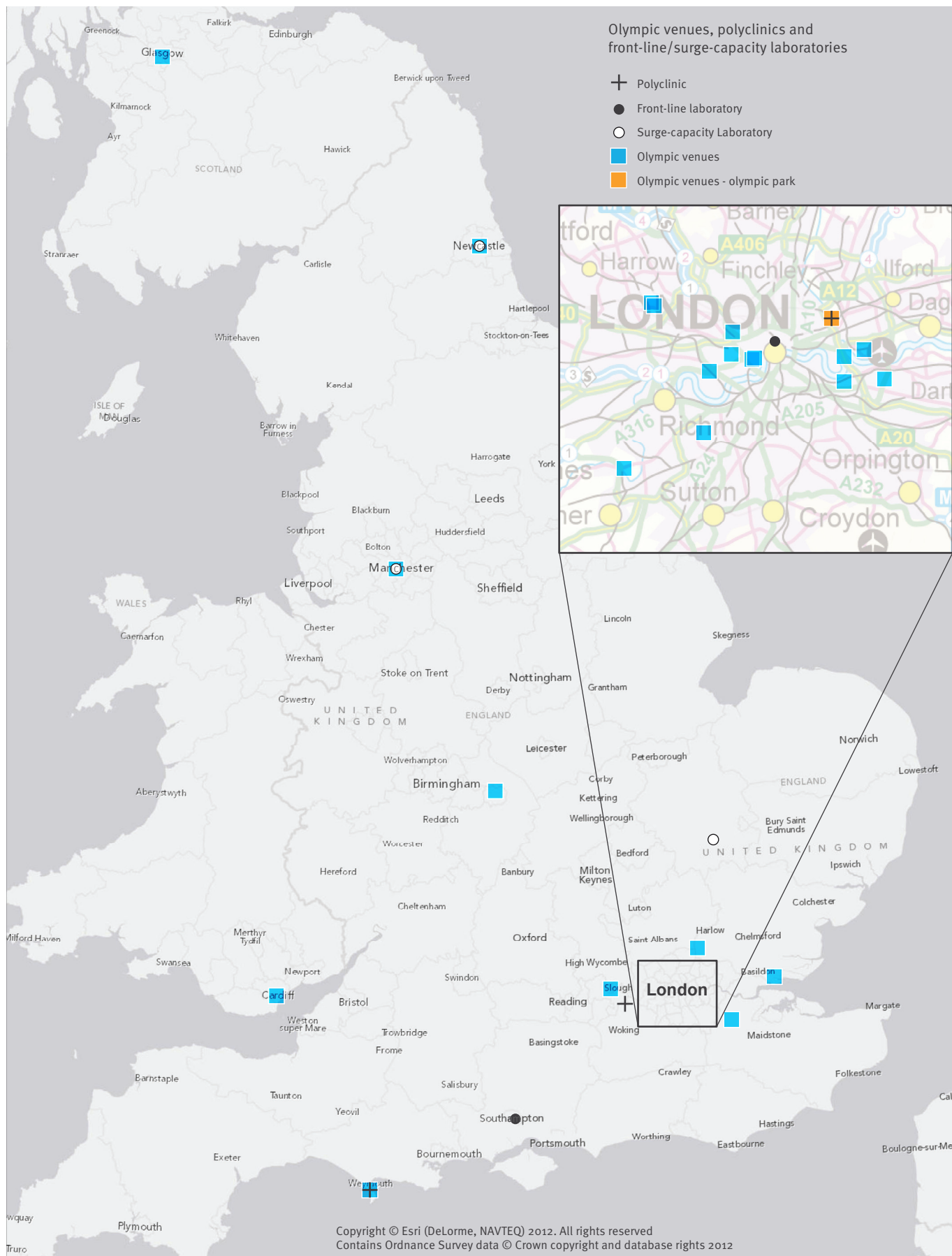
number of surveillance systems that have been developed to meet particular epidemic requirements during the Games will continue to run after this period, or be available for reactivation should the need arise.

