
Microbiological aspects of public health planning and preparedness for the 2012 Olympic Games

J. MORAN-GILAD, M. CHAND, C. BROWN, N. SHETTY, G. MORRIS,
J. GREEN, C. JENKINS, C. LING, J. McLAUCHLIN, T. HARRISON,
N. GODDARD, K. BROWN, F. J. BOLTON AND M. ZAMBON* on behalf of HPA
Microbiology Services Olympics Planning Group

Health Protection Agency, Microbiology Services, UK

*Received 25 May 2012; Final revision 27 July 2012; Accepted 27 July 2012;
first published online 15 August 2012*

SUMMARY

Although communicable diseases have hitherto played a small part in illness associated with Olympic Games, an outbreak of infection in a national team, Games venue or visiting spectators has the potential to disrupt a global sporting event and distract from the international celebration of athletic excellence. Preparation for hosting the Olympic Games includes implementation of early warning systems for detecting emerging infection problems. Ensuring capability for rapid microbiological diagnoses to inform situational risk assessments underpins the ability to dispel rumours. These are a prelude to control measures to minimize impact of any outbreak of infectious disease at a time of intense public scrutiny. Complex multidisciplinary teamwork combined with laboratory technical innovation and efficient information flows underlie the Health Protection Agency's preparation for the London 2012 Olympic and Paralympic Games. These will deliver durable legacies for clinical and public health microbiology, outbreak investigation and control in the coming years.

Key words: Microbiology, Olympic Games, public health.

MICROBIOLOGY AND INFECTIOUS DISEASE RISKS ASSOCIATED WITH THE OLYMPIC GAMES

Planned or spontaneous mass gatherings of people congregating for cultural, sporting, religious or political reasons, may strain the transport, security and health infrastructure resources of a community or nation state [1]. If the gathering draws visitors from

different regions and cultures the potential for importation of unusual infectious diseases creates additional challenges. Mass gatherings pose ideal circumstances for the spread of infectious diseases. Examples include meningitis at the Hajj pilgrimage or the norovirus outbreak during the 2006 Football World Cup. Increased demand for ready-to-eat foods amplify the attendant risks of foodborne and/or waterborne disease. Other communicable diseases such as respiratory infections (particularly viruses), meningitis, measles, sexually transmitted infections and rare infections such as viral haemorrhagic fever [2] may also occur in clusters as a result of unusual

* Author for correspondence: Professor M. Zambon, HPA Colindale, 61 Colindale Avenue, London NW9 5EQ, UK.
(Email: maria.zambon@hpa.org.uk)

mixing patterns. The potential spread of unusual antimicrobial resistance is also of concern, although the actual risk may be only slightly greater than normal.

Essential preparation for mass gatherings includes developing strategies to prevent and respond to communicable disease threats, enhanced epidemiological surveillance and a rapid response capability [1]. The UK's Health Protection Agency (HPA) will play a key role during the London 2012 Olympic and Paralympic Games to ensure the health of those visiting and participating is protected from infectious diseases or environmental hazards. New systems include surveillance of undiagnosed serious infectious illness (USII) and enhanced syndromic surveillance within services more likely to be used by international visitors, including emergency departments (the Emergency Department Syndromic Surveillance System). A further syndromic surveillance development to monitor out-of-hours and unscheduled general practice activity is described in a recent paper [3].

A key preparedness and response aspect during the London 2012 Olympic and Paralympic Games for which the HPA has lead responsibility is delivery of public health information, risk assessment, diagnostic testing and disease control measures based on specialist and reference microbiology testing. This paper details the planning and preparation undertaken within the HPA Microbiological Services prior to the Olympic Games to enable it to discharge these responsibilities.

THE OLYMPIC GAMES

The Olympic Games, hosted by a different nation every 4 years, is an example of a planned mass gathering. The globally changing location means that new health issues arise each time dependent on location, geography and climate of the host venue, and these are additional to other common health threats, wherever the location. Preparation needs to take into account location specific factors such as geography and climate of the host venue as well as generic risks associated with mass gatherings. The host nation is expected to have the capability to monitor health risks closely and to have the capacity to identify, alert and rapidly respond to any public health incident or emergency.

