



Establishment of public health security in Saudi Arabia for the 2009 Hajj in response to pandemic influenza A H1N1

Z A Memish, S J N McNabb, F Mahoney, F Alrabiah, N Marano, Q A Ahmed, J Mahjour, R A Hajjeh, P Formenty, F H Harmanci, H El Bushra, T M Uyeke, M Nunn, N Isla, M Barbeschi, and the Jeddah Hajj Consultancy Group*

Lancet 2009; 374: 1786–91

Published Online

November 14, 2009

DOI:10.1016/S0140-

6736(09)61927-9

See [Editorial](#) page 1724

*Members listed at end of paper

Ministry of Health, Riyadh, Saudi Arabia (Z A Memish MD);

Office for Surveillance, Epidemiology, and Laboratory Services, US Centers for Disease

Control and Prevention, Atlanta, GA, USA

(S J N McNabb PhD); US Centers

for Disease Control and

Prevention Office, Jakarta,

Indonesia (F Mahoney MD);

National Center for

Immunization and Respiratory

Diseases, US Centers for Disease

Control and Prevention,

Atlanta, GA, USA (F Mahoney,

R A Hajjeh MD, T M Uyeke MD);

Department of Medicine, King

Faisal Specialist Hospital and

Research Centre, Riyadh, Saudi

Arabia (F Alrabiah MD);

National Center for

Preparedness, Detection and

Control of Infectious Diseases,

US Centers for Disease Control

and Prevention, Atlanta, GA,

USA (N Marano DVM);

Department of Medicine,

Division of Pulmonary Disease,

Winthrop University Hospital,

Mineola, NY, USA

(Q A Ahmed MD); Division of

Communicable Disease

Control, Eastern Mediterranean

Regional office, World Health

Organization, Cairo, Egypt

(J Mahjour MD, H El Bushra MD);

Department of Global Alert and

Response, World Health

Organization, Geneva,

Switzerland (P Formenty MD,

M Nunn MSc, N Isla MSc,

M Barbeschi PhD); and Global

Influenza Program, World

Health Organization, Geneva,

Switzerland

(Prof F H Harmanci MD)

Correspondence to:

Dr Z A Memish, Ministry of

Health, Riyadh 11176,

Saudi Arabia

zmemish@yahoo.com

Mass gatherings of people challenge public health capacities at host locations and the visitors' places of origin. Hajj—the yearly pilgrimage by Muslims to Saudi Arabia—is one of the largest, most culturally and geographically diverse mass gatherings in the world. With the 2009 pandemic influenza A H1N1 and upcoming Hajj, the Saudi Arabian Ministry of Health (MoH) convened a preparedness consultation in June, 2009. Consultants from global public health agencies met in their official capacities with their Saudi Arabian counterparts. The MoH aimed to pool and share public health knowledge about mass gatherings, and review the country's preparedness plans, focusing on the prevention and control of pandemic influenza. This process resulted in several practical recommendations, many to be put into practice before the start of Hajj and the rest during Hajj. These preparedness plans should ensure the optimum provision of health services for pilgrims to Saudi Arabia, and minimum disease transmission on their return home. Review of the implementation of these recommendations and their effect will not only inform future mass gatherings in Saudi Arabia, but will also strengthen preparedness efforts in other settings.

Introduction

Mass gatherings of people, from worldwide sporting events (eg, Olympic or World Cup Soccer finals) to global religious occurrences (eg, papal visits, Hajj—pilgrimage by Muslims to Mecca [Makkah], Saudi Arabia), present unique challenges and add burden to the host countries and travellers' countries of origin.^{1–4} Public health systems become strained even if they are advanced and effective in preventing and controlling the endemic disease burden,^{5–7} and even if the countries have the appropriate resources.^{8,9}

Hajj is the largest, most diverse mass gathering of people in the world. Distinguished by its occurrence once a year, Hajj attracts more than 2·5 million pilgrims.¹⁰ Umrah involves visits to the same holy sites in Makkah as Hajj, and can be completed within a day at any time during the year, and some Muslims do it more than once in their lifetimes. By contrast, pilgrims during Hajj visit the holy sites in Makkah with long stays at specific locations. Muslims should make at least one Hajj in their lifetime. Mass gathering of pilgrims from more than 160 countries increases public health risks (eg, foodborne diseases, meningococcal outbreaks, heat exhaustion, unintentional injuries, and respiratory illnesses).^{11,12} Crowd densities can increase to seven individuals per m² during Hajj (figure). Although the basic reproduction number for the 2009 pandemic influenza A H1N1 virus was estimated to be 1·2–1·7,¹³ the reproduction number and secondary attack rates could be greater among exposed, susceptible individuals in intensely crowded settings like Hajj.

