

Risk Assessment of Importation and Transmission of Ebola Virus Disease (EVD) during Hajj Season

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Abstract

Background: The largest Ebola Virus Disease (EVD) outbreak ever recorded in history occurred in four West African countries, including Nigeria. Kingdom of Saudi Arabia (KSA) conducted a rapid risk assessment of introduction of EVD into KSA; especially from Nigeria, and its potential impact on Hajj as part of the preparation for Hajj season of 2014.

Methods: Three levels of risks of importing a case of EVD and five different methods or approaches: developing scenarios, estimating probabilities of having an imported case without any restrictive measure, reviewing current international spread of disease, assessing the local national capacities to respond to an imported case of EVD and other considerations.

Results: The probability of getting at least one case of EVD from Guinea, Sierra Leone and Liberia without any control measures was 0.01; and 0.012 from Nigeria. KSA prepared guidelines for management of suspected or confirmed EVD for the different scenarios and actions to be taken; and conducted drills and simulation exercises to ensure that the required actions could be implemented. Health-Care Workers (HCWs) at the Points of Entry (POE) were trained on using a well-defined algorithm. A mission from WHO visited Jeddah twice to ensure competent capacities at POE according the requirement of the IHR 2005.

Discussion: The risk for importing a single case through Nigerian Hajjees and subsequent infection of HCWs and the general public outside Hajj area was very low and even lower should MOH consolidate all ongoing preparatory activities into EVD preparedness plan, including assignment of ownership and tasks force, conduct gap analysis, regular review and update of risk assessment and planned actions.

Conclusions: The Saudi and Nigerian health authorities set an example for coordinated IHR effort. The Saudi Ministry of Health announced a ban on visas for pilgrims from Sierra Leone, Liberia, and Guinea; Nigeria was left out.

Keywords: Ebola; Outbreak; Pilgrimage to Makkah (Hajj); Risk Assessment; Outbreak; Saudi Arabia

Abbreviations

AR: Attack Rate; CCC: Command and Control Center; CDC: Centers for Disease Control; CFR%: Case-Fatality Rate percent; ECDC: European Center for Disease Control; EEI: Effective Early Indicators; EU: European Union; EVD: Ebola Virus Disease; Hajj: Pilgrimage to Makkah; HCWs: Health Care Workers; IHR: International Health Regulations, 2005; IPC: Infection Prevention and Control; IQR: Inter-Quartile Range; KSA: Kingdom of Saudi Arabia; MERS: Middle East Respiratory Syndrome; NCDC: Nigerian Center for Disease Control; MoFA: Ministry of Foreign Affairs; MOH: Ministry of Health; MoI: Ministry of Interior; NFP: National Focal Point; PHEIC: Public Health Emergency of International Concern; POE: Point of Entry; Ro: Reproduction Number; RRT: Rapid Response Team; UK: United Kingdom; VHF: Viral Hemorrhagic Fevers; WHO: World Health Organization

Introduction

Ebola viruses are highly transmissible by contact with infected blood, secretions, tissues, organs or other bodily fluids of dead or living infected persons; and requires special containment measures and barrier protection, particularly for healthcare workers [1,2]. Person-to-person transmission, close contact during burial or care-giving, and sexual transmission are considered principal modes of transmission during human outbreaks of Ebola Virus Disease (EVD) [3,4]. Since the first documented EVD outbreak in the Democratic Republic of Congo (formerly Zaire) in 1976, 24 outbreaks of EVD have been documented [5,6]. The latest EVD outbreak in West Africa, which occurred in the mid of 2014, was the largest EVD outbreak ever recorded in history with unprecedented scale and consequence [7-11]. The EVD outbreak in west Africa resulted in a total of 28,652 suspected, probable or confirmed cases, including 15,261 laboratory-confirmed

cases and 11,325 deaths [2,9,12]. The latest outbreak, which occurred for the first time outside of poor, remote pockets of Africa, began in Guinea in December 2013; and by 4 August 2014, the outbreak involved transmission in Guinea, Liberia, Sierra Leone and Nigeria [8,9]. The fragile health systems in the affected countries, inexperience in dealing with Ebola outbreaks, inadequate infection prevention and control (IPC) practices, and significant deficits in human, financial and material resources in the affected countries have significantly compromised the ability of these countries to respond effectively to the outbreak [13-15].

Potential risk of spread Ebola Virus Disease (EVD) during pilgrimage to Makkah (Hajj)

What is already known on this subject?

The risk for world-wide of a rapidly spreading outbreak of Ebola Virus Disease (EVD), which occurred for the first time outside of poor, remote pockets of Africa, was high; particularly in view of the virulence of the virus, the intensive community and health facility transmission patterns. A number of countries and airline companies issued travel bans to the affected areas. On 6 August 2014, the World Health Organization (WHO) Emergency Committee under the International Health Regulations (IHR), 2005, declared the Ebola outbreak in West Africa a Public Health Emergency of International Concern (PHEIC). WHO recommended control measures did not include travel restrictions as per International Health Regulations. Concerned countries were obliged to develop and or improve their preparedness plans. A number of unaffected countries have made a range of travel related advice or recommendations. Pilgrimage to Makkah (Hajj) presented a potential threat for further amplified spread of the disease worldwide.

What does this study add?