The United Kingdom's (UK's) Health Protection Agency (HPA) performed a risk assessment of the potential health threats to the 2012 Games, concluding that serious infectious disease outbreaks associated with the Games are unlikely. No major communicable disease outbreaks were reported associated with the previous four Olympic Games, in Atlanta, Sydney, Athens and Beijing [4-6]. Nonetheless mass gatherings events have been found to be associated with the occurrence of clusters of infectious diseases, particularly of respiratory infections and gastrointestinal illness [7]. International travel to mass gatherings has been associated with the possibility of susceptible residents or visitors being infected by pathogens either imported to or endemic in the country hosting the mass gathering [8]. During the Games, athletes and spectators are expected to arrive from over 200 nations [1], including areas where the incidence of infectious diseases is much higher than in the UK [9]. Given the potentially increased concentration of visitors, the possibility of infectious disease spread through international travel and the public and political profile of the Games, enhanced epidemiological surveillance is considered an essential component of public health preparedness [10]. In this paper, we outline the communicable disease surveillance systems established in preparation for the London Games.

The main features of the surveillance systems described below are outlined in Table 1. Information collected through different systems and arrangements will be conveyed in daily situation reports to the HPA Olympic Coordination Centre for inclusion in a daily public health report to the London Organising Committee of the Olympic and Paralympic Games and the Department of Health (Figure 2). Daily reports also include non-infectious environmental hazards of

**FIGURE 1**

London 2012 Olympic and Paralympic Games venues, Olympic polyclinics and front-line and surge-capacity laboratories



Olympic venue location data are supplied by the Olympic Delivery Authority and used in accordance with their data terms and conditions (agreement with the Health Protection Authority; 15/02/2012).

**TABLE 1**

Overview of Health Protection Agency infectious disease surveillance systems for London 2012 Olympic and Paralympic Games

System	New/pre-existing	Purpose	Data sources	Olympic relevance
Health protection event-based surveillance	<ul style="list-style-type: none"> <li>Pre-existing; adapted for daily reporting and Olympic link risk-assessment</li> <li>New: HPZone<sup>a</sup> daily screening to identify significant infectious disease events</li> </ul>	To accelerate the reporting and the risk assessment of Health Protection events	Infectious diseases reports validated at HPU or regional level	<ul style="list-style-type: none"> <li>Daily risk assessment of all Health Protection events</li> </ul>
Notifications of infectious diseases	Pre-existing; adapted for daily reporting and telephone notifications	To report infectious diseases notifiable under public health legislation	Medical practitioners	<ul style="list-style-type: none"> <li>Daily analysis both at HPU and national level</li> <li>Notifications available also from Olympic polyclinics</li> <li>Notifications form includes questions about possible Olympic links</li> </ul>
Laboratory surveillance	Pre-existing; adapted for daily reporting, new tests	To provide enhanced microbiological testing, risk assessment and expert advice	NHS laboratories, 21 HPA reference laboratories, 8 regional PH laboratories and 5 FWE laboratories	<ul style="list-style-type: none"> <li>Data analysed daily for key gastrointestinal and respiratory diseases</li> <li>New enhanced diagnosis of leptospirosis</li> <li>New multiplex PCR assay for gastrointestinal pathogens</li> </ul>
Syndromic surveillance	<ul style="list-style-type: none"> <li>NHSDirect<sup>b</sup> and GP-based: pre-existing; adapted for daily reporting</li> <li>EDSSS and GP OOHSS: new</li> </ul>	To enable the early identification of the impact (or absence of impact) of potential public-health threats and to reassure about lack of wider impact in the event of an incident	NHSDirect, GPs, GP OOHs, EDs	<ul style="list-style-type: none"> <li>'Real-time': no delay in reporting</li> <li>Daily data available, including during weekends, public holidays and evenings</li> </ul>
Undiagnosed serious infectious illness surveillance	New	To detect possible new or emerging infections presenting as undiagnosed serious infectious illness	Sentinel ICU/PICUs	<ul style="list-style-type: none"> <li>Data collected on risk factors, including Olympic attendance</li> <li>Limited delay in reporting</li> <li>Weekly nil notifications</li> </ul>
Mortality surveillance	Pre-existing; adapted for daily reporting	To detect excess all-cause mortality that can result from infectious and non-infectious events	General Register Office	<ul style="list-style-type: none"> <li>Close to real-time detection of excess deaths</li> </ul>
International surveillance	Pre-existing; adapted for daily reporting	To analyse the global infectious disease situation	WHO (including GOARN and IHR); EWRS; and a wide range of other sources including both official reports (e.g. from other countries' health agencies) and open access unofficial information, including media reports	<ul style="list-style-type: none"> <li>Daily communications between international partners</li> <li>Risk assessment of events related to the Games, travels to/from the UK, media or public concern</li> <li>Attention to changes in diseases epidemiology and potential for transmission</li> </ul>