Individuals doing Hajj vary in age, but tend to be older and poorer than participants in other mass gatherings. Results from a study suggest that the average pilgrim has a disproportionate number of pre-existing health problems, and does not have adequate health literacy and access to advanced pre-Hajj health care.¹⁴

Transmission of infectious disease during mass gatherings has a global effect when visitors return to

their country of origin.¹⁰ Individuals going on Hajj contributed to a global cholera outbreak in the 19th century.¹⁵ Although the public health management during mass gatherings in Saudi Arabia has improved with modernity, outbreaks still occur.⁴ A global Hajj-related group A meningococcal disease outbreak was reported in 1989 among pilgrims and the other individuals they came into contact with in their countries of origin.¹⁰ Reports of other Hajj-related meningococcal outbreaks with global spread have prompted the Saudi Arabian officials to mandate meningococcal vaccination for pilgrims to obtain visas for Hajj.^{10,16}

Challenges

Modern transportation contributed to the emergence and global spread of the 2009 pandemic influenza A H1N1.¹⁷ Some passengers with 2009 pandemic influenza A H1N1 virus infection might not be detected at entry to Saudi Arabia if they are within the disease incubation period, and might have illness onset and be contagious after arrival. Most pilgrims arrived by land or sea during the 1957 (n=215 000) and 1968 (n=318 000) influenza pandemics.¹⁸ The 2009 pandemic is the first since 1970, the year when the numbers of individuals using air travel to arrive in Saudi Arabia for the purpose of Hajj surpassed the numbers of those travelling by sea.

So the 2009 pandemic influenza A H1N1 poses a great concern for the Saudi Arabian officials.^{19–21} Transmission of seasonal influenza virus has been reported among pilgrims during Hajj,^{10,22–27} and although most pilgrims are likely to be susceptible to infection with the 2009 pandemic influenza A H1N1 virus, there is little evidence of cross-immunity from seasonal influenza vaccination or previous infection, except among elderly individuals.^{28,29} Additionally, few pilgrims are likely to have access to the 2009 pandemic influenza A H1N1 vaccine before they travel to Saudi Arabia for Hajj.³⁰

Children and young adults (>15 years and <49 years) had the highest illness rates during the early phase of the 2009 pandemic influenza A H1N1.³¹ Although most people who were ill had mild-to-moderate, self-limited disease, specific groups—including children, pregnant women, people with underlying comorbidities (eg, metabolic, respiratory, cardiac, renal, and immunosuppressive disorders, and obesity)—had severe disease as defined by admission to hospital or death.^{32–40}

Organisers have acquired extensive skills in the planning and management of the Hajj. However, such knowledge remains largely unshared with global partners. Furthermore, the absence of outcome measures and standardised practices prevents transparent scientific exchange of knowledge and techniques used to deal with mass gatherings. Preparation for the 2009 Hajj afforded an opportunity not only to share the skills but also to strengthen preparations for the pandemic influenza A H1N1.

Consultation process

To safeguard the health of pilgrims during Hajj and mitigate disease transmission on their return were paramount considerations. With these issues in mind, the Saudi Arabian Ministry of Health (MoH) urgently convened a strategic and technical consultation with global public health counterparts. Consultants from global agencies with considerable knowledge about mass gatherings of people, infectious disease epidemiology, public health practice, migration and border control, and public health systems convened in their official capacities. They identified gaps, considered interventions, and made recommendations to form a logical, comprehensive, and evidence-based plan for prevention and control of 2009 pandemic influenza A H1N1 during and after Hajj. The consultation took place in Jeddah, Saudi Arabia, which is the main route for travellers to Hajj with several important pilgrim processing sites, during June 26–30, 2009. The consultants inspected the Hajj terminal at King Abdulaziz International airport, screening procedures, seaport health facilities, and the laboratory in Jeddah.