Using five different approaches, the study provides evidence that the risk for importing a single case through 92,436 Nigerian Hajjees travelling to Saudi during Hajj season was negligible and does not pose a high risk for further spread of the disease despite reporting of cases of EVD in Nigeria. There was no justification for travel restriction. The paper describes an example for successful coordinated IHR effort between Saudi and Nigerian health authorities. Saudi Arabia developed, piloted and implemented detailed preparedness plans.

Figure 1

The quick spread of an EVD outbreak in West Africa has led a number of countries and airline companies to issue travel bans to the affected areas [16]. The risk of further international spread of the EVD outbreak to other countries was high particularly in view of the virulence of the virus, the intensive community and health facility transmission patterns [8,17]. The virus has escaped across countries and continents via air travel in this outbreak [12]. Concerned countries, at different levels of risk and vulnerability to have imported cases as of EVD as long as intense transmission continues in West Africa, were obliged to develop and or improve their preparedness plans. A number of unaffected countries have made a range of travel related advice or recommendations. On 6 August 2014, the World Health Organization (WHO) Emergency Committee under the International Health Regulations (IHR), 2005, declared the Ebola outbreak in West Africa a Public Health Emergency of International Concern (PHEIC) [18,19]. WHO recommended that unaffected States with potential risk to have imported Ebola transmission should urgently establish appropriate surveillance; ensure that health workers are aware of and trained in appropriate IPC procedures; and establish rapid response teams with the capacity to investigate and manage EVD cases and their contacts [18]. More than 40 countries put in place some additional measures affecting travel, transport and trade that go beyond the WHO temporary recommendations, such as quarantine of returning travelers and refusal of entry [20].

Kingdom of Saudi Arabia hosts the annual pilgrimage to Makkah (Hajj), a religious mass gathering where over two million Muslim pilgrims from more than 140 countries congregate to perform strenuous and physically-demanding religious rites [21]. About 80% of all Hajjees come from ten countries, including Nigeria. About 92,436 Nigerians performed Hajj in 2013 and a similar number was expected to participate in the Hajj season of 2014 according the Hajj quota system. As Hajjees move together over five days, the overcrowding of such large numbers in confined areas is inevitable, unparalleled and unavoidable; and the risk for acquiring infectious diseases during Hajj increases; especially in congested healthcare facilities. Infectious diseases imported by Hajjees could be transmitted between pilgrims, domestic population and to the whole world by returning Hajjees [22-25].

Just prior to Hajj season; on 23 July 2014, Nigeria, Africa's most populous country, announced the country's first laboratory-confirmed case of Ebola Virus Disease (EVD) [26,27]. The Ebola virus entered Lagos on 20 July via an infected Liberian air traveler. When we started the study, there were 17 confirmed cases of EVD reported from Lagos, one of the Africa's largest cities, where a large population lives in crowded and unsanitary conditions in many slums [28]. The emergence of the EVD outbreak in Nigeria raised a major concern Health officials in Saudi Arabia were worried about bringing Ebola to the Hajj pilgrimage. The Saudi health authorities conducted a thorough risk assessment to decide whether or not Nigerians should be allowed to participate in the Hajj of 2014 which commenced on 3 October 2014.

Every year, Saudi Arabia takes preventive measures against importation and or spread of selected epidemic-prone diseases; namely, meningococcal meningitis, cholera, and poliomyelitis [22,29]. In 2014, KSA had to make historic decisions and put measures in place to guard against importation of a deadly disease, EVD, caused by a virulent incurable virus and lack of a protective vaccine or effective antiviral drug [30]. Experts and decision-makers were heavily involved in deep intellectual discussions to decide whether or not KSA should deny Nigerian Hajjees entry visas for performing Hajj; develop a very detailed preparedness plan for Hajj using a very sensitive case definition to ensure detecting all suspected cases; and conduct special simulation exercises that involve different ministries other than health authorities.

This paper documents the process for one of "best practices" for containing an Ebola outbreak quickly, risk assessment. Besides Ebola, health officials are also on alert for another deadly pathogen: Middle East respiratory syndrome (MERS). The objective of this paper is to conduct a rapid risk assessment of the EVD outbreak in West Africa, the risk of introduction of the disease into a country and its potential impact on Hajj and Saudi Arabia as part of the preparation for Hajj of 2014.

Material and Methods

The Command and Control Center (CCC) developed a very sensitive case definition for EVD. For the sake of risk assessment, three levels of risks of getting infected with Ebola virus according to type of contact with a human case were defined. The assessment was conducted using five different methods or approaches: (1) developing scenarios, (2) estimating probabilities of having an imported case without any restrictive measure, (3) reviewing current international spread of disease, (4) assessing the local national capacities to respond to an imported case of EVD and (5) other considerations. The investigators used the WHO data as reported by the affected countries for assessment of the risk using different possible settings. The International Health Regulations (IHR) National Focal Points (NFP) in KSA and Nigeria communicated regularly before Hajj to ensure full transparency of Nigeria. The Nigerian Medical Mission escorting Nigerian Hajjees maintained daily communication with the Saudi health authorities throughout the Hajj period. KSA conducted a series of drills at the International air and seaports, major hospitals and a series of training modules.

