

## Review

# Strengthening health security at the Hajj mass gatherings: characteristics of the infectious diseases surveillance systems operational during the 2015 Hajj

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## Abstract

**Background:** Hajj is one of the largest and the most ethnically and culturally diverse mass gatherings worldwide. The use of appropriate surveillance systems ensures timely information management for effective planning and response to infectious diseases threats during the pilgrimage. The literature describes infectious diseases prevention and control strategies for Hajj but with limited information on the operations and characteristics of the existing Hajj infectious diseases surveillance systems.

**Method:** We reviewed documents, including guidelines and reports from the Saudi Ministry of Health's database, to describe the characteristics of the infectious diseases surveillance systems that were operational during the 2015 Hajj, highlighting best practices and gaps and proposing strategies for strengthening and improvement. Using Pubmed and Embase online search engines and a combination of search terms including, 'mass gatherings' 'Olympics' 'surveillance' 'Hajj' 'health security', we explored the existing literature and highlighted some lessons learnt from other international mass gatherings.

**Results:** A regular indicator-based infectious disease surveillance system generates routine reports from health facilities within the Kingdom to the regional and central public health directorates all year round. During Hajj, enhanced indicator-based notifiable diseases surveillance systems complement the existing surveillance tool to ensure timely reporting of event information for appropriate action by public health officials.

**Conclusion:** There is need to integrate the existing Hajj surveillance data management systems and to implement syndromic surveillance as an early warning system for infectious disease control during Hajj. International engagement is important to strengthen Hajj infectious diseases surveillance and to prevent disease transmission and globalization of infectious agents which could undermine global health security.

**Key words:** Hajj, surveillance, mass gatherings, infectious diseases, outbreak

## Rationale for Improved Health Security at the Hajj

The number of pilgrims participating in the Hajj religious mass gathering has increased significantly over the years, with ~2 million pilgrims attending annually in the last 2 years compared with 135 265 in 1954.<sup>1,2</sup> Unhygienic practices and close contacts between pilgrims in overcrowded situations during

the Hajj rituals, as well as international travel, increase the risks of outbreaks and the spread of infectious diseases among pilgrims.<sup>3</sup> The risk of infectious diseases transmission may extend to the local Saudi population and to the home population of returning pilgrims after Hajj.<sup>4,5</sup> This could strain the public health services in Saudi Arabia and may threaten global health security.

Historically, several outbreaks of infectious diseases have been reported at the Hajj. These include an outbreak of cholera during the 1865 Hajj that caused an estimated 30 000 deaths among pilgrims<sup>6</sup> and a number of international Hajj-related outbreaks of meningococcal diseases in 1987, 2000 and 2001.<sup>7</sup>

The introduction of a number of pragmatic public health preparedness strategies for Hajj, including vaccination and chemoprophylaxis and improved food safety and waste management, ensured that no outbreaks of cholera and meningococcal meningitis occurred during the event in recent years.<sup>7</sup> However, both diseases remain a priority for public health control as do other infectious disease with global significance such as tuberculosis and Zika virus disease.<sup>8,9</sup> In addition, new and emerging corona and influenza viruses, such as influenza H1N1 virus, severe acute respiratory syndrome coronavirus and the middle east respiratory syndrome coronavirus (MERS-CoV) remain an ever present threat to mass gatherings such as Hajj.<sup>2</sup> As yet, no confirmed cases of MERS-CoV were reported during Hajj. However, given the current outbreak of the disease in the Kingdom, MERS-CoV continues to be a major risk during the event.

Effective health information management and dissemination allow the formulation of appropriate strategies to prevent and/or control outbreaks and the international spread of diseases.<sup>10</sup> The use of appropriate surveillance systems during mass gatherings ensures the timely collection, analysis and interpretation of health data for effective planning and response to infectious diseases threats.<sup>11</sup> Additionally, public health surveillance systems play a substantial role in providing reassurance of the absence of a deleterious public health event to mass gathering organizers and political office holders during an international mass gathering.<sup>11</sup> In the context of Hajj and Saudi Arabia, MERS-CoV is a case in point. Thus, an effective infectious diseases surveillance system (IDSS) during Hajj should be highly sensitive to detect infectious diseases events in a timely manner and to minimize the threats to the safety and well-being of pilgrims and their contacts after the mass gathering.