Surprisingly, communicable diseases have not been a major cause of morbidity during recent major international sporting mass gatherings. During the 1996 Atlanta and 2000 Sydney Games, infectious

diseases accounted for less than 1% of healthcare visits [4]. Data from the 2004 Athens Games showed that the most common health problems related to infectious diseases, for which people visited a primary-care physician, were respiratory infections (6.7% of visits) and gastroenteritis (3.7% of visits). Salmonellosis accounted for about half of the mandatory notifications followed by tuberculosis (17%), hepatitis B (5%), aseptic meningitis (4%) and bacterial meningitis (3%). In addition, *Salmonella* was isolated in two thirds of positive stool cultures reported, followed by *Campylobacter* spp. (19%), *Giardia* spp. (4%) and *Shigella* spp. (3%). Morbidity from infectious diseases recorded was very low (2–3%). There were 14 small clusters (2–4 people) and eight large clusters (6–38 people) of foodborne or waterborne disease reported in August 2004. None of these outbreaks was reported from Olympic venues, including residential areas, athletic stadiums or cruise ships [5].

In Beijing 2008, the number of cases of communicable diseases (including gastrointestinal infections) paradoxically fell by 40% compared to the previous year and no infectious disease outbreaks were reported [6]. It is possible that enhancement of health protection measures, particularly food safety and hygiene, resulted in an absolute decrease in morbidity.

KEY RISKS DURING MASS GATHERINGS

Foodborne and waterborne infections

Despite robust hygiene standards in many industrialized countries, contaminated food, water and the environment (e.g. mass production of food and a 'just-in-time' food chain distribution system) have the potential to cause explosive and extensive outbreaks of gastrointestinal diseases. Examples include a large outbreak of shigellosis after a music festival attended by more than 3000 women in Michigan in 1988 caused by the lack of food handling hygiene [7]; *Campylobacter* infection at a festival attended by more than 70 000 people in the UK in 1992 caused by drinking unpasteurized milk [8]; and verocytotoxin-producing *Escherichia coli* (VTEC) O157 outbreak at the Glastonbury Festival, Somerset, UK caused by cattle faeces contaminating mud [9].

Freshwater sports carry a unique threat of leptospirosis in participants, e.g. among triathlon athletes in Germany [10] and the USA [11], and following

whitewater rafting in Malaysian Borneo [12], with competitions that take place in sea water or treated artificial water sources being an unlikely source of leptospirosis. Legionellosis may present as outbreaks during mass gatherings and prevention requires specific input from environmental engineers and inspectors who carry out regular inspection of water systems in hotels, hostels and other forms of accommodation.

Respiratory infections and airborne transmission

Unusual mixing patterns and high density of individuals during mass gatherings creates opportunities for efficient seeding of respiratory infections from single infected hosts. This may result in diseases primarily affecting the respiratory tract such as influenza or clusters of systemic diseases such as measles, mumps, and meningococcal infection in susceptible, unvaccinated groups [13] where infection has occurred as a result of respiratory transmission. Influenza, particularly because of its short incubation period, has the propensity to spread and cause extensive morbidity and mortality, and has frequently been noted at sporting and music events such as World Youth Day in Sydney, NSW, Australia July 2008 [14], the Winter Olympics in Salt Lake City, UT, USA, 2002 [15], and music festivals in Belgium [16], Serbia [17] and Hungary [18] in 2009. While new influenza strains can be introduced into a country 'out of season' by international travellers, rigorous attention to control measures, including vaccination, were successful in averting outbreaks of influenza A(H1N1) 2009 during the global pandemic in 2009, at the Hajj and the Asian Youth Games, Singapore [19].

Unusual situations

Recently Pantone–Valentine leucocidin (PVL) positive *Staphylococcus aureus* (methicillin sensitive or resistant) causing severe skin and soft tissue infections has been reported in close contact sports participants in, e.g. wrestling, American football, rugby and judo. Risk factors include compromised skin integrity, skin-to-skin contact, and sharing of contaminated items such as towels [20]. Nevertheless, the risk for such infections among competing athletes appears low and it is likely that such cases would be managed by sports team medical staff and go unreported.