Case Definition

A suspected case of EVD was defined as "A person with elevated body temperature or subjective fever or symptoms, including severe headache, fatigue, muscle pain, vomiting, diarrhea, abdominal pain, or unexplained hemorrhage, features suggestive of EVD (e.g. thrombocytopenia); AND an epidemiologic risk factor, including a history of travel to a country with widespread Ebola virus transmission or cases of EVD (visited or been resident in Guinea, Liberia, Sierra Leone, Nigeria or another country reporting imported cases with local transmission), or been hospitalized in Guinea, Liberia, Sierra Leone, Nigeria or another country reporting imported cases with local transmission in urban settings with uncertain control measures or contact with a person with Ebola while the person was symptomatic [31]. Healthcare workers (HCWs) were instructed and trained to manage all suspected cases as confirmed case until prove otherwise, including isolation in a single room with a private bathroom, following stringent adherence to standard, contact, and droplet precautions and use of other appropriate control measures [32].

Risk Assessment

The risk of getting infected with Ebola virus according to type of contact with a human case is categorized into three levels as follows:

- **Very low or no recognized risk:** Casual contact with a feverish, ambulant, self-caring patient. Examples: sharing a sitting area or public transportation; receptionist tasks
- **Low risk:** Close face-to-face contact with a feverish and ambulant patient. Example: physical examination, measuring temperature and blood pressure
- **High risk:** Close face-to-face contact within one meter without appropriate personal protective equipment (including eye protection) with a suspected patient, who is coughing or vomiting, has nosebleeds, or who has diarrhea. Percutaneous, needle stick or mucosal exposure to virus-contaminated blood, body fluids, tissues or laboratory specimens in severely ill or known positive patients or participation in funeral rites with direct exposure to human remains of a suspected case without appropriate personal protective equipment [33].

The investigators used the following five approaches or methods for risk assessment of importing a single case of EVD to KSA during the Hajj season.

Developing scenarios

Five different scenarios of potential types of patients were identified for assessment of the planned clinical response to these types of patients presenting. These include:

1. Suspicion of exposure to Ebola virus: Saudi Citizen travelling to, residing in, or having been in contact with a suspected patient.
2. Person presenting with symptoms compatible with EVD: Concerned individuals are not related to Hajj (e.g. someone with a travel history to the affected countries returning to Riyadh after a vacation or a mission in one of the known affected countries). Symptoms include flu-like symptoms with fever, muscle aches, myalgia, weakness, headache and sore throat at the prodromal phase.
3. Passenger with symptoms compatible with EVD on board an airplane: Passenger with symptoms compatible with EVD identified by crew on board of an airplane.
4. Patients and healthcare workers having been exposed to an unrecognized Ebola patient: Patient or Health care workers who had exposure to patients who were undiagnosed at the time, but diagnosed with Ebola disease. Example: The Senegal case, diagnosed and treated as Malaria, to be found that it was Ebola.
5. A religious visitor (Hajjee) presenting with symptoms compatible with EVD: Similar to scenario 2 but only concerning individu-

Estimating probabilities

During the assessment, EVD outbreak in West Africa was reported from Nigeria, Sierra Leone, Liberia and Guinea. Generally, the number of Hajjees per country that would be allowed to participate in Hajj is determined according to long-standing "rule of thumb" that Says: "one Hajjee per thousand Muslim per country". We estimated probabilities of having an imported case without any restrictive measure using the total population and the number of Hajjees of 2013 as an estimate of religious visitors that would participate in Hajj of 2013; and assuming even distribution of cases in the country. The numerator included all suspected, probable and confirmed cases that have been reported; whereas the denominator Muslim population in 1000s. To be more conservative, it has been assumed that one out of every five travelers manages to escape and bypass the screening system in Nigeria; and the probability that a Hajjee with EVD would land in Saudi Arabia was recalculated.

Reviewing current international spread of disease

The investigators reviewed the location of current suspected and or confirmed cases of EVD cases outside Sierra Leone, Liberia, Guinea and Nigeria¹ throughout the world. Suspected cases confirmed as being negative, and resolved cases, were excluded.

Assessing the local national capacities to respond to an imported case of EVD

This EVD outbreak demonstrated to a large extent, the relative importance of some factors that were not generally heavily emphasized in many other outbreaks. The factors include overall coordination, establishing Rapid Response Teams (RRT), increasing public awareness and community engagement, infection prevention and case management, safe and dignified burials, epidemiological surveillance, contact tracing, collection, shipment and laboratory diagnosis and capacities at points of entry. In addition, it is conceivable that allocation and quick disbursement of sufficient financial and other resources is necessary and critical.

Other relevant considerations

Risk level is assessed by combining probability and impact in one algorithm; risk is assessed through answering 6 distinct questions developed by ECDC.

Measures taken

A series of preparatory measures have been taken to further reduce probability on introducing EVD into the Kingdom. Before departure (Visa ban for Sierra Leone, Guinea, and Liberia as well as daily communication between IHR NFPs (KSA, Nigeria)). Nigeria with five-step screening at airports, and other eleven steps before departure, includes checking list of traced contacts for each individual leaving country. At assessment point of time, there were 258 contacts of Ebola case under direct supervision (Annex 1). Two first aid trained crew members per plane were trained to detect symptomatic patients reported to airport while on flight. At point of entry (POE), a detailed protocol was developed to handle symptomatic travelers.