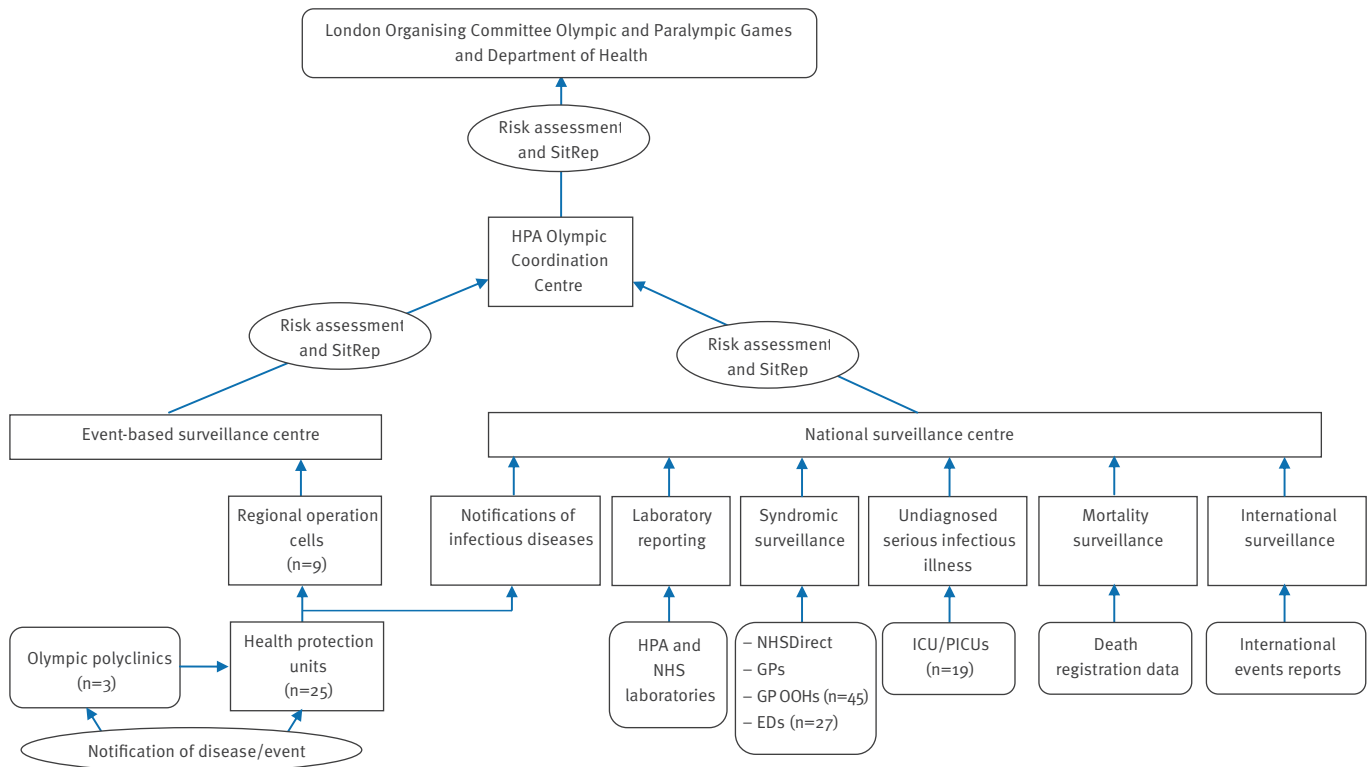
ED: emergency department; EDSSS: emergency department syndromic surveillance system; EWRS: European Early Warning and Response System; FWE: food, water and environment; GOARN: Global Outbreak Alert and Response Network; GP: general practitioner; HPA: Health Protection Agency; HPU: health protection unit; ICU/PICU: adult/paediatric intensive care unit; IHR: International Health Regulations; NHS: National Health Service; OOH: out-of-hours service/unscheduled care; OOHSS: out-of-hours/unscheduled care surveillance system; PCR: polymerase chain reaction; PH: public health; UK: United Kingdom; WHO: World Health Organization.