The dissipation of rumours is another important function of a world-class public health surveillance system designed for mass gatherings. Having communication systems in place to provide accurate laboratory results which inform public health risk assessment and assurance to the public through mass media is a key expected output.

Preparing for London 2012

Past experience from previous mass gatherings suggests a wide range of communicable diseases need to be considered as part of preparation for hosting the Olympic Games. Although these have not hitherto played a major role, the threshold for response to any acute communicable disease incidents during the Games period will be lower than usual to expedite control measures and avoid Games disruption as a result of increased public and media scrutiny.

The London 2012 Olympic and Paralympic Games are expected to involve over 15 000 athletes from 204 competing nations and up to 200 000 Games support workers, officials and volunteers and media [21]. They will take place in 33 distinct venues spread across Great Britain, associated with hundreds of complementary outdoor festivals and satellite events, but not unexpectedly, most crowding is expected to occur in the Greater London area. During Games time the population of London is expected to increase by up to a million people at any given time and around 500 000 spectators are expected to travel in and around London daily. These figures moderately exceed the number of people expected in the UK during the season.

Overall, the additional burden on acute care medical facilities (all-cause) is expected to be about 5%. Medical care of athletes and accompanying personnel will be delivered by specialized polyclinics around the Olympic villages. Several medical centres in London have been designated as hospitals which will provide acute care services for the Olympic family and spectators.

As mentioned above, the HPA has strengthened its event-based surveillance capabilities, including enhancement of existing systems and setting up of new systems [3]. Laboratory reporting of infectious diseases is one of the key components of surveillance. Reports generated through NHS and HPA frontline laboratories will feed into the national surveillance system of the HPA, through which they will inform an ongoing risk assessment and situation report. HPA

laboratories are therefore required to detect infections by a lower threshold for testing and improved turnaround time using state-of-the-art newly developed robust diagnostic systems and coordinate the laboratory response where applicable.

INFECTIOUS DISEASE/ MICROBIOLOGICAL ASPECTS OF PLANNING AND PREPAREDNESS

Diagnostic capability

The Olympic Games are regarded as an 'event' rather than an emergency situation. Nevertheless, a major outbreak of infectious disease associated with the event requires a shift to a generic coordinated response while maintaining other essential services. Such an event could have an explosive impact on many different parts of the country's health infrastructure including acute care provision, diagnostic testing, reporting, intervention and surveillance [1]. Enhanced clinical, public health and environmental microbiology laboratory capability and capacity are required to meet any increased demands during the Games period, as well as maintaining a rapidly scalable capability for response to outbreaks of infectious diseases. A lower threshold for response to potential public health incidents requires the provision of rapid, accurate diagnoses and expert advice 24/7 as well as surge capacity. Workforce planning is therefore essential to ensure staffing resilience.

Risk management to deliver a rapid and robust response to any incidents must take into account the increased public health risk from temporary increases in population density and unusual mixing patterns together with specific identifiable risks such as foodborne disease associated with food-handling and mass-catering operations. The communicable disease threats identified are summarized in Table 1 and Figure 1.

Diagnostic pathways

Although most clinicians will be aware of the likely spectrum of diseases in the context of the Olympics, explicit robust diagnostic pathways are vital to ensure that any microbiological samples are speedily analysed to facilitate early public health action. Clinical diagnostic algorithms have been produced for various syndromic presentations of diseases with public health significance, developed in consultation with

epidemiological and laboratory scientists and clinicians [22]. The scope of the algorithms was determined by consideration of likely clinical presentations of affected athletes and spectators following mass-gathering exposure, and the potential for unvaccinated visitors contracting communicable disease. Likely common scenarios include clusters of 'rash illness', isolated suspected meningococcal disease, respiratory tract infections, undiagnosed serious illness, water-related infections and diarrhoea and vomiting outbreaks. Online resources will help clinicians and microbiologists.