In addition, the CCC platform monitored implementation of the following related activities:

- **Capacity-building:** Purchasing of specialized PPE for Ebola (e.g. Full body suits, masks, etc.) and laboratory testing equipment. Ports of Entry readiness (staffing, training and equipment)
- **Infection prevention and Control (IPC):** Mask fit testing, training of all staff including locums, amending and communicating IPC guidelines for viral hemorrhagic fevers (VHF) to cover Ebola, improving IPC staffing capacity.
- **Public Health (Port of entry Ebola readiness):** Active screening for Ebola at ports of entry (Ebola screening cards), meeting with Nigerian health authorities and daily update from them on Ebola, screening at Nigerian airports (via collaboration with local authorities), assessment of Hajj surveillance system, methodology of tracing contacts of suspected Ebola cases, designing a protocol for home isolation of Ebola suspected cases, and designing and communicating VHF data abstraction form.
- **Communication:** Communicating Ebola case definition and IPC guidelines (in Arabic and English), developing communication protocols regarding management of suspected Ebola patient, organizing a national workshop on VHF, communication of modified suspected VHF data abstraction form, developing a communication strategy for consequence management; and managing internal and external channels (with news agencies and International Health Organizations (as WHO, CDC).
- **Laboratory:** Training on Ebola Specimen Sampling and Handling, specialized equipment needs for suspected. Ebola patients Specimen collection, transportation and handling training.
- **Scientific Advisory Board:** Approval of Ebola case definition, approval of VHFs suspected patients data abstraction form, approval of VHF screening cards, approval VHF (including Ebola) IPC guidelines, provision recommendations on travel restrictions from/to Ebola Epidemic countries, readiness of the situation room in Mina Al Taware Hospital.
- **Control Tower:** Conducting training related to Hotline for Infectious Disease.
- **Inter-Ministerial Coordination:** Acceleration of CCC consultants business visa issuance, approval of Ministry of Foreign Affairs (MoFA) to screen travel history of Epidemic Ebola countries, and approval of self-discharge control instructions and agree on its enforcement with Ministry of Interior (MoI).

Results

Table 1 summarizes the distribution of confirmed, probable and suspected cases of EVD and related deaths that were reported in West African countries just prior to Hajj season of October 2014.

Country	Confirmed	Probable	Suspected	Total	Deaths ²
Sierra Leone	935	37	54	1,026	422
Liberia	322	674	382	1,378	694
Guinea	482	141	25	648	430
Nigeria ³	15	1	3	19	7
Total	1754	853	464	3071	1553

Table 1: Distribution of confirmed, probable and suspected cases of EVD and related deaths, West African countries just prior to Hajj season of 2014.

Cases reported by WHO.

In Nigeria, the first 14 confirmed cases were linked to persons, including health care workers in close contact with an air traveler from Liberia. A total of 8 suspected cases have been identified outside of West Africa.

Approach 1

Table 2 summarizes the description and the actions to be taken by the health and other authorities based on the five different scenarios of potential types of suspected patients that could be identified for assessment and the corresponding planned clinical response. MOH, KSA prepared IPC guidelines for management of suspected or confirmed EVD for the different scenarios and actions to be taken: The MOH conducted drills and simulation exercises to ensure that the required actions could be implemented. Appendix 1 summarized the process to follow to identify an EVD case at entry gates upon arrival and the protocol for symptoms of EVD identified on a plane.

Scenario 1	Suspicion of exposure to Ebola Virus
Scenario description	Citizen travelling to, or residing in, an affected country who suspects that they have been exposed to Ebola virus
Actions to be taken	Keep in logbook and public health team to follow up daily by phone for 21 days. Check if patient is from Ebola epidemic countries or has visited or came in contact with someone from these countries. Consult Ebola ID consultant to assess case. If case is confirmed, follow standard infection control guidelines for management of suspected or confirmed Ebola Virus Disease issued by the Ministry: Follow infection control guidelines; including e.g.: Personal protective equipment guidelines. Patient care equipment guidelines. Safe injection practices. Environmental infection control. Monitoring and training of visitors. Monitor potentially exposed healthcare workers. Monitor potentially exposed non-healthcare workers. Ensure proper management of the deceased (e.g. body washing in hospital).
Scenario 2	Person presenting with symptoms compatible with EVD
Scenario description	Concerns individuals not related to Hajj (e.g. someone with a travel history to the affected countries returning to Riyadh). Symptoms include flu-like symptoms with fever, muscle aches, myalgia, weakness, headache and sore throat at the prodromal phase.
Actions to be taken	Consult Ebola ID consultant and test case. Place confirmed case in Isolation Unit .If case is confirmed, follow standard infection control guidelines for management of suspected or confirmed Ebola Virus Disease issued by the Ministry: Follow infection control guidelines; including e.g.: Personal protective equipment guidelines. Patient care equipment guidelines. Safe injection practices. Environmental infection control. Monitoring and training of visitors. Monitor potentially exposed healthcare workers. Monitor potentially exposed non-healthcare workers. Ensure proper management of the deceased (e.g. body washing in hospital).
Scenario 3	Passenger with symptoms compatible with EVD on board of an airplane
Scenario description	Passenger with symptoms compatible with EVD identified by crew on board of an airplane. Cabin crew members and members of the ground staff should follow strict guidelines on how to handle passenger, how to reduce risk of transmission, how to communicate the event to the destination airport, and how to record passenger contact details on locator cards for the two rows around the case
Actions to be taken (From ECDC document)	Inform and brief airlines / medical teams. Inform public health authorities and medical services at the airport in advance of arrival. Assessment on arrival by public health team/experts. Record passenger details on locator cards for two rows around the case. If Hajji, deny participation in Hajj. Monitor key contacts of case and decide whether they can participate. If case is confirmed, follow standard infection control guidelines for management of suspected or confirmed Ebola Virus Disease issued by the Ministry
Scenario 4	Patients and healthcare workers having been exposed to an unrecognized Ebola patient
Scenario description	Patient has had exposure to other patients and was treated by healthcare workers while his Ebola disease was not recognized. Example: The Senegal case, diagnosed and treated as Malaria, to be found later that it is Ebola
Actions to be taken	Consult Ebola ID consultant and test case. Place confirmed case in Isolation Unit. If case is confirmed, follow standard infection control guidelines for management of suspected or confirmed Ebola Virus Disease issued by the Ministry. Follow infection control guidelines; including e.g.: (Personal protective equipment guidelines, Patient care equipment guidelines, Safe injection practices, Environmental infection control). Monitoring and training of visitors. Monitor potentially exposed healthcare workers. Monitor potentially exposed non-healthcare workers. Ensure proper management of the deceased (e.g. body washing in hospital).
Scenario 5	Hajji presenting with symptoms compatible with EVD
Scenario description	Hajji pilgrim presents symptoms compatible with EVD. Similar to scenario 2 but only concerning individuals participating in Hajj
Actions to be taken	Consult Ebola ID consultant and immediately test case. Deny further participation in Hajj. Check if patient is from Ebola epidemic countries or has visited or came in contact with someone from these countries. Test people who were living in the same tent. Move case to specific Ebola hospital in Jeddah if transferable, otherwise keep in ICU under droplet and contact precautions. If case is confirmed, follow standard infection control guidelines for management of suspected or confirmed Ebola Virus Disease issued by the Ministry: Follow infection control guidelines. Monitor potentially exposed healthcare workers. Monitor potentially exposed non-healthcare workers. Ensure proper management of the deceased (e.g. body washing in hospital).