Eight functional domains, representing a comprehensive public health perspective during mass gatherings, were selected from WHO's core guidance for control of infectious diseases (panel 1). In plenary session, authorities reviewed the preparedness plans, epidemiology of influenza, and status of the current pandemic. Consultants separated into groups that were stratified according to the first four domains (panel 1). After discussion using scripted templates to probe specific issues, recommendations were made to the entire group. Each group discussion was followed by an open debate towards achieving a consensus. The process was repeated for the other four domains. The funding source for the consultation was the Saudi Arabian MoH. The staff members of the MoH and members of the



Figure: Crowds circumambulating the Ka'ba on the 27th night of Ramadan

The Ka'ba is a cuboid building, representing the House of God, located in the centre of the Al Haram Mosque in Mecca (Makkah), Saudi Arabia.

Panel 1: Functional domains for mass gathering of pilgrims during Hajj

- Hajj cross-cutting issues
- Medical services, infection control, and emergency medical services
- International Health Regulations (2005)⁴¹, travel, and quarantine
- Command and control (including health security, communications systems, risk communications, deaths)
- Risk management
- Surveillance, epidemiology, and informatics
- Laboratories and diagnostics
- Outbreak response

national scientific committee for infectious diseases assisted in the discussions, analysis, interpretation, and writing of the report.

Constraints

There were constraints in the development of evidence-based recommendations. First, pandemic vaccine would not be available in sufficient quantity before the 2009 Hajj, thus the focus of recommendations was on best hygiene practices, pretravel preparations, surveillance, public health communications, border screening, and use of antiviral drugs in specific circumstances. The use of declarations about the health of travellers, thermal scanning, and influenza laboratory tests, and isolation of ill travellers until test results were available could not prevent the transmission of the 2009 pandemic influenza A H1N1 virus. The assessment of

For more on control of infectious diseases during mass gathering see http://www.who.int/csr/mass_gatherings/en/index.html

For more on Jeddah international consultation report see http://www.emro.who.int/csr/h1n1/pdf/infectiousdiseases_hajj_umra.pdf

the feasibility and effectiveness of screening large numbers of travellers, and the isolation of ill individuals was a challenge for the MoH. Although screening of individuals on arrival to the country might result in the detection of some symptomatic individuals, it would probably miss those incubating the 2009 pandemic

Panel 2: Recommendations for public health preparedness during 2009 Hajj

Screening and isolation

- In the absence of sustained community transmission, a facility with the capacity to house 200–500 individuals should be made available to isolate any pilgrims showing signs that meet the definition of influenza-like illness on their arrival to Saudi Arabia.
- Individuals in the isolation areas should wear masks, and use hand gel and tissues.
- Thermal scanning should be considered for the identification of individuals with influenza-like illness at ports of entry only in the absence of sustained community transmission.
- Isolation and influenza testing of pilgrims should be considered (until isolation capacity is exceeded, in which case an additional facility might be needed) only in the absence of sustained community transmission.
- Influenza testing and isolation of all pilgrims with influenza-like illness is not recommended because there might be too many individuals to test; once widely publicised, isolation will be a powerful deterrent to the self-reporting of illness; separation of individuals from groups might cause them considerable difficulty in reuniting with other members of their group.

Surveillance, epidemiology, and informatics

- Saudi Arabian Ministry of Health (MoH) should review the existing list of notifiable diseases (ie, meningococcal disease, yellow fever, poliomyelitis, food poisoning, plague, acute diarrhoea, haemorrhagic fever, and influenza—especially those reported during Hajj) for appropriateness, variables gathered, timeliness of reporting, and interventions.
- Laboratory-confirmed infection with 2009 pandemic influenza A H1N1 or seasonal influenza A or B virus, influenza-like illness, and complications of severe acute respiratory illness (eg, pneumonia) requiring admission to hospital or death should be included in the list of notifiable illnesses.
- MoH should establish a laboratory-based sentinel surveillance for patients with influenza-like illness who are treated in hospital.
- Testing of patients with influenza-like illness and severe acute respiratory illness should be based on surveillance strategies and clinical indications.
- Surveillance for infection with seasonal influenza virus and 2009 pandemic influenza A H1N1 virus among health-care workers should also be included in the plan.

