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Waterpipe smoking as a public health risk: Potential risk for transmission of MERS-CoV

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ABSTRACT

The Middle East Respiratory Syndrome (MERS-CoV) emerged in the Kingdom of Saudi Arabia in 2012 causing a critical challenge to public health. The epidemiology of MERS-CoV remain enigmatic as human-to-human transmission is not fully understood. One possible scenario that might play a role in the virus transmission is the cultural waterpipe smoking. Cafés providing waterpipe smoking in cities within Saudi Arabia have been moved to areas outside city limits that frequently place them close to camels markets. We report results of a surveillance study wherein waterpipe hoses throughout several regions in Saudi Arabia were tested for the presence of MERS-CoV. A total of 2489 waterpipe samples were collected from cities where MERS-CoV cases were continuously recorded. MERS-CoV RNA wasn't detected in collected samples. Irrespective of the negative results of our survey, the public health risk of waterpipe smoking should not be underestimated. To avoid a possible transmission within country where MERS-CoV is prevalent, we recommend the replacement of reusable hoses with "one-time-use" hoses in addition to a close inspection of waterpipe components to assure the appropriate cleaning and sanitization.

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1. Introduction

The Middle East Respiratory Syndrome (MERS-CoV) emerged in the Kingdom of Saudi Arabia in 2012 causing a critical challenge to public health (Zaki et al., 2012). According to the World Health Organization (WHO), there have been a total of 2147 cases of MERS-CoV worldwide with 750 fatal cases (fatality rate of 34.99%). While these MERS-CoV cases were reported from at least 27 countries, the largest proportion of recorded cases were from Saudi Arabia, followed by South Korea (WHO, 2015). As of March 20, 2018, a total of 1738 cases of MERS-CoV infections with 703 fatal cases (fatality rate of 41.6%) were reported by the Saudi Ministry of Health (<https://www.moh.gov.sa/en/CCC/PressReleases>). MERS-CoV has shown a considerably high pathogenicity and mortality among patients who are infected with the virus, particularly immunocompromised ones (Assiri et al., 2013; Arabi et al., 2014).

Although animal reservoirs for MERS-CoV are not fully understood, MERS-CoV has been isolated from dromedary camels suggesting its zoonotic origin (Azhar et al., 2014; Briese et al., 2014). Current studies indicate that MERS-CoV might have been circulating in camels in Saudi Arabia and Africa as early as 1983 (Alagaili et al., 2014; Corman et al., 2014).

Based on the source of the infection, MERS-CoV infections have been classified as primary (direct) and secondary. Primary infection generally represents a direct contact with camels or their products (e.g., milk). The secondary source represent nosocomial infection or a positive case contact outside the healthcare facilities, mainly among family members of an infected person. However, there are several recorded cases that were classified as primary with unknown source of infection or exposure.

Until now, answers for many questions regarding the epidemiology of MERS-CoV remain enigmatic. One possible scenario that might play a role in MERS-CoV human-to-human transmission is the cultural waterpipe smoking, so called "Shisha", "Hookah", or "Narghile", a widely used type of smoking in the Middle East. Thus, it's important to thoroughly investigate this scenario in an attempt to fill in the gap associated with this common smoking practise.

Waterpipe smoking is the process of inhaling tobacco smoke, passed through a chilled water chamber, via a hose capped with a plastic mouthpiece. Globally, there are an estimated 100 million

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daily hookah smokers (Wolfram et al., 2003). More recently, demand for the waterpipe smoking has grown in several countries that have no previous tradition of use, including the United States and Saudi Arabia (Maziak et al., 2007). In the regions where waterpipe smoking is prevalent, it has been linked with numerous smoking-related health problems such as: oral diseases, urinary bladder cancer, cardiovascular disease and pulmonary dysfunction (Al-Belasy, 2004; Bedwani et al., 1997; Jabbour et al., 2003). The smoke inhaled as a result of waterpipe smoking contains toxic materials similar to those resulting from smoking cigarettes such as carbon monoxide, hydrocarbons, and carcinogenic polycyclic aromatic volatile aldehydes (WHO, 2005; Chaouachi, 2009; Kiter et al., 2000). Although the average frequency of waterpipe smoking in the United States is lower than that of cigarettes, a single waterpipe session typically lasts for 45 min and may produce 50–100 times the smoke volume inhaled from a single cigarette (Lipkus et al., 2011; Rastam et al., 2011; Primack et al., 2012; Alzoubi et al., 2013; Maziak, 2013).