<sup>a</sup> The HPA's electronic public health management system.

<sup>b</sup> National telephone health helpline.

**FIGURE 2**

Flowchart of Health Protection Agency infectious disease surveillance systems for London 2012 Olympic and Paralympic Games



ED: emergency department; GP: general practitioner; HPA: Health Protection Agency; ICU/PICU: adult/paediatric intensive care unit; NHS: National Health Service; OOH: out-of-hours service; SitRep: situation report.

concern to the Games, such as air pollution. Specialist teams of HPA national experts in the different disease areas will support risk assessments and situation reports compilation. Other public health concerns, such as injuries and alcohol-associated morbidity are reported by the National Health Service (NHS) to the Department of Health.

### Olympics and Paralympics-related infectious disease event surveillance

Local and regional surveillance of infectious diseases in England has been enhanced to rapidly detect and report any event that could possibly have a link with or an impact on the Games.

The statutory notifications of infectious diseases (NOIDs) system has been modified to ensure registered medical practitioners include specific information about possible Olympics and Paralympics-related exposures when reporting notifiable infectious diseases, such as pertussis or food poisoning in resident and visitor populations [11,12]. NOIDs reports will be analysed at local and regional units and by specialist teams at the national surveillance centre on a daily basis. The HPA maintains a 24/7 system for receiving

notifications from clinicians through front-line local health protection unit (HPU) on-call teams, who can provide immediate risk assessment and advice on public health control measures for communicable diseases and non-infectious environmental hazards. Major public health concerns can be escalated by HPUs to regional or national level at any time of day or night. Specific 24/7 escalation arrangements have been established for Games-associated incidents.

To monitor infectious diseases among overseas athletic teams and avoid under-reporting, infectious disease notification was made a compulsory component of the temporary General Medical Council registration for overseas team doctors. Three polyclinics provide care for athletes and officials: the Olympic Village Polyclinic in London, the Weymouth Polyclinic in Dorset and the Royal Holloway Polyclinic in Surrey. Information on infectious diseases and clinical syndromes suggestive of infection is collected daily from the polyclinics. An HPA representative is in the Olympic Village Polyclinic in London to monitor data collection, offer public health advice and provide an initial response to any incident. All information is reported daily to the HPA in London.