(Continues in next column)

(Continued from previous column)

- Deployment of a mobile, handheld data gathering and communication system (with geographical information system capability) for gathering and transmitting data about notifiable diseases to the central command centre should be considered. This equipment should be provided to public health personnel in the primary health centre, in collaboration with medical mission staff and the mutawifs (local representatives who look after groups of pilgrims).
- Develop and undertake an assessment of study and programme to monitor the economic and structural effects of the 2009 pandemic influenza A H1N1 on the Saudi Arabian health-care system during Hajj.
- Public health communication strategies are needed to orient and remind providers about case definitions and management of all diseases that need to be reported, with emphasis on the 2009 pandemic influenza A H1N1. One such strategy is to establish a core team of public health workers, recruited, trained, and deployed during Umrah to assist with public health surveillance and response activities. These workers could liaise with various medical missions in camps and primary health centres to undertake surveillance; orient the mutawifs to improve coordination with activities in preventive health; assist in outbreak investigations; and train the trainers.
- Deployment of the same staff members to undertake these tasks during Umrah and Hajj will improve preparedness during Hajj.
- MoH should update manuals about communicable diseases (including infection control) and distribute them widely.
- International Health Regulations⁴¹ should be used for reporting public health events to WHO.

Laboratory testing

- Protocols are needed to test patients for severe acute respiratory illness; specimen management, including which specimens to be collected and management of processing and laboratory database; specimen transportation and shipping, and sharing and dissemination of the surveillance data; testing algorithms that include seasonal influenza; mandatory laboratory reporting of notifiable diseases; maintenance and distribution of reagent stockpiles and sample collection kits.
- MoH should strengthen the capacity of influenza laboratories (ie, staff and laboratory equipment) in Mecca (Makkah) and Medina, Saudi Arabia.
- MoH should purchase and install new equipment as needed.
- MoH should test respiratory specimens from all patients admitted to hospital with severe acute respiratory illness for 2009 pandemic influenza A H1N1 virus infection and other influenza virus infections.

(Continues on next page)

(Continued from previous page)

- One approach is to systematically take samples from patients with severe acute respiratory illness for testing on the basis of laboratory capacity if testing all patients for influenza virus infection is not possible.
- MoH laboratory-based surveillance of patients with influenza-like illness and severe acute respiratory illness should begin as soon as possible for detection of seasonal influenza A and B viruses and 2009 pandemic influenza A H1N1 virus in respiratory specimens with real-time RT-PCR and viral culture.
- Testing patients with influenza-like illness for infection with influenza virus should be based on sentinel surveillance strategies and not done ad hoc.
- MoH should use other laboratories in surge events—ie, laboratories in King Abdul Aziz University (Jeddah), National Guard Hospital (Jeddah), and El Haddah Military Hospital.

Infection control

- Patients with influenza-like illness seeking medical care should be given education and personal hygiene kits to prevent transmission of respiratory pathogens.
- WHO should emphasise the importance of hand hygiene and similar behavioural measures (eg, cough etiquette) in their travel guidance for people attending mass gatherings.⁴⁹

Treatment of 2009 pandemic influenza A H1N1 infection

- All patients with severe acute respiratory illness admitted to hospital should be treated empirically with oseltamivir or zanamivir as soon as possible according to MoH guidelines.
- All outpatients with influenza-like illness in high-risk groups for severe disease with suspected pandemic influenza A H1N1 virus infection should be treated as soon as possible with oseltamivir or zanamivir. These patients include pregnant women, people with chronic diseases, immunosuppressed individuals, people older than 64 years, children younger than 5 years, health-care workers, essential infrastructural staff working in Hajj areas, and all individuals diagnosed with pneumonia.
- Decision to use other antiviral drugs for seasonal influenza treatment should be based on surveillance data and dominant virus strains (US Advisory Committee on Immunization Practices statement and WHO recommendations).⁴⁶
- Consider treating all patients with influenza-like illness with oseltamivir or zanamivir in settings in which the health-care system is strained and assessment of all patients seeking care is not possible.
- Maintain treatment during influenza surge. Medical treatment teams and facilities should be on standby; involve other missions, departments, and backup teams; and have a quick access plan (eg, use of motorcycles) in place for getting to outbreak sites (Mina, Saudi Arabia).