In practice, several IDSSs are operational during Hajj. A regular IDSS is applicable Kingdom-wide and generates routine reports from the health facilities to the regional and central public health directorates of the Ministry of Health (MoH) all year round. During Hajj, this system is complemented by enhanced IDSSs to ensure timely reporting of event information for appropriate action by public health officials. However, there is little documentation of the components and operations of each system, their advantages and disadvantages as well as their efficiency in terms of timeliness of alerts and channels of reporting. Here, we describe the characteristics of the IDSSs that were operational during the 2015 Hajj, highlighting best practices and gaps and propose strategies for strengthening and improvement.

## Hajj Public Health Planning and Organization of Health Services in 2015

The main Hajj rituals take place on Day 8–14th of *Dhu-al-Hijjah* (Hajj month in the Islamic calendar). The Saudi MoH collaborates with other organizations, such as the municipality and the ministry of Hajj to ensure food and water safety, vector control, waste management and to provide other public health

services during Hajj. To that end, the MoH conducted various risks assessments in preparation for the 2015 Hajj, including an international health regulations (IHRs) public health core capacity assessment at the points of entry and disseminated the updated pre-travel advice and health requirements for pilgrims and workers involved in the Hajj.<sup>12</sup> The latter includes details of the vaccination requirement for meningococcal meningitis, yellow fever, seasonal influenza and polio.<sup>12</sup>

In line with IHR 2005, pilgrims arriving from certain countries in Africa and South and Central America were required to present a valid yellow fever vaccination certificate on arrival. All pilgrims were required to present valid certificate of vaccination with quadrivalent (ACYW135) meningococcal vaccine, and those arriving from countries in the African meningitis belt, were given 500 mg of oral ciprofloxacin as chemoprophylaxis to lower meningococcal carriage rate among these pilgrims. Oral ingestion of ciprofloxacin was directly observed by healthcare workers to ensure adherence. All pilgrims travelling from polio risk countries received 1 dose of oral polio vaccine at borders points on arrival in Saudi Arabia regardless of age and vaccination status. The MoH also recommended the administration of seasonal influenza vaccine to all pilgrims before arrival for Hajj, particularly pilgrims at risk of developing severe complications of seasonal influenza, including pregnant women, elderly individuals, children aged 6 months to 5 years, pilgrims with co-existing medical conditions and healthcare workers.<sup>12</sup>

The command and control centre (CCC) is a special MoH unit created in the aftermath of the MERS-CoV outbreak in 2012 to coordinate an appropriate response to infectious diseases outbreaks in Saudi Arabia. As the crisis management arm of the MoH, the CCC coordinated the outbreak response plans of the MoH during the 2015 Hajj, establishing clearly defined interfaces between various MoH departments and international organizations to ensure appropriate and timely response to outbreaks of infectious diseases. The CCC created three situation rooms at key locations in Hajj sites; the Health Directorate of Makkah Region, Almahbat Mina and the Mina Emergency Hospital. These sites were selected because pilgrims spend most of their time in Makkah and Mina, performing Hajj rituals which potentially impacts on their safety and well-being.

Overall, 1 952 817 pilgrims, including 193 645 Saudis and 1 759 172 non-Saudis from 135 countries participated in the 2015 Hajj. Within Makkah city and the Holy areas, the Saudi government provided free healthcare services through 128 primary healthcare centres and 16 hospitals including, 7 seasonal health facilities only operational during Hajj. The hospitals had a combined bed capacity of 4214 beds.

## Types of Infectious Disease Surveillance Operational during the 2015 Hajj

### Regular Infectious Diseases Surveillance

This indicator-based IDSS is implemented country-wide in Saudi Arabia for routine facility-based notification of infectious diseases events all year round, including during Hajj.<sup>13</sup> Each regional public health directorate is made up of 3–6 administrative sub-units known as ‘health sectors’. These sub-units receive and review infectious disease surveillance data from the health

facilities within specified geographical areas in the region for reporting to the regional public health directorates.

The surveillance teams at the regional-level collate data pooled from the health sectors on disease-specific excel sheets for monthly reporting to the central directorate of public health at the MoH headquarters. Despite limited data management capabilities, this surveillance system was proven effective in detecting and triggering timely responses to outbreaks of measles and scabies in the Kingdom in 2012/2013 and 2015, respectively.