**TABLE 2****Risk assessment criteria for infectious disease events during London 2012 Olympic and Paralympic Games**

Standard factors	Olympic factors
<ul style="list-style-type: none"> <li>• The population affected (e.g. children vs adults, immunocompromised persons)</li> <li>• The number of individuals affected by the occurrence (e.g. large vs small outbreaks)</li> <li>• The severity of the disease</li> <li>• The transmissibility of the pathogen, especially in the general community (e.g. influenza virus vs HIV)</li> <li>• The ease of control</li> <li>• Whether the source of an outbreak is known (e.g. <i>Salmonella</i> outbreak associated with a particular food outlet vs community outbreak with no identified source)</li> <li>• Community or a closed group (e.g. care home)</li> <li>• The background rate of disease in the community</li> <li>• The seasonality of the disease</li> <li>• The potential for media attention</li> <li>• The potential for public concern</li> </ul>	<ul style="list-style-type: none"> <li>• Involving Olympic athletes, staff, visitors</li> <li>• The geographical location e.g. within an Olympic area</li> <li>• Proximity to an Olympic venue</li> <li>• Proximity to a training site</li> <li>• Proximity to a major Olympic transport hub</li> <li>• Nosocomial infection in an Olympic polyclinic</li> <li>• The time of the occurrence in relation to the Olympic event</li> </ul>

Information on outbreaks and incidents is collected by local HPUs and can be reported to the Olympic Coordination Centre through the Health Protection event-based surveillance (EBS) system. EBS is the organised process to detect, validate, analyse, rapidly assess and report on significant infectious disease events of potential public health risk that may have an impact on the Olympic and Paralympic Games. A significant infectious disease event is defined as any event related to an infectious agent affecting an individual or a group of individuals that may put the health of those participating, visiting or working at the Games at considerable risk or may result in widespread public concern. The reporting process in England is coordinated by the national EBS team in London and involves all HPA units at local and regional level. On a daily basis, the 25 HPUs in England perform a preliminary risk assessment of infectious disease events using criteria shown in Table 2 and electronically report significant infectious disease events, or the absence of such events, to the EBS team in London via nine regional operation cells. Similar events occurring in Scotland, Wales and Northern Ireland are reported to the HPA national surveillance centre.

In addition, the EBS team screen the characteristics of events entered into HPZone – the HPA’s electronic public health management system – three times a day to identify potential significant infectious disease events. Any case or situation entered onto HPZone with a link to an Olympic venue triggers an email alert to the EBS team. The EBS team use the information from the regional reporting and from HPZone to compile and send a daily situation report to the Olympic Coordination Centre.

### Laboratory surveillance

HPA Microbiology Services (MS) Division consists of 21 reference laboratories, eight regional public health laboratories and five food, water and environmental laboratories spread across England. During the Games period, HPA-MS are providing enhanced microbiological testing, risk assessment and expert advice. Coordination across the network during the Games period is through an HPA-MS Olympic national operational cell. The cell is led on a rotational basis by a senior medical microbiologist and is based at the HPA national surveillance centre. A daily national review of ongoing laboratory activity is held to provide an early warning of unusual outbreaks or incidents. All samples from Games athletes or visitors with a suspected infectious disease are tested by or referred to one of two designated HPA front-line laboratories, with surge capacity provided by a further three regional laboratories. Key reference laboratories provide enhanced typing services seven days a week.

Following a gap analysis performed by HPA-MS, microbiological assay development took place to enhance diagnostic capacity. A multiplex polymerase chain reaction (PCR) assay for gastrointestinal pathogens has been introduced in the HPA front-line and surge-capacity laboratories, allowing the rapid diagnosis of a wide range of bacterial, viral and parasitic pathogens from a single sample. Another multiplex PCR was developed for the early diagnosis of leptospirosis, considered an important pathogen for athletes participating in outdoor water sports.

During the Games, HPA-MS will link directly with the agency’s epidemiology intelligence on a daily basis, informing part of the public health situation report. Furthermore, laboratory data will be analysed by disease-specific epidemiologists on an ongoing basis. Since October 2010, statutory reporting by clinical and public health diagnostic laboratories for a range of infectious pathogens is included in health protection legislation [12]. Laboratory reports are submitted electronically to the HPA. Reported data are used to calculate exceedance scores to detect an increase in infectious diseases. This is done by using a statistical algorithm to compare observed occurrence with that expected, based on data from the previous five years for the three weeks either side of the reporting date [13]. During the Games period, these data will be analysed and interpreted on a daily basis.