influenza A H1N1 virus, people taking antipyretic drugs, and those who were afebrile.

Assessment of the country's capacity for timely and accurate influenza laboratory testing is difficult because currently available rapid influenza antigen tests have low sensitivity.^{42,43} Additionally, there are other infectious causes for the acute respiratory or influenza-like illnesses among pilgrims.^{21,44} With the laboratory capacity in Saudi Arabia (in terms of the number of test kits and trained personnel), real-time RT-PCR might not be practical for screening large numbers of travellers for the presence of the 2009 pandemic influenza A H1N1 virus.

Another constraint is the scarcity of data for the effectiveness of individuals wearing masks in public. Although in controlled studies the efficacy of household members wearing masks and maintaining hand hygiene was inadequate,⁴⁵ the efficacy among pilgrims is unknown. Consultants also realised that wide-scale use of antiviral drugs for chemoprophylaxis was simply not feasible during Hajj.⁴⁶

Transmission of the 2009 pandemic influenza A H1N1 virus to pilgrims might also be spread to individuals they come into contact with on aeroplanes. However, on the basis of feasibility, screening or provision of oseltamivir to symptomatic individuals before they returned home after Hajj was not recommended because of the high rates of respiratory illness among the returning pilgrims. Also, we did not think that there was the need to provide antiviral drugs to large numbers of returning pilgrims. Although the circulating 2009 pandemic influenza A H1N1 virus is susceptible to oseltamivir and zanamivir, treatment is generally recommended for all inpatients as well as any outpatients who are at high risk of severe complications. Therefore, administration of antiviral chemoprophylaxis to pilgrims on arrival and throughout the duration of the Hajj was not a feasible strategy. The reported sporadic cases of resistance to oseltamivir have caused concern that mass chemoprophylaxis could lead to emergence of resistant strains of the virus.^{47,48}

We also had difficulty in assessing the potential effect of the pandemic on the capacity of the Saudi Arabian health-care system. On the basis of the recorded rates of admissions to hospital in currently affected countries, and the expected high prevalence of chronic health problems among the pilgrims, wide-scale transmission could lead to substantial numbers of individuals needing treatment in hospital, including many patients who might need to be treated in an intensive care unit.

Recommendations and conclusions

Panel 2 shows the recommendations made by the consultants. The most important recommendation was to encourage individuals at risk of severe disease to postpone their participation in Hajj until another year. These include elderly people, pregnant women, individuals with chronic diseases, and children. The recommendations were applicable before or during Hajj.

Mass gatherings of people challenge public health vigilance and knowledge⁵⁰ because they increase the epidemiological potential for the spread of disease to a maximum, increase the risk of non-intentional injuries, and exacerbate pre-existing chronic conditions. Continual vigilance to improve public health effectiveness and efficiency should become best practice—ie, the state-of-the-art policies, planning, communications, surveillance, and operations in stressful and emergency conditions should be continually reviewed. Furthermore, after-action reviews should be done to improve future performance on the basis of real-time experience. Noteworthy is that the recommendations generated during this meeting were based on the current status of the pandemic and therefore might need revision, dependent on the changes in virus characteristics and epidemiology of infections with the 2009 pandemic influenza A H1N1 virus.