Table 2 (Approach 1): Five different scenarios of potential types of patients were identified for assessment of the planned clinical response to these types of patients presenting.

Approach 2

Table 3 shows that the probability of importing a case of EVD from Nigeria is very low as compared very small numbers of Hajjees from Sierra Leone, Liberia and Guinea and on the assumptions that one fifth of nationals from these countries could escape and get visa for Hajj from another neighboring country.

Country	Population in 1000s	Muslim population in 1000s	Cases (suspected, probable, confirmed)	Incidence Per 1000	Incidence per million	Hajjees 2013	Hajjees 2014	Expected probability (risk) EVD Hajjees with 2013 numbers	Expected probability (risk) EVD Hajjees 2014
Nigeria	175,000	94,500	17	0.00010	0.10	92,436	92,436	0.008979497	0.008979
Sierra Leone	6,200	3,720	1,026	0.16548	165	57	11	0.009432581	0.001887
Liberia	4,200	500	1,378	0.32810	328	8	2	0.002513633	0.000503
Guinea	10,600	9,700	648	0.06113	61	492	98	0.030076981	0.006015
Total								0.051002692	0.017384
Assumptions: Number of Hajjees from Nigeria in 2014 equals number of Hajjees from Nigeria in 2013, Other 3 countries number of Hajjees is 1/5 th of 2013 given visa ban									

Table 3 (Approach 2): Estimated probability of importing a case of EVD from Nigeria and other West African countries.

Approach 3

Global overview: Location of current suspected Ebola cases outside of Sierra Leone, Liberia, Guinea and Nigeria¹, Canada (case 1), UK (1), Germany (2), Senegal (1), India (1), Democratic Republic of Congo (2). Today: 2 suspected cases. Prior to today: 6 suspected cases. NOTE: Suspected cases confirmed as being negative, and resolved cases, are not included in the above map 1 Additional detail on individual cases in appendix

If we assume that, similar to the previous year, 92,500 Nigerian Hajjees are expected to participate in Hajj of 2014; and if we assume that EVD is homogeneously distributed in Nigeria; and if we assume that one fifth (20%) of 2013 Hajjees volume “slips the system” despite visa ban against Sierra Leone, Liberia, Guinea; the probability (incidence) of getting at least one case of EVD from Guinea/Sierra Leone/Liberia even without any further measures is 0.01 and the probability of having an EVD case from Nigeria is 0.012. However, during the current outbreak, Nigerian cases were limited to non-Muslim dominant region with no Muslim cases as of now.

Approach 4

A mission from WHO/EMRO visited Jeddah twice to ensure competent capacities at Points of Entry (POE) according the requirement of the IHR 2005. The missions visited the international Airport and the Jeddah Islamic Seaport and attended simulation exercises

Approach 5

HCWs at the POE were trained on using the algorithm developed by ECDC based on asking six questions (Table 4 and Table 5).

Implications for Policy and Practice:

- Transforming challenges into opportunities: The EVD outbreak in west Africa offered Saudi Arabia to strengthen its surveillance system and develop good preparedness plans
- Importance of transparency and cooperation: The International Health Regulations (IHR) National Focal Points (NFP) in Saudi Arabia set an example in real-time sharing of clinical, epidemiological and laboratory information in a transparent manner that made Saudi Arabia allow Nigerians perform Hajj in 2014
- Over-reaction of countries is not justified. The World Health organization (WHO) Emergency Committee (EC) is functional and made appropriate scientifically sound recommendations. Member States should entrusted even during public Health Emergencies of International Concern (PHEIC).