### Enhanced Infectious Diseases Surveillance

Enhanced IDSSs are activated during the Hajj season to ensure early detection and prompt response to infectious diseases outbreaks. For the 2015 Hajj, the enhanced surveillance became operational from the first *Dhul-Qa'dah* (Islamic calendar month preceding Hajj) with the arrival of the first batch of pilgrims, and continued until the end of *Moharam* (first month of the Islamic year following Hajj) after the departure of the last group of pilgrims. This system is active at three main points: key points of entry to the Kingdom, healthcare facilities in the Hajj areas and medical office for pilgrims (formerly known as medical missions). Each of these is described later.

### Points of Entry Surveillance

Effective surveillance at the points of entry is required to prevent and control the international spread of diseases during mass gatherings, including the importation of infectious agents to the host country.<sup>14</sup> During the 2015 Hajj, public health surveillance teams trained to detect and report public health threats and to monitor the compliance of arriving pilgrims with the health requirements for the Hajj were deployed at the Kingdom's Hajj entry points. These teams consisted of 589 personnel at Jeddah airport, 101 at Jeddah seaport and 187 at Medina airport. Approximately 97% of international pilgrims arrive through these three points of entry.

At each point of entry, the surveillance teams reviewed the vaccination status of arriving pilgrims by checking their vaccination cards, reported any cases of unvaccinated pilgrims or those with unverifiable vaccination status and recommended appropriate actions for these cases. The surveillance teams were also responsible for identifying and managing ill pilgrims, as well as the notification and transfer of suspected cases of infectious diseases.

### Health Facility-Level Surveillance

Hospital-based surveillance teams were operating in each hospital within the Hajj areas in 2015.<sup>15</sup> These were hospital staff trained to rapidly detect and report manually and electronically cases of infectious diseases presenting to the hospitals. Suspected cases of infectious diseases identified at primary health centres were referred to pre-specified hospitals for confirmation of diagnosis, further management and notification to the CCC. The hospital teams were reinforced by 21 fixed and 15 mobile surveillance teams from the regional directorates to ensure 24-h active surveillance during the Hajj.<sup>15</sup> Whereas each fixed team consisted of 1 medical doctor and 1 health inspector, each mobile team was made up of 2 medical doctors (a male

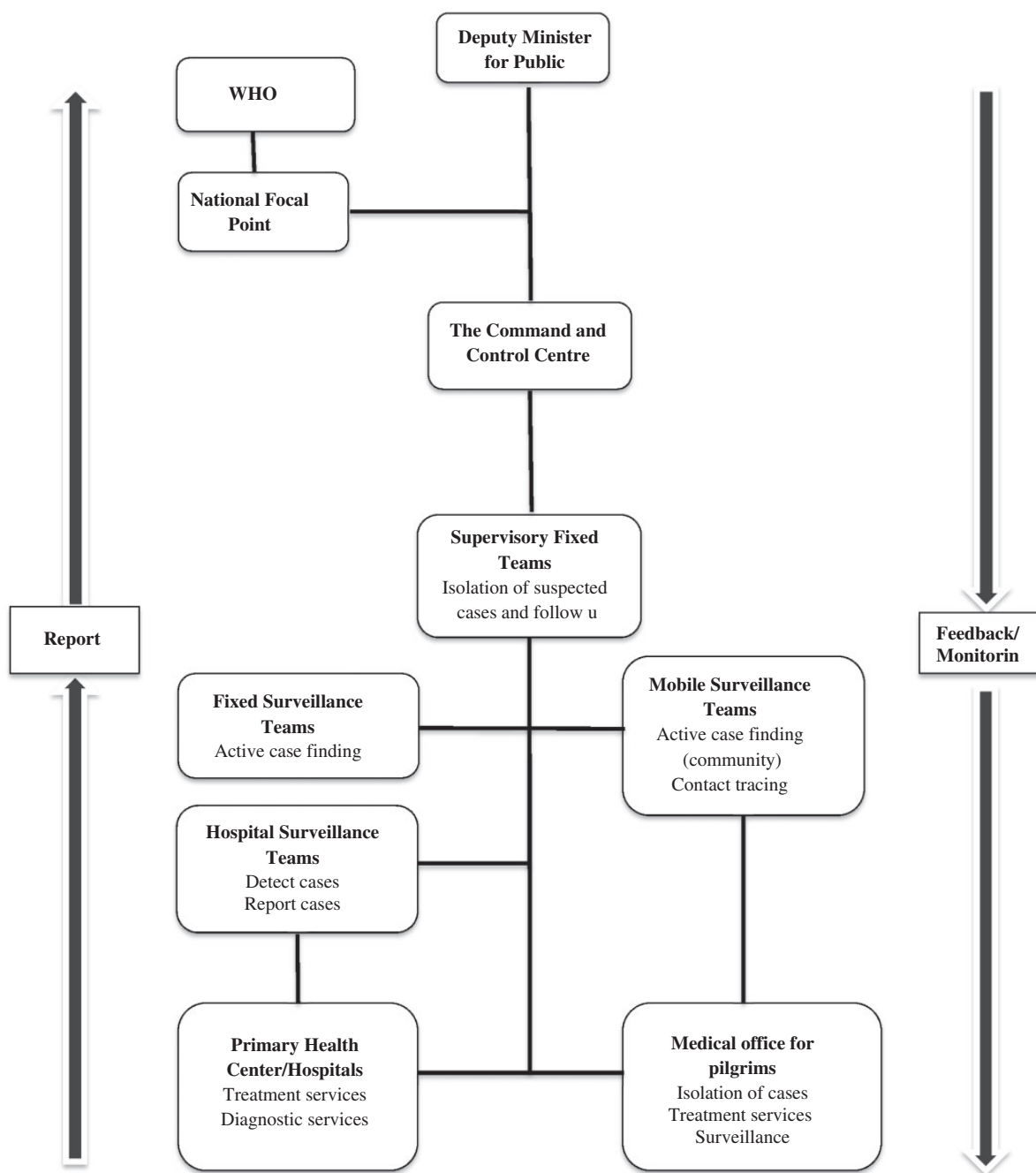
and a female), 1 health inspector and 1 driver. These personnel were drawn from different regional health directorates, across the country and mobilized for a 4-day refresher course, accredited by the Saudi Commission for Health Specialties. Among other relevant topics, the refresher course was focused on discussing the current trends in the management and control of infectious diseases as well as the reporting formats and tools for infectious diseases surveillance during Hajj. The fixed surveillance teams were assigned to each hospital operating in the Hajj areas and reviewed admission logbooks for cases with clinical features of infectious diseases and followed up on cases admitted into the wards to identify and report suspected cases of notifiable diseases to ensure no cases were missed by the hospital surveillance teams. The mobile surveillance teams were tasked to conduct field investigations for reported cases of infectious diseases. These included active case finding and safe transfer of suspected cases to designated facilities, contact tracing, risk communication and liaison with medical office for pilgrims (see later) to facilitate case reporting and effective follow-up of contacts of cases.