Contributors

ZAM was the meeting chair and organiser; participated in the preworkshop planning and workshop activities; and contributed to development and drafting of recommendations, data interpretation, and writing and editing the report. SJNM, MN, and MB cofacilitated the meeting. SJNM and MB participated in the premeeting planning and workshop activities, drafting and editing the report, and contributed to data interpretation. FHH and FA participated in the workshop, editing, and recommendations. NM, JM, RAH, PF, and HEB contributed to recommendations for drafting, and revisions. NM also contributed to data gathering and interpretation, and writing the report. NI contributed to the meeting organisation and planning, and in writing the report. FM participated in the workshop, was a facilitator, and assisted with writing and editing the final report. QAA participated in data interpretation, and writing, revising, and serial editing the report. TMU contributed to the recommendations and drafting, revisions, and writing of the report. MN drafted the original report and did some subsequent edits.

Jeddah Hajj Consultancy Group

Saudi Arabia Ali Al-Barrak, Sami Al-Hajjar, Saud Al-Hassan, Abdullah Al-Hokail, Ibraheem Al-Omar, Sami Badawood, Nuha Dashash, Khalid Dhafar, Raafit Hakim, Sahar Makki, Khaled Marghalani, Amin Mishkhas, Adel Turkestani, Abdul Hafeez Turkustani.
Sweden Evelyn Depoortere. *Egypt* Ahmed Elgenainy, Malik Mamunar.
USA Ngozi Erondu, James Gale. *Australia* Jan Fizzell.
Switzerland Max Hardiman. *China* Chin-Kei Lee. *UK* Brian McCloskey.
Greece Takis Panagiotopoulos.

Conflicts of interest

We declare that we have no conflicts of interest.

Acknowledgments

We thank Ngozi Erondu and Sylvie Briand for their support and scientific input, and extraordinary contributions to the meeting about public health preparedness for mass gatherings held in June, 2009. Consultants were drawn from WHO and included specific members of WHO Virtual Interdisciplinary Advisory Group on mass gatherings; US Centers for Disease Control and Prevention, Atlanta, Georgia, USA; European Centre for Disease Prevention and Control, Stockholm, Sweden; Centre for Health Protection, Department of Health, Sydney, NSW, Australia; University of Washington, Seattle, WA, USA; Health Protection Agency, London, UK; and Hellenic Centre for Disease Control and Prevention, Athens, Greece. The views expressed in this report are those of the authors and do not necessarily represent the decisions or the stated policy of the agencies or organisations for which the authors work.

References

- Rashid H, Haworth E, Shafi S, Memish ZA, Booy R. Pandemic influenza: mass gatherings and mass infection. *Lancet Infect Dis* 2008; **8**: 526–27.