Figure 2

	Description	Risk rating ¹	Rationale (Assessment along relevant questions 1-6)
Nigerian Tents in Mina	Hajjees from Nigeria	Moderate	<ul style="list-style-type: none"> • Potential for transmission within State/specific groups is considered low • Threat is not unexpected, hence low risk • Probability of further spread to other areas is high • Threat is likely to cause severe disease in this population • There are effective treatments and control measures
Other tents for Hajjees from other nationalities in Mina	Hajjees from all countries and regions other than Nigeria	Low	<ul style="list-style-type: none"> • Potential for transmission within State/specific groups is considered low • Threat is not unexpected, hence low risk • Probability of further spread to other areas is low • Threat is not likely to cause severe disease in this population • There are no effective treatments and control measures
Support staff - Healthcare workers	All staff involved in Healthcare that could be exposed to the virus	Moderate	<ul style="list-style-type: none"> • Potential for transmission within State/specific groups is considered low • Threat is not unexpected, hence low risk • Probability of further spread to other areas is high • Threat is not likely to cause severe disease in this population • There are no effective treatments and control measures
Other support staff	Non-HC worker support staff (e.g., drivers)	Low	<ul style="list-style-type: none"> • Potential for transmission within State/specific groups is considered low • Threat is not unexpected, hence low risk • Probability of further spread to other areas is high • Threat is likely to cause severe disease in this population • There are effective treatments and control measures
General public (M/M/J)	General public living in Makkah, Madina and Jeddah	Low	<ul style="list-style-type: none"> • Potential for transmission within State/specific groups is considered low • Threat is not unexpected, hence low risk • Probability of further spread to other areas is high • Threat is not likely to cause severe disease in this population • There are effective treatments and control measures
General public other	All other public	Very Low	<ul style="list-style-type: none"> • Potential for transmission within State/specific groups is considered very low • Threat is not unexpected, hence very low risk • Probability of further spread to other areas is very low • Threat is not likely to cause severe disease in this population • There are effective treatments and control measures

Table 4 (Approach 5): Overall risk assessment.

There are six different segments entailing different levels of risk.

Due to the fact that two specific segments have a moderate risk the overall risk of the disease should be considered moderate with the control efforts focused on these specific segments.

Detail of risk rating in appendix.

	Question	Nigerian tents	Other tents	Healthcare workers	Other Support staff (non-healthcare)	General KSA public in Jeddah region (including Makkah, Madinah)	General KSA public outside Jeddah region
Q1	Are there specific groups at increased risk of infection? If YES, complete a separate information table and repeat risk assessment for general population and each risk group separately?	Yes	Yes	Yes	Yes	Yes	Yes
Q2	Rate the potential for transmission within the Member State. Also rate the potential for transmission in specific groups.	Low	Low	Low	Low	Low	Low
Q3	In this threat unusual or unexpected	No	No	No	No	No	No
Q4	What is the probability of further spread within KSA?	High	Low	High	High	Low	Low
Q5	Is the threat likely to cause severe disease in this population/group?	Yes	No	No	No	Yes	No
Q6	Are effective treatments and control measures available?	Yes	No	No	Yes	Yes	Yes
	Conclusion	Moderate risk	Low risk	Moderate risk	Low risk	Low risk	Very Low risk

Table 5: Risk Assessment where risk level is assessed by combining probability and impact in one algorithm; risk is assessed through answering six distinct questions. If in doubt (e.g. due to insufficient evidence), select the higher risk option.

Discussion

Since the emergence of EVD in Zaire and till 2013, 23 outbreaks of EVD were reported in seven African countries: Democratic Republic of Congo (6 outbreaks), Uganda (5), Gabon (4), Republic of Congo (3), South Sudan (3), Cote d'Ivoire (1) and South Africa (1). The EVD outbreaks occurred in remote areas and the number of affected persons in these outbreaks ranged from 1 case (3 outbreaks) to a maximum of 425; inter-quartile range (IQR) = 11 - 143). The case-fatality rates ranged between 25% - 89% in outbreaks with more than one human case. There was only two case of EVD reported outside Africa in England and Russia; both were laboratory-acquired [34]. Three EVD cases have been infected outside of the West African region, and all have epidemiological links to the outbreak in West Africa [35].

The declaration of WHO that EVD in West Africa is considered as a PHEIC has highlighted the potential for disease to spread across international borders and provided an impetus for countries to review their preparedness plans [7]. Implementation of travel and border health measures to prevent international spread of the disease, educate and protect travelers and communities, and minimize disruption of international travel and trade might have helped control further spread of EVD epidemic to other countries. With around an expected number of 92,436 Nigerian Muslims expected to perform Hajj, health screening checks have been put in place at the Lagos Murtala Mohammed International Airport and across other departure points in the country. The Nigerian exit strategy focused on deterring or preventing travel by symptomatic or exposed persons and by educating travelers about protecting themselves before they depart Nigeria [36]. Nigeria prepared and distributed information packs on EVD at airports, airlines, port authorities and shipping agents, and practical simulation exercises were held at relevant sites [7].