Additionally, supervisory units composed of epidemiologists and infectious diseases specialists were established by the regional directorates to monitor the activities of the mobile and fixed surveillance teams and to serve as an intermediary between these surveillance teams and the regional directorates (Figure 1). The supervisory units were also responsible for the isolation of suspected cases, follow-up of laboratory investigations and clinical status of hospitalized cases, as well as monitoring to ensure the implementation of the appropriate infection prevention and control procedures for patients, healthcare personnel and visitors.

Although the surveillance teams investigated all suspected infectious diseases cases, the following diseases were listed as high priority during Hajj, and clear guidelines were provided for reporting suspected cases of these disease: MERS-CoV, Ebola virus disease (EVD), cholera, meningococcal meningitis, yellow fever, polio, Rift Valley fever, Crimean fever, Dengue fever, malaria, influenza and food poisoning. Of all suspected cases detected by the IDSSs in the 2015 Hajj, 94 cases of malaria, 72 cases of influenza H1N1, 22 cases of food poisoning, 3 cases of Dengue and 2 cases of non-meningococcal meningitis were confirmed after investigations.<sup>16</sup> There were no confirmed cases of MERS-CoV illness, EVD or cholera during the 2015 Hajj season.

### Medical Office for Pilgrims-Level Surveillance

Hajj medical office for pilgrims refers to the healthcare representatives of some countries which send pilgrims for the Hajj and accompany pilgrims during the event. They may set up clinics or hospitals within the Hajj areas and provide healthcare services for their own pilgrims in compliance with the Saudi MoH rules and regulations. The composition of the medical office for pilgrims varies from country to country; however, it is recommended that a minimum of 20% of their staff should have a public health background.<sup>17</sup> A memorandum of understanding is established between the Saudi authorities and the medical office for pilgrims for effective coordination and communication of the standard public health requirements for the Hajj. The medical offices are required to comply with the standard sanitary



**Figure 1.** Reporting pathway for the Hajj enhanced IDSS.

requirements for food preparation and handling, to educate pilgrims on personal hygiene and proper waste disposal and to submit a valid contract with an accredited firm for medical waste management to the regional directorates. Additionally, they are required to provide daily reports on notifiable diseases, to establish isolation areas for suspected cases and to coordinate with the public health supervisory teams for the safe transfer of these cases when necessary. Of the 60 country medical offices operational during the 2015 Hajj only 20 (33%) were found to be compliant with the standard requirements of the Saudi MoH. The inconsistency of some medical representatives, with regards to compliance with the requirements of the MoH and the frequent change

of medical teams by countries sending pilgrims, often soon after the Hajj limits sustainable partnership between the MoH and the medical offices for pilgrims.