- Fizzell J, Armstrong PK. Blessings in disguise: public health emergency preparedness for World Youth Day 2008. *Med J Aust* 2008; **189**: 633–36.
- Arbon P. Mass-gathering medicine: a review of the evidence and future directions for research. *Prehosp Disaster Med* 2007; **22**: 131–35.
- Ahmed QA, Arabi YM, Memish ZA. Health risks at the Hajj. *Lancet* 2006; **367**: 1008–15.
- Alzeer AH. Respiratory tract infection during Hajj. *Ann Thorac Med* 2009; **4**: 50–03.
- Landry P, Slama S. Pilgrimage and other mass gatherings: epidemiology and prevention. *Rev Med Suisse* 2008; **4**: 1192–95.
- Schenkel K, Williams C, Eckmanns T, et al. Enhanced surveillance of infectious diseases: the 2006 FIFA World Cup experience, Germany. *Euro Surveill* 2006; **11**: 234–38.
- Ahmed QA, Barbeschi M, Memish ZA. The quest for public health security at Hajj: the WHO guidelines on communicable disease alert and response during mass gatherings. *Travel Med Infect Dis* 2009; **4**: 226–30.
- Savoia E, Biddinger PD, Fox P, Levin DE, Stone L, Stoto MA. Impact of tabletop exercises on participants' knowledge of and confidence in legal authorities for infectious disease emergencies. *Disaster Med Public Health Prep* 2009; **3**: 104–10.
- Memish ZA, Venkatesh S, Ahmed QA. Travel epidemiology: the Saudi perspective. *Int J Antimicrob Agents* 2003; **21**: 96–101.
- Memish ZA, Ahmed QA. Mecca bound: the challenges ahead. *J Travel Med* 2002; **9**: 202–10.
- Rashid H, Shafi S, Haworth E, et al. Viral respiratory infections at the Hajj: comparison between UK and Saudi pilgrims. *Clin Microbiol Infect* 2008; **14**: 569–74.
- WHO. Mathematical modeling of the pandemic H1N1 2009. *Wkly Epidemiol Rec* 2009; **84**: 341–48.
- Kaiser R, Coulombier D. Epidemic intelligence during mass gatherings. *Euro Surveill* 2006; **11**: E061221.3.
- Duguet F. Le pèlerinage de La Mecque au point de vue religieux, social et sanitaire. Paris: Rieder, 1932.
- Memish ZA. Meningococcal disease and travel. *Clin Infect Dis* 2002; **34**: 84–90.
- Khan K, Arino J, Hu W, et al. Spread of a novel influenza A (H1N1) virus via global airline transportation. *N Engl J Med* 2009; **361**: 212–14.
- Long DE. The Hajj today—survey of the contemporary Makkah pilgrimage. New York: State University of New York Press, 1979.
- Rashid H, Shafi S, Haworth E, et al. Influenza vaccine in Hajj pilgrims: policy issues from field studies. *Vaccine* 2008; **26**: 4809–12.
- Madani TA, Ghabrah TM. Meningococcal, influenza virus, and hepatitis B virus vaccination coverage level among health care workers in Hajj. *BMC Infect Dis* 2007; **7**: 80.
- Human infection with new influenza A (H1N1) virus: WHO Consultation on suspension of classes and restriction of mass gatherings to mitigate the impact of epidemics caused by influenza A (H1N1), May 2009. *Wkly Epidemiol Rec* 2009; **84**: 269–71.
- Rashid H, Shafi S, Haworth E, et al. Value of rapid testing for influenza among Hajj pilgrims. *Travel Med Infect Dis* 2007; **5**: 310–13.
- Marti F, Steffen R, Mutsch M. Influenza vaccine: a travelers' vaccine? *Expert Rev Vaccines* 2008; **7**: 679–87.
- Balkhy HH, Memish ZA, Bafaqeer S, Almuneef MA. Influenza a common viral infection among Hajj pilgrims: time for routine surveillance and vaccination. *J Travel Med* 2004; **11**: 82–86.
- El Bashir H, Haworth E, Zambon M, Shafi S, Zuckerman J, Booy R. Influenza among UK pilgrims to hajj, 2003. *Emerg Infect Dis* 2004; **10**: 1882–83.
- Rashid H, Shafi S, El Bashir H, et al. Influenza and the Hajj: defining influenza-like illness clinically. *Int J Infect Dis* 2008; **12**: 102–03.
- Al-Asmary S, Al-Shehri AS, Abou-Zeid A, Abdel-Fattah M, Hifnawy T, El-Said T. Acute respiratory tract infections among Hajj medical mission personnel, Saudi Arabia. *Int J Infect Dis* 2007; **11**: 268–72.
- Hancock K, Veguilla V, Lu X, et al. Cross-reactive antibody responses to the 2009 pandemic H1N1 influenza virus. *N Engl J Med* 2009; published online Sep 10. DOI:10.1056/NEJMoa0906453.