## Syndromic surveillance

Syndromic surveillance is defined as ‘a real-time (or near real-time) collection, analysis, interpretation, and dissemination of health-related data to enable the early identification of the impact (or absence of impact) of potential human or veterinary public health threats that require effective public health action’ [14]. Syndromic surveillance of human illness will play a major role in the surveillance for the Games. Based on non-specific health indicators such as ‘vomiting’, ‘fever’, ‘impact of heat’ or ‘rash’ rather than laboratory-confirmed diagnoses of a disease, syndromic surveillance can be more rapid and flexible than other systems, particularly in the case of unexpected threats [14].

The UK has several established syndromic surveillance systems including a national general practitioner (GP) surveillance system dating back to 2004 [15] and a nationwide surveillance system using data from the NHS Direct national telephone health helpline, which has been operational since 1999 [16]. During the Games period, the NHS Direct and GP systems will be analysed and interpreted on a daily basis.

The HPA risk assessment identified two shortcomings in the current surveillance systems: (i) lower data availability during weekends, evenings and public holidays; and (ii) different health-seeking behaviour of international visitors as compared with that of UK residents. Two new syndromic surveillance systems have been set up to address this. The GP out-of-hours/unscheduled care surveillance system (GP OOHSS) monitors daily out-of-hours/unscheduled primary care activity provided by NHS-commissioned services and therefore complements existing GP surveillance systems by monitoring activity during evenings, overnight, weekends and public holidays. Currently 45 out-of-hours/unscheduled primary care providers provide daily data for patient-care episodes in 119 of 145 primary care trusts (PCTs) in England, including 30 of 31 PCTs in London and those hosting the rowing and sailing events taking place outside London. The second system, the emergency department syndromic surveillance system (EDSSS), monitors the daily numbers of attendances in a network of sentinel emergency departments across England [17]. Currently 27 sentinel emergency departments provide daily data on a range of generic clinical indicators. Triage data are also monitored, providing an indication of the severity of the presentations. As the syndromic surveillance systems are diverse and at different stages of development, with differing amounts of historical data, statistical analyses are tailored to the specific systems. The in-hours GP surveillance rates are based on practice-registered populations, while other systems use a dynamic denominator (calls made to NHS Direct, emergency department attendances, GP out-of-hours/unscheduled care contacts) and report the proportion of these due to a particular syndrome [18]. The GP OOHSS and EDSSS will remain operational after the Games.

## Undiagnosed serious infectious illness surveillance

The influx of international visitors during the Games has the potential to increase the risk of introduction of new and emerging infections, which may present as ‘undiagnosed serious infectious illness’ (USII) [19]. The HPA risk assessment identified this as a gap and therefore a new surveillance system was established to detect possible new or emerging infections presenting as USII during the Games.

A USII case is defined as ‘any adult or child admitted to an adult or paediatric intensive care unit (ICU/PICU) with a serious illness suggestive of an infectious process where the clinical presentation does not fit with any recognisable clinical picture or there is no clinical improvement in response to standard therapy and initial laboratory investigations for infectious agents are negative or do not establish a diagnosis.’

The surveillance system involves sentinel ICU/PICUs reporting USII cases online or, where no cases have occurred, providing weekly nil notifications. Cases are reported using a restricted-access web-based reporting tool, and are investigated for epidemiological links, including temporal and spatial clustering. Results from a pilot study undertaken between January and July 2011 indicate that this system is feasible and able to detect cases, allowing for investigation of clusters of USII in a timely manner [19]. Based on these results, the system was expanded to cover a total of 12 ICUs and seven PICUs in London and the south-east of England, where the majority of the Games venues are based.

Following the Games, an evaluation of the USII surveillance system will take place in which the potential for extending this system across England will be explored. Reporting of USII cases could continue through the established sentinel network of ICUs and PICUs as a public health legacy of the Games [19].

## Mortality surveillance

Weekly mortality monitoring in the UK has previously allowed quantification of excess deaths associated with health threats such as influenza and heatwaves [20,21]. Throughout the London 2012 Games, the General Register Office is providing daily data on the total number of deaths for England each weekday to the HPA for Games-time mortality surveillance by age group and region. This daily monitoring enables close to real-time detection of excess deaths, after correcting for reporting delays and accounting for time from exposure or illness onset to death (typically three days for heat exposure at national level) [20-22].