Molecular assay development and implementation

The summer months are typically the peak period for *Salmonella* and VTEC infections and outbreaks in the UK. The possibility of norovirus transmission through food or food handlers remains a potential concern, due to imported infection from the Southern Hemisphere where it typically peaks at this time of year. While foodborne infections are likely to cause only limited number of infections, due to the high number of food vendors and their geographical spread, the HPA will support epidemiological investigations of all foodborne illness related to the Games. Key disease syndromes of public health importance, where more rapid diagnosis could alter clinical and public health management of individuals linked to Olympic events or venues have been identified. These include bacterial, viral and parasitic gastrointestinal infections, and acute leptospirosis illness. New real-time PCR-based assays have been developed and evaluated to address specific diagnostic gaps and improve the time for detection of infectious aetiology. The bacterial, viral and parasitic targets are given in Table 2. Notably, quality assurance of these new assays includes internal amplification controls [phocine distemper virus and *E. coli* gfp (green fluorescent protein)]. For rapid detection in environmental samples a similar range of real-time PCR assays is available in the HPA food, water and environmental microbiology laboratories. Viral PCRs [influenza A(H1N1) 2009, other influenza A, influenza B, RSV, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus] will also be available during Games time together with normal routine microbiological services. The application of molecular tests is intended to reduce the time required to achieve definitive diagnosis, thus enhancing the capability to provide an early intervention.

Leptospirosis is a theoretical risk to participants and staff in the freshwater sporting events. Since the exposure history will be known, there is the opportunity to diagnose the disease early in the non-specific phase of symptoms. A gap analysis of microbiological capability unrelated to the Olympics has identified a need to develop and implement a rapid molecular assay for the diagnosis of leptospirosis. While the disease itself is quite rare in the UK, there is a significant number of cases being tested annually because of a compatible illness and epidemiological link or travel history. Traditional serological methods require convalescent serum samples and provide a retrospective diagnosis. A real-time PCR assay capable of identifying pathogenic leptospires has thus been developed for use with blood in early disease (HPA, unpublished observations). Enhanced service delivery through rapid test turnaround times, electronic data reporting and swift communication lines to front-line public health delivery units will also be implemented to ensure seamless overall response coordination. The HPA microbiological services are expected to be in a position to dismiss leptospirosis as a cause of waterborne infection, however rare, since this diagnosis could potentially disrupt water sports competitions. This is a clear example of Olympic legacy in microbiology.

Training and exercises

A series of national and local exercises have taken place at regular intervals since autumn 2011 to provide assurance of high level command and control arrangements, cross-governmental communication, and the ability to respond to simultaneous incidents of escalating severity. These have been supplemented by more local exercises designed to test understanding of responsibilities for health protection support and advice, including the effectiveness, resilience and decision-making capability of Games time operating structures and processes.

To test decision making and technical resilience, front-line HPA clinical as well as HPA food, water and environmental microbiology laboratories have participated in real-time laboratory exercises using public health scenarios and simulated samples containing live organisms. This allows assessment of responses to public health scenarios, quality of microbiological output, turnaround time, public health advice provision, referral to reference laboratories and communication with the Olympic reporting structure

and surveillance systems, well in advance of Games time. Scenarios used were those considered possible threats during the Games, such as a new influenza subtype, PVL-positive *Staphylococcus aureus* outbreak, gastrointestinal infection outbreaks (e.g. VTEC and *Salmonella*) and imported diseases in visitors. The ability to deploy specialized sampling kits for clinical, food and water testing was also tested, providing valuable lessons in logistics. Such scenario-based exercises have led to improvements in the reporting systems, better understanding of risk assessment and communication requirements during the Games.

By participating in the exercises and operational planning days, a high degree of staff engagement has ensued. All participating members of staff have gained a clearer understanding of plans, procedures and infrastructures that will be in operation during the Games period, and of their own roles and responsibilities. Despite a small increase in workload, supportive feedback from laboratory staff has been a universal finding and has led to incremental improvements in planning activities.

The likelihood for the deliberate release of a biological, chemical or radiological agent during the Olympic Games remains low. However, if a deliberate release is suspected, e.g. through patients presenting with unusual symptoms or cohorts of patients presenting with similar symptoms, then rapid access to early specialist advice is required. Microbiological testing will need to be performed as required according to presenting symptoms and suspected cause in the appropriate reference laboratory, necessitating training and refreshers for attending medical and laboratory staff. Training days were developed for staff in all roles related to the Games, covering operations, relevant issues for medical microbiology and service provision, deliberate release and risk assessment. Staff members have also been cross-trained to take on roles separate from their normal duties, including operating as task managers and coordinating with an operation centre.