The outbreak of EVD in West Africa resulted in significant strengthening of Health preparedness in Saudi Arabia which made excellent preparatory measures at the POE; including development of a very sensitive disease surveillance system for EVD, activation of the direct communication between the NFP for IHR in KSA and Nigeria, development of the detailed guidelines, training and repeated live drills and simulation exercises increased the confidence of the Saudis in their ability to host the Nigerian Hajjees. Saudi Arabia implemented a chain of coordinated competent entry risk assessments at the airports that involved different ministries to manage the flow of arriving Hajjees in as independent cohorts with continued active monitoring. The Saudi experience highlighted the crucial importance of fostering new and existing partnerships to the success of this response of implementation of exit-entry strategy [36]. Yet, the assessment exercise was aware that screenings can be misleading as a man who flew from Liberia to Dallas was diagnosed with Ebola.

The increasing number of cases during the EVD outbreak in West Africa was associated with world-wide travel restrictions at an unprecedented scale in 2015 to contain and eliminate Ebola virus disease. The IHR emphasizes that countries should not impose travel restrictions or interference with international trade in the absence of a WHO recommendation or scientific evidence; and provides a mechanism to coordinate global action during PHEIC [37]. WHO has not put general ban on international travel or trade with affected countries. Yet, of 187 States Parties, 43 (23.0%) prohibited the entry of foreigners who had recently visited a country with widespread Ebola transmission and another 15 (8.0%) imposed other substantial restrictions on such travellers: the requirement to produce a medical certificate documenting no infection with Ebola ($n = 8$), mandatory quarantine ($n = 6$) or other restrictions ($n = 1$) [38,39]. Some 58 (31.0%) States Parties exceeded or disregarded the recommendations [39]. The quick spread of an Ebola outbreak in West Africa has led a number of countries and airline companies to issue travel bans to the affected areas [16].

Travel restrictions were reported to be more efficient to control the spread of disease locally during an early phase of an epidemic than to attempt to control the epidemic at international borders. A stochastic dynamic model was performed to estimate the risk of EVD importation into the top 20 final destination countries of air travelers departing from within the three epidemic countries, Guinea, Liberia and Sierra Leone and the effectiveness of air travel restriction concluded that the daily effective reproduction numbers (R_t) was estimated at 0.72 - 1.32 in Guinea, 0.62 - 1.38 in Liberia and 0.81 - 1.38 in Sierra Leone. The restriction of air travel may mitigate the risk up to 67.7% (95% CI 66.6 - 68.7) [11].

The findings of the study indicated that the probability of importing Ebola to KSA through an infected Hajjees from the Nigeria is very low despite the fact that an infected traveler brought Ebola to Nigeria and so as the case in Senegal. There were no cases of EVD that have occurred outside Africa except for medical evacuations to the UK (one case), Germany (one case) Spain (one case), USA (two cases [39,40], without complete denial of issuance of entry visas to travelers to the citizens or residents from the affected countries. Laboratory testing of a Saudi gold merchant who died from an unknown fatal disease soon after his return from West Africa a few weeks before the Hajj season proved to be a non-EVD case [41].

There is some controversy on effect of travel restriction prevention of global spread of EVD. However, WHO recommended that the public and travelers to Ebola affected and at-risk areas should be provided with accurate and relevant information on risks, measures to minimize those risks, and advice for managing a potential exposure; states should be prepared to detect, investigate, and manage Ebola cases. Any person with an illness consistent with EVD should not be allowed to travel unless the travel is part of an appropriate medical evacuation. There should be no international travel of Ebola contacts or cases, unless the travel is part of an appropriate medical evacuation. To minimize the risk of international spread of EVD: States with EVD transmission should consider postponing mass gatherings until EVD transmission is interrupted.

The impact of epidemic travel restrictions on mobility itself remains difficult to measure with traditional methods [40,42]. The assessment exercise was not a simple straightforward calculation. There were a number of uncertainties that could not be fully clarified or controlled. Sources of uncertainty were many. During the assessment period, the available epidemiological information was insufficient to fully assess the extent and dynamics of the EVD epidemic in West Africa due to problems with disease surveillance, the extent of utilization and performance of the tests used for laboratory confirmation, and data management (e.g. status updates on follow-up of suspected EVD cases), International travel pattern of people having passed through or originating from affected countries cannot be fully assessed and controlled. Meanwhile, the outbreak continued to escalate as > 40% of total number of cases have occurred within 21 days prior to the assessment exercise. It was likely that more EVD cases would continue to be reported in three affected countries, Guinea, Sierra Leone and Liberia as well as appearance of some additional infected cases in Nigeria.

The regular communication between the IHR NFP in KSA and Nigeria was helpful in ensuring real-time sharing of epidemiologic information and monitoring the situation of the EVD outbreak in Nigeria. Unlike the situation in Guinea, Liberia and Sierra Leone, all identified contacts in Nigeria were physically monitored on a daily basis for 21 days. The few contacts who attempted to escape the monitoring system were all diligently tracked, using special intervention teams, and returned to medical observation to complete the requisite monitoring period of 21 days. With assistance from WHO, the US Centers for Disease Control and Prevention (CDC), and others, government health officials reached 100% of known contacts in Lagos and 99.8% at the second outbreak site, in Port Harcourt, Nigeria's oil hub. Federal and State governments in Nigeria provided ample financial and material resources, as well as well-trained and experienced national staff.

The infection of HCWs with EVD while treating EVD patients in treatment centers in West Africa was quite disturbing. Moreover, the relatively long incubation period of EVD increases the risk of exporting the disease via air travel; poses a considerable threat to the Kingdom especially during Hajj. Ebola can spread throughout the world in people who are still healthy in their incubation period, so there is a threat whenever people from this part of Africa travel to other parts of the world; there is a risk.