### Infectious Diseases Surveillance Tools during Hajj

#### Electronic Surveillance Systems (HESN, CITREX)

Increasingly electronic surveillance systems are gaining international recognition as effective public health tools for real-time data management by stakeholders operating from different

locations.<sup>2,18</sup> Overall, two electronic surveillance systems were operational during the 2015 Hajj: the health electronic surveillance network (HESN) and the electronic statistical system for Hajj referred to as CITREX. HESN is a web-based electronic solution, introduced by the Saudi MoH to improve communication among public health professionals involved in outbreak management as well as to provide quality health data for planning and effective allocation of resources. HESN was initially implemented as a pilot in Makkah region of Saudi Arabia in 2012. By January 2014, a country-wide implementation was initiated to control the outbreak of MERS-CoV in the Kingdom. During the 2015 Hajj, in addition to the traditional data capture and reporting tools, the hospital surveillance teams also collated and entered infectious diseases data directly into HESN once a notification was received from the laboratory, emergency rooms, isolation wards and other departments in hospitals. The uploaded data were immediately displayed on electronic dashboards in the CCC's situation rooms. Data were analysed and reports generated in real-time that could be immediately accessed by public health officials and decision makers or disseminated through phone messages to responsible persons for immediate action.

CITREX is a web-based electronic solution that predates HESN and was used in the preceding Hajj seasons. In 2015 Hajj, this system was operational alongside HESN. Unlike HESN which is implemented country-wide, CITREX is used only during Hajj to manage infectious diseases data captured in real time from the health facilities in the Holy areas (Makkah, Medina, Arafat and Mina). Although the hospital surveillance teams handled data entry into HESN, the fixed surveillance teams captured the same health data into CITREX for analysis and notification on distinct electronic dashboards at the CCC.

### Gaps and Areas for Strengthening and Improvement

Over the years, the Saudi government has allocated substantial resources to protecting public health during the Hajj. This contributed to the development of modern surveillance systems for the Hajj, evolving from the paper-based reporting tools to a more efficient web-based electronic surveillance systems. Enhanced IDSSs were introduced to complement the conventional surveillance system in addressing the increased risks of infectious diseases transmission and outbreaks during the Hajj. Existing electronic surveillance systems (HESN and CITREX) automatically generates reports and have the advantage of timeliness, as public health personnel at different locations can access and synchronize information management once data is captured at the reporting sites. However, the implication of having parallel systems capturing and interpreting the same health data has some potential implications, including duplication of work, depletion of already limited resources during Hajj and uncertainty of the accuracy of the data. Therefore, there is a need to conduct operational studies to assess the feasibility of integrating the diverse surveillance systems utilized during Hajj into one efficient tool. Prioritizing systems that remain operational for routine surveillance after Hajj may promote the most efficient use of resources.<sup>14</sup> Furthermore, there is need to sustain the enhanced surveillance system and other public health

interventions at key locations in the Kingdom, including the points of entry, after the Hajj, as a prevention and control strategy for the international spread of diseases during other mass gatherings with international dimensions, principally the Umrah pilgrimage. It is estimated that over 8 million pilgrims arrive to the Kingdom yearly to participate in the Umrah, which occurs nearly all-year round.