Games time daily activities

Hosting the London 2012 Olympic and Paralympic Games will entail the collation of a daily public health situation report (SITREP) through established permanent laboratory and other surveillance reporting systems from all regions of England. A daily SITREP will run for several weeks prior to the start of the Games to ensure recognition of a 'baseline' steady

Table 1. Communicable disease threat assessment for microbiological preparedness for the 2012 Olympic Games

Syndrome	Agent	Clinical severity	Risk for sporadic illness	Public health risk/outbreak potential	Epidemiological link	Frontline clinical diagnostic methods	Reference diagnostic methods
Systemic	Leptospirosis	Variable	Low	Low	Freshwater sports	Screening ELISA for IgM, real-time PCR for blood (under development)	Serology (microagglutination test)
	Multi-resistant bacteria (e.g. carbapenem-resistant Gram-negative bacilli)	High	Moderate	Low	Hospital-associated outbreaks	Manual or automated instruments for phenotypic testing	MIC-based methods, detection of molecular mechanisms, genotyping
	Haemorrhagic fever viruses	Variable	Low	Low	Mostly imported, vector-borne (occasionally person-to-person)	Not in place (primary diagnosis in reference labs)	Molecular detection, serology
	Typhoid (and paratyphoid) fever	High	High	Low	Mostly imported, occasional autochthonous cases	Culture-based methods	Serotyping/phage-typing, sequence typing
	Viral ‘rashes’	Variable (usually moderate)	Moderate	Moderate	Crowding	Serology	Molecular
Respiratory	Influenza	Low (but strain dependent)	Low to moderate	High	Imported strains from Southern hemisphere	Molecular (depends on type)	Typing, sequencing, antiviral resistance testing
	Tuberculosis	High	High	Low, delayed presentation likely	Crowding	Microscopy, culture, PCR	Molecular, resistance testing, typing
	Legionellosis	Variable	High	Moderate	Water sources, ventilation and air conditioning systems	Culture (clinical and environmental), PCR, urinary antigen	Molecular, speciation, sequence-based typing
	SARS/other emerging virus	Variable	Low	Moderate	Crowding	Not in place	Wide repertoire of tests, molecular, sequencing
	Other respiratory viruses (adenoviruses, parainfluenza)	Low	Moderate	Moderate	Crowding	Antigen detection, PCR	Molecular, sequencing, typing

Table 1 (*cont.*)

Syndrome	Agent	Clinical severity	Risk for sporadic illness	Public health risk/outbreak potential	Epidemiological link	Frontline clinical diagnostic methods	Reference diagnostic methods
Gastro-intestinal	Salmonellosis	Moderate	High	High	Food	Culture	Serotyping, resistance testing, sequence typing
	Shigellosis	Moderate to severe	Low to Moderate	Low to moderate	Food, shared facilities	Culture	Serotyping, resistance testing, typing
	Cryptosporidiosis	Low to moderate	Low to Moderate	Moderate	Water sources	Microscopy	Molecular
	Food poisoning (toxigenic)	Low	High	High	Food	Not in place (primary diagnosis in reference labs)	Molecular
	Viral gastroenteritis	Low	Moderate to high	High	Crowding	PCR	Molecular, sequencing
	Viral hepatitis (A and E)	Variable	High	Low to moderate	Food	Serology	Molecular, typing
Neurological	Meningococcal disease	High	High	Low	Crowding (adolescents and young adults susceptible)	Culture, antigen	Molecular, resistance testing
	Viral encephalitides	High	Low	Low	Vector-borne	PCR for common viruses	Molecular, sequencing, typing
Sexually transmitted infections	Gonococcal infection	Low	High	Low (occasional clustering)		Culture, PCR	Molecular, resistance testing
	HIV	High	High	Low, delayed presentation likely		Serology, PCR	Molecular, resistance testing