Screening of travellers at airports in affected countries would be the most efficient frontier at which to assess the health status of travellers at risk of Ebola virus exposure, Capacity building for local containment and coordinated and expedited international cooperation are essential to reduce the risk of global transmission. 17 There is need to expand the joint experience of Nigeria and Saudi Arabia to develop new proactive disease control and prevention methods at airports. The current system depends on showing vaccination cards for yellow fever or scanning body temperature; e.g. during the SARS outbreak. There is need to develop innovative syndromic surveillance system for apparently healthy individuals, contacts of suspected cases and generation of a set of effective early indicators (EEI) based on a comprehensive system where IHR NFPs could communicate effectively and share relevant information. Within countries all national authorities at POE should be involved. The role of drill exercises in training activities cannot be over-emphasized.

This EVD outbreak demonstrated to a large extent, the relative importance of some factors that were not generally heavily emphasized in many other outbreaks. The factors include overall coordination, establishing Rapid Response Teams (RRT), increasing public awareness and community engagement, infection prevention and case management, safe and dignified burials, epidemiological surveillance, contact tracing, collection, shipment and laboratory diagnosis and capacities at points of entry. In addition, it is conceivable that allocation and quick disbursement of sufficient financial and other resources is necessary and critical. The assessment was not only to determine the likelihood of having an imported case of EVD, but also the assessment of the Saudi health system and services to deal with imported cases as outlined by the different five scenarios. Ability of the Saudis to cope efficiently with an imported case has been used to neutralize some of the risks. In Saudi Arabia, pilgrims arriving at the King Abdul-Aziz International Airport near Makkah are also being screened for EVD. During such major outbreaks, partnership with the private sector should be sought to ensure bringing in substantial resources to help scale up control measures that would eventually such a major EVD to an early end.

The WHO Emergency Committee emphasized that all countries should enhance their preparedness activities and, in line with their IHR obligations, ensure their capacities to detect, assess and respond to any introduction of EVD [43]. The WHO temporary recommendation highlighted the value of continued active and vigilant surveillance; especially at land crossings borders of affected countries; cross-border cooperation, robust exit screening as a critical measure for minimizing the risk of exportation of Ebola cases in the three affected countries until Ebola transmission is confirmed to have stopped in these countries. The affected countries should be transparent, regularly share information on the number of people screened at international airports and the outcomes of exit screening; whereas the international community should support a sustainable approach to this exit screening.

EVD is a rare and deadly viral illness. Although EVD could be spread, it is important to remember that it is not an airborne virus. Risk is the probability or threat of damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities, and that may be avoided through pre-emptive action. Risk assessment is a proxy measurement of the degree to which people, property, resources, systems, and cultural, economic, environmental, and social activity is susceptible to harm, degradation, or destruction on being exposed to a hostile agent or factor. Exposure of Hajjees and HCWs to blood-borne diseases due to trauma, injuries or unhealthy reuse of razor blades during head-shaving, a religious rite commonly practiced during, cannot be ruled out. Physicians and health personnel must be aware of these and other risks of blood borne virus infections that could spread through sharing or using communal razors for head shaving [9]. This shows the importance of advanced planning of public health surveillance and response at these religious events. Likewise, failure of some HCWs to adhere fully to the recommended IPC guidelines during Hajj season may occur; thus compromise the Saudi preparedness plan

Case definitions of suspected EVD developed over time and varied by country [41,44]. Measures taken by the Nigerian authorities have been helpful in limiting further international spread; and created a very low probability of EVD patients arriving in KSA. During the assessment period, there were several people were still under surveillance in Lagos and the southern oil city of Port Harcourt in Nigeria. If any of those people tested positive for EVD, there would be a slight chance they may have already infected others. However, the risk of bringing the disease to Makkah from this group of travelers seemed to be fairly remote. The southern part of Nigeria, where Lagos and Port Harcourt are located, is mostly Christian while the northern part of the country, which has not had any reported EVD cases, is Muslim.

There were only 20 Ebola cases in Nigeria (relatively few compared to the West African nations that are currently managing thousands), and the country reported last week that they have no suspected cases at the moment. The Nigerian response to the outbreak was greatly aided by the rapid utilization of a national public institution (NCDC) and the prompt establishment of an Emergency Operations Centre, supported by the Disease Prevention and Control Cluster within the WHO country office; and boosted outbreak investigation, risk assessment, contact tracing and clinical care.

The assessment concluded that overall risk should be considered to be low and is slightly higher for Nigerian Hajjees who would stay together in crowded tents during Hajj season and to the HCWs. The risk is estimated to be very low for the general public outside Makkah, Madinah and Jeddah. The Saudi MOH announced a ban on visas for pilgrims from Sierra Leone, Liberia, and Guinea - the three nations most affected by Ebola this year with at least 5,800 cases but Nigeria was left out. Meanwhile, the Saudi health authorities emphasized strict implementation of some additional specific steps: consolidation of all ongoing preparatory activities into single Ebola preparedness plan including assignment of ownership and tasks force, conduct gap analysis, and regular review and update of risk assessment and planned actions.

The Saudi experience in preparing for Hajj event, including the simulation exercises, drills, possible different scenarios and development of detailed guidelines on surveillance and IPC should be shared with other countries as they would be useful in similar public health responses.

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Consent to Publish

Not applicable.

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Authors used surveillance and published data. References cited

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