The output from this surveillance will be interpreted with that of other surveillance systems, depending on the incident, such as laboratory or meteorological reports and syndromic surveillance of influenza-like illness or heat illnesses, contributing to a more complete picture of the impact on the health of the population.

## International surveillance

International infectious diseases surveillance and collaboration with overseas and international health agencies has been a feature of public health preparedness at recent summer Olympic and Paralympic Games, with the World Health Organization (WHO) as the main collaborating partner [4-6].

Global infectious disease scanning and risk assessment for relevance to the London 2012 Games is being undertaken daily throughout the summer by collaboration between various parts of the HPA that have a routine role in international surveillance, the European Centre for Disease Prevention and Control (ECDC) and the HPA-commissioned National Travel Health Network and Centre (NaTHNaC). Sources of information include those provided by WHO (such as through the Global Outbreak Alert and Response Network (GOARN) and under the International Health Regulations (IHR)), the European Early Warning and Response System (EWRS) and a wide range of other sources including both official reports (e.g. from other countries' health agencies) and open access unofficial information, including media reports. A number of exercises have been used to test and refine the surveillance process, with a secure web-based database and daily teleconferences used for coordination.

While global infectious disease situational analysis for public health protection is routine work for specialists in the three organisations, additional criteria were developed for Olympic risk assessment. These included potential for impacting on the running of the Games or travel to and from the UK, incidents that may attract particular media or public concern, and those that may require specific advice for clinicians or port health or public health measures to be implemented. Consideration is given to significant changes in disease epidemiology, potential for transmission within the UK and degree of uncertainty surrounding potentially emerging infections.

In addition to scanning for international incidents of local significance, reporting of any UK incidents of international significance will continue throughout the Games through routine IHR and EWRS communications.

## Discussion

The HPA has built robust systems for the surveillance of infectious diseases in preparation for the London 2012 Olympic and Paralympic Games. Pre-Olympic exercises were performed to test the different surveillance systems' ability to detect infectious disease events of potential significance to the Games and resulted in refinement of reporting criteria and processes for risk assessment.

Communication between the HPA and environmental health officers, microbiologists from the laboratory network, hospital consultants, medical practitioners and international partners has been strengthened in order to fulfil the Agency's commitment to the

Olympics. Enhanced pre-existing systems and new arrangements will be operated during the Games for the effective management of infectious disease risks due to the large number of visitors and to the high visibility of the event.

With both a simultaneous influx of Games visitors and potential efflux of the resident population during this holiday period, the precise increase in the London population is not readily measurable. While some surveillance systems, such as emergency department syndromic surveillance, use dynamic denominators, others, such as laboratory case count 'exceedance scores' assume a relatively static population, and so outputs from such systems require further interpretation. Providing reassurance that there is not a need for public action can be as important as the rapid detection of events that do require such action during mass gatherings, when increased media attention can generate public and political concern regarding incidents of low or no public health concern. While real-time surveillance and rapid laboratory services (for infection-related concerns) are important in providing such reassurance, robust arrangements for rapid expert threat assessment are also required. Finally, despite a robust information technology business continuity plan to support surveillance operations, major electronic or telecommunication disruptions could impede several core activities in an era where IT dependency is the norm. Evaluations of the overall infectious disease surveillance and of the different surveillance systems have been planned after the Games, which will consider how such issues have been handled and any lessons learned.

The Olympics and Paralympics legacy for the HPA will not only be the reinforcement of UK infectious disease surveillance systems, but also the strengthened partnerships with ECDC and the London-based WHO Collaborating Centre on Mass Gatherings and High Visibility/High Consequences Events. These partnerships will enable the knowledge and experience gained from the London 2012 Games to be shared with those planning infectious disease surveillance for future mass gathering events.

## Members of the Olympics Surveillance Work Group

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