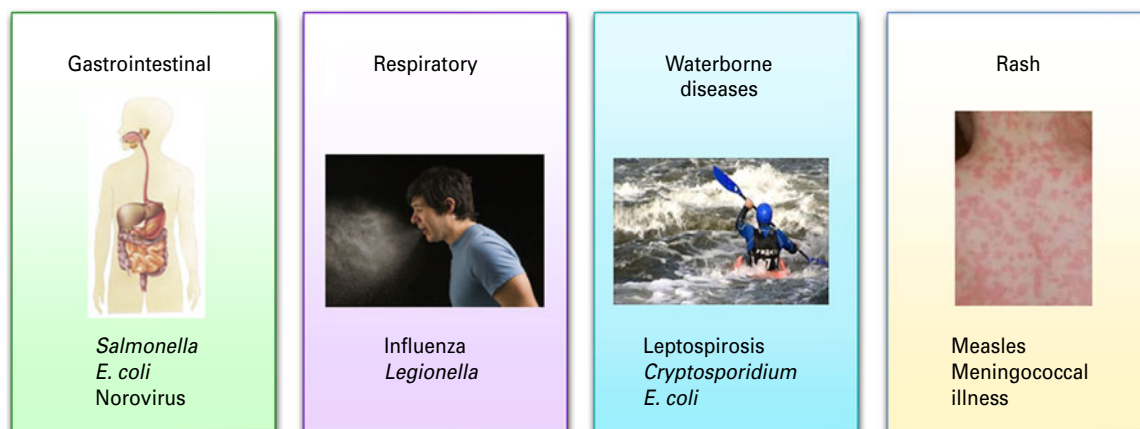


Fig. 1 [colour online]. Key infection risks for the London 2012 Games.

Table 2. *Microorganisms and genetic targets of new gastrointestinal multiplex assay**

Molecular assay	Microorganism	Molecular target
Para1 (Triplex)	<i>Entamoeba histolytica</i>	18S rRNA
	<i>Giardia</i> spp.	ss rRNA
	<i>Cryptosporidium</i> spp.	18S rRNA
Bac1 (Triplex)	<i>Salmonella</i> spp.	ttr
	<i>Campylobacter coli</i>	ceuE
	Verocytotoxigenic <i>E. coli</i>	vtx1
Bac2 (Triplex)	<i>Salmonella</i> subsp. 1	hilA
	<i>Shigella</i> spp.	ipaH
	Enteroaggregative <i>E. coli</i> .	aag
Bac3 (Duplex)	<i>Campylobacter jejuni</i>	mapA
	Verocytotoxigenic <i>E. coli</i>	vtx2
Vir1 (Triplex)	Norovirus (G-I)	vp2
	Norovirus (G-II)	Polymerase
	Rotavirus	vp6
Vir2 (Triplex)	Adenovirus 40/41	Fibre
	Astrovirus	Capsid
	Sapovirus	Polyprotein

* Each assay also includes internal amplification controls.

state. Laboratory and other data will be used to produce exceedance scores which highlight unusual disease activity across a range of syndromes.

Influenza is perceived as a particular threat during Games time as the influx of visitors from the Southern hemisphere is consistent with enhanced circulation of influenza during this period. Microbiological test results from key regional hospitals will be extracted from a more comprehensive respiratory virology surveillance system operating from key laboratories established during the 2009 influenza pandemic and analysed daily (DataMart).

In addition, a daily verbal reporting system for 'soft' intelligence about outbreaks and any cases related to Olympic venues will be in operation as well as international intelligence. Each specialist HPA food, water and environmental microbiology laboratory in England will contribute a 'nil or exception' daily report to inform microbiological diagnoses, as part of an early warning system for the detection of microbiological threats to the Olympic Games. Relevant information from this will be used to inform the overall national situation report. Collation of information and risk assessment will be led by a senior and experienced clinical microbiologist to coordinate the regional, reference and specialist microbiology activities in the event of an outbreak or incident. Information requested of the microbiology reference services, and all activity within the front-line laboratory network, is therefore closely monitored and coordinated to ensure appropriate and consistent information flows. Expert microbiology advice can therefore be provided to regional or national epidemiology teams, as well as to front-line laboratories or clinicians, in a coordinated and consistent fashion.