Syndromic surveillance could complement the existing notifiable disease surveillance systems, as an early warning system for public health threats during the Hajj and Umra mass gatherings.<sup>14</sup> Various risk assessments have shown that case-based notification systems do not meet the surveillance requirements for international mass gatherings, in terms of timeliness and coverage of possible risks groups.<sup>11,19</sup> Quite often, time-consuming laboratory processes required for making diagnosis may stall the disease notification process, and hence prolong the time for initiating an intervention to a potential threat. Symptomatic pilgrims who prefer 'quick-to-access' pharmacies may not present to the health facilities, eluding the current notifiable disease surveillance systems operational during Hajj. Syndromic surveillance uses aggregated data of symptom groups from a wide range of sources that precedes clinical diagnosis to set thresholds for responding to a threat.<sup>14</sup> This kind of surveillance is also useful for dispelling or confirming rumours of outbreaks, based on changes in the reported number of aggregated cases in an area.<sup>11</sup> The potential benefits of syndromic surveillance during mass gatherings were reported during previous Olympic games. For example, the syndromic surveillance system implemented during the 2008 Beijing Olympic Games improved the detection and response time to potential outbreaks during the games.<sup>20</sup> Additionally, the daily syndromic surveillance data captured during the 2012 London Olympics and Paralympic Games reassured public health officials and political office holders of the absence of outbreaks, which substantially impacted on planning, and boosted the legacy of the event.<sup>11</sup> Thus, the MoH through the global centre for mass gatherings medicine (GCMGM) and the Saudi field epidemiology training programme is setting up a syndromic surveillance system for the Hajj and Umra mass gatherings to complement the enhanced IDSS, as an early warning system for public health threats. This system may become operational during the 2016 Hajj.

### International Engagement

Ensuring the health and safety, security and well-being of pilgrims are top priorities for the Kingdom. Achieving this is a collective responsibility that needs to be shared by Saudi Arabia and each country that sends pilgrims to the Hajj. This is because the Hajj experience is not limited to the few days pilgrims spend performing the Hajj rituals. Rather, it starts well before they arrive to the Kingdom and lasts long after they have returned to their home countries. Prevention of importation and exportation of infectious agents in Hajj is key for global health security and effective infectious disease surveillance both in the Kingdom during Hajj, as well as in the countries of origin of pilgrims, is crucial in achieving this. Therefore, it is apparent that there is a great need for the development of a well-structured, harmonized and effective collaboration, data collection and information sharing network involving the Saudi health



authorities and representatives from all countries sending pilgrims to the Hajj. Such a network would be crucial in strengthening infectious disease surveillance, preventing illnesses and responding to outbreaks during Hajj, minimizing disease transmission as well as strengthening global health security through adherence to the IHRs, including notifiable diseases reporting to the WHO.

For these reasons, the GCMGM in collaboration with the WHO intends to create this global network by the appointment of a Hajj and Umra focal point in each country which sends pilgrims to Saudi Arabia for these mass gatherings. Considering the potential diplomatic and practical hurdles that may stall the implementation of such an international system, both organizations aim to prioritize countries sending the largest number of pilgrims to the Hajj, and to retrain existing WHO IHR country focal point or WHO country office staff to function as focal point and to coordinate the activities of the network in each country. These focal points shall engage in public health preparedness activities such as dissemination of health education messages, monitoring pilgrims' health status and compliance with the Hajj and Umra health requirements, as well as routine surveillance for public health emergencies of international concern. Additionally, they shall develop and maintain a database on pilgrims' demographics and health information as well as on public health threats including disease outbreaks in pilgrims' home countries. This database will allow the focal point to generate periodic and on-request reports on infectious disease to the WHO, the GCMGM or the local health authorities as required, facilitating the monitoring of disease patterns and trends globally and strengthening the Kingdom's public health Hajj preparedness and response capabilities.

During the recently concluded 2016 Hajj, the ministry of Hajj introduced an electronic wrist bracelet, which pilgrims were urged to wear at all times during the pilgrimage. The bracelet captured salient demographic information for each pilgrim, including age and nationality, and was Global Positioning System (GPS) enabled to track pilgrims' location and inform crowd control and risk communication priorities during the Hajj. The MoH is already exploring ways of incorporating vital health information, such as comorbidity, blood type and known allergies, in the electronic device to provide relevant data for health planning and improved health services delivery during future Hajj.

## Summary

The Saudi authorities have invested significant resources in developing model IDSSs for the Hajj to ensure the safety and well-being of pilgrims, the Saudi population and the population of countries sending pilgrims for the Hajj. Existing surveillance systems operating during Hajj would be complemented by syndromic surveillance systems to ensure timely response to potential public health threats. Since the Hajj experience is not limited to the short time pilgrims spend performing the Hajj in Saudi Arabia, there is a need for sustainable international collaborations between the Saudi authorities, countries which send pilgrims for the Hajj and international organizations to strengthen infectious diseases surveillance and to prevent disease

transmission and globalization of infectious agents which could undermine global health security.

**Conflict of interest:** None declared.

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