- 29 Itoh Y, Shinya K, Kiso M, et al. In vitro and in vivo characterization of new swine-origin H1N1 influenza viruses. *Wkly Epidemiol Rec* 2007; **82**: 384–88.
- 30 WHO. Health conditions for travellers to Saudi Arabia for the pilgrimage to Mecca (Hajj). *Wkly Epidemiol Rec* 2007; **82**: 384–88.
- 31 WHO. New influenza A (H1N1) virus: global epidemiological situation, June 2009. *Wkly Epidemiol Rec* 2009; **84**: 249–57.
- 32 Centers for Disease Control and Prevention. Surveillance for pediatric deaths associated with 2009 pandemic influenza A (H1N1) virus infection—United States, April–August 2009. *MMWR Morb Mortal Wkly Rep* 2009; **58**: 941–47.
- 33 Vaillant L, La Ruche G, Tarantola A, Barboza P, epidemic intelligence team at InVS. Epidemiology of fatal cases associated with pandemic H1N1 influenza 2009. *Euro Surveill* 2009; **14**: 19309.
- 34 WHO. Human infection with pandemic A (H1N1) 2009 influenza virus: clinical observations in hospitalized patients, Americas, July 2009–update. *Wkly Epidemiol Rec* 2009; **84**: 305–08.
- 35 Jamieson DJ, Honein MA, Rasmussen SA, et al, Novel Influenza A (H1N1) Pregnancy Working Group. H1N1 2009 influenza virus infection during pregnancy in the USA. *Lancet* 2009; **374**: 451–58.
- 36 Jain S, Kamimoto L, Bramley AM, et al; the 2009 Pandemic Influenza A (H1N1) Virus Hospitalizations Investigation Team. Hospitalized patients with 2009 H1N1 influenza in the United States, April–June 2009. *N Engl J Med* 2009; published online Oct 8. DOI:10.1056/NEJMoa0906695.
- 37 Kumar A, Zarychanski R, Pinto R, et al; for the Canadian Critical Care Trials Group H1N1 Collaborative. Critically ill patients with 2009 influenza A (H1N1) infection in Canada. *JAMA* 2009; **302**: 1872–79.
- 38 Domínguez-Cherit G, Lapinsky SE, et al. Critically ill patients with 2009 influenza A (H1N1) in Mexico. *JAMA* 2009; **302**: 1880–07.
- 39 The ANZIC Influenza Investigators. Critical care services and 2009 H1N1 influenza in Australia and New Zealand. *N Engl J Med* 2009; published online Oct 8. DOI:10.1056/NEJMoa0908481.
- 40 Louie J, Acosta M, Winter K, et al. Factors associated with death or hospitalization due to pandemic 2009 influenza A (H1N1) infection in California. *JAMA* 2009; **302**: 1896–902.
- 41 WHO. International health regulations (2005). http://whqlibdoc.who.int/publications/2008/9789241580410_eng.pdf (accessed Nov 5, 2009).
- 42 Vasoo S, Stevens J, Singh K. Rapid antigen tests for diagnosis of pandemic (Swine) influenza A/H1N1. *Clin Infect Dis* 2009; **49**: 1090–93.
- 43 Faix DJ, Sherman SS, Waterman SH. Rapid-test sensitivity for novel swine-origin influenza A (H1N1) virus in humans. *N Engl J Med* 2009; **361**: 728–29.
- 44 Alborzi A, Aelami MH, Ziyaeyan M, et al. Viral etiology of acute respiratory infections among Iranian Hajj pilgrims, 2006. *J Travel Med* 2009; **16**: 239–42.
- 45 Cowling BJ, Chan KH, Fang VJ, et al. Facemasks and hand hygiene to prevent influenza transmission in households: a cluster randomized trial. *Ann Intern Med* 2009; **151**: 437–46.
- 46 WHO. WHO guidelines for pharmacological management of pandemic (H1N1) 2009 influenza and other influenza viruses. Aug 20, 2009. http://www.who.int/csr/resources/publications/swineflu/h1n1_guidelines_pharmaceutical_mngt.pdf (accessed Nov 5, 2009).
- 47 Centers for Disease Control and Prevention. Oseltamivir-resistant 2009 pandemic influenza A (H1N1) virus Infection in two summer campers receiving prophylaxis—North Carolina, 2009. *MMWR Morb Mortal Wkly Rep* 2009; **58**: 969–72.
- 48 WHO. Oseltamivir-resistant pandemic (H1N1) 2009 influenza virus, October 2009. *Wkly Epidemiol Rec* 2009; **84**: 453–68.
- 49 WHO. Behavioural interventions for reducing the transmission and impact of influenza A(H1N1) virus: a framework for communication strategies. http://www.who.int/csr/resources/publications/swineflu/framework_20090626_en.pdf. (accessed Nov 5, 2009).
- 50 Hadjichristodoulou C, Mouchtouri V, Soteriades E S, et al. Mass gathering preparedness: the experience of the Athens 2004 Olympic and Para-Olympic Games. *J Environ Health* 2005; **67**: 52–57.