Business continuity

There are several elements to Olympic planning. The highest priority is to maintain essential normal activity and services. This will include responding to incidents and outbreaks unrelated to the Olympics. It is not unusual for the HPA to manage concurrent national incidents. However, during the Olympic period an enhanced service will be provided over 12 weeks. Frontline clinical laboratories will manage the majority of Olympic-related diagnostic work, with a scalable capacity and robust workforce plans.

Trigger points and business continuity arrangements have been established and tested for resilience and robustness. All planned maintenance and calibration and accreditation inspections will be scheduled for completion before the Olympics. Maintenance and repair contracts for essential equipment will be upgraded to ensure rapid response, and active supply chain management undertaken to increase stocks of buffers of key reagents and consumables, emergency arrangements for restocking and recovery plans for any key dependencies identified, including communication systems, laboratory information systems (LIMS) and IT networks.

Informatics

Effective management of information is key to delivering timely outputs to stakeholders during the Olympics or during unplanned incidents. The Olympics project management team established a data management group within the planning process whose activities were focused on: (1) mechanisms for effective collation and integration of laboratory, clinical and other datasets for both 'routine' Olympic outputs and in the event of significant infectious disease; (2) workforce planning – identifying the cadre of staff with data manipulation and information management skills and developing rotas for support.

Integration of data from a range of data streams and establishing appropriate processes for interpretation and authorization during the production of outputs represents a key and complex challenge. Laboratory data are held in a number of systems including: (1) MOLIS; the reference microbiology laboratories' specimen tracking, management and reporting system; (2) LabBase – an automated system collecting positive laboratory identifications from about 200 NHS and HPA laboratories; (3) HPZone – a clinical case-management system with some imported laboratory data; (4) Hospital LIMS systems used for daily DataMart reporting.

Novel data extraction procedures have been required to extract information from the new diagnostic assays developed for use during the Olympics using the 'DataMart' platform. Processes to identify duplication of data were implemented, providing a single 'case repository' which can be used for reporting purposes as well as informing exceedance and other analysis.

The data management/informatics planning group has also developed and implemented task

and document management systems which allow effective cascade of tasks fit for audit trails and ensuring information governance. A task management system was built using an open source content management system with specific functions for the management of tasks, files, calendar of events which will be used to cascade tasks throughout the HPA from local to national as necessary. A legacy of this development will be an incident response administration system that can be used for other infectious disease-related major events.

A FORWARD LOOK

Ensuring a fit-for-purpose public health microbiology service to support the hosting of the London 2012 Olympic and Paralympic Games, in one of the most densely populated cities in the world, is a complex planning task. Key requirements are early warning capability for detection of communicable diseases with potential to disrupt the Games [23], scalable laboratory testing capability in the face of an escalating infection outbreak, coordination and analysis of microbiological information coming from multiple different sources, and expert risk assessment to inform wider public health responses. Delivering these requirements has involved multidisciplinary team working, identification of gaps in current service provision and opportunities for improving and enhancing routine diagnosis, especially for gastrointestinal pathogens and robust arrangements for information sharing. Rigorous scenario and exercise testing have allowed incremental improvements in operational laboratory service delivery following implementation of new testing and reporting arrangements, providing the foundations for an improved public health microbiology service delivery as a durable NHS legacy for the population of England.

NOTE

This paper was written prior to the 2012 Olympic Games and therefore reflects an expectation of events.

ACKNOWLEDGEMENTS

We acknowledge all members of the GI assay development and validation groups, including HPA and non-HPA members of staff at Colindale (London), Barts Health NHS Trust (London), the Hospital for

Tropical Diseases (London), the UK Cryptosporidium Reference Unit (Swansea), Public Health laboratories (Cambridge, Manchester, Newcastle, Southampton), Neill Keppie for data management, Professor Sarah O'Brien for permission to access IID 2 specimens. We also acknowledge HPA staff involved in the leptospirosis assay development at Colindale (London) and Porton Down (Salisbury) and the Leptospirosis Reference Unit (Hereford).

DECLARATION OF INTEREST

None.

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