In Saudi Arabia, in response to recent government regulations, cafés providing waterpipe smoking have been moved to areas outside city limits that frequently place them close to camels markets (i.e. Riyadh). Herein, our interest focused on waterpipe cafés in general, with a special emphasis on cafés close to camels markets. These cafés attract people visiting camels market, camels' market workers and owners who prefer to accompany their friends for a waterpipe smoking. Importantly, it should be noted that waterpipes and hoses are generally reused by other smoking customers at the same night and even shared between friends during the same visit to a café. Furthermore, the use of cold water in the water chamber for a cold air flow may facilitate the survival of viruses and bacteria. Here we report a surveillance study wherein waterpipe hoses throughout several regions in Saudi Arabia were tested for the presence of MERS-CoV to find out whether waterpipe smoking can be a risk factor for MERS CoV transmission. To our knowledge, this is the first study of this kind.

2. Methods

Samples were collected from several cities within Saudi Arabia where repeated MERS-CoV cases were recorded. Our team immediately visited these cafés for sampling hoses once primary MERS-CoV cases were announced by the Saudi Ministry of Health. Sampling protocol aimed to randomly swab waterpipe hoses at various cafés within each city, with emphasis to visit cafés close to camels market or located on highways leading to a camels market.

Since the majority of customers prefer to smoke waterpipes in the evening, samples were collected in late evenings. Sterilized, individually wrapped swabs with a long plastic stick (Copan Diagnostics Inc., USA) were used to swab waterpipe hoses. Whenever a waterpipe was brought back from a customer to the café back rooms, a sample was taken from both ends of each hose then immediately immersed into a tube containing RNAlater (Qiagen). Tubes were placed in a dry shipper (MVE CryoShipper, 3A-CRYOGENIC FZE, United Arab Emirates) containing liquid nitrogen then transported to the laboratory for further investigation and screening. Samples were stored at the laboratory at -80°C prior to extraction.

2.1. Nucleic acids extraction and Real time RT-PCR

A QiaCube robot (Qiagen) was used for total nucleic acid extraction from the swabs using Cador Reagent kits (Qiagen). Real time quantitative reverse transcription polymerase chain reaction (RT-qPCR) was applied using a OneStep Real-Time qPCR buffer (Invitro-

gen, Life Technologies). Real time PCR was performed on BioRad CFX thermocyclers (BioRad). Primer and probes *upstream of E gene* (upE) were as described by Corman et al. (2012a,b) and synthesized by MWG-Biotech (Germany).

3. Results

Sampling was done during the winter and spring of 2015 and 2016 at cafés near sites of MERS-CoV emergence. Repeated sampling was pursued at sites where MERS-CoV cases were continuously recorded. Two types of tobacco are consumed in cafés: Moassel, a paste containing molasses, flavoured tobacco, and glycerol mixture was widely used and preferred by most customers, especially youth and women; and Jurak, a paste containing fermented tobacco leaves, fermented minced fruits, molasses, and glycerol, that was preferred by the elderly males. Moassel is used in small sized waterpipes that require a short hose (~1 m). Some moassel consumers reuse hoses used by others consumers; however, others, bring their own hoses or purchase a one-time-use hose. Jurak consumers invariably employ reusable, long (3 m) leather hoses. Sampling efforts included both types of hoses. The majority of samples were collected from Moassel waterpipe hoses. During the collection visits at various sites, we noted that all sampled hoses were moist at both ends of the hoses.

A total of 2489 waterpipe samples were collected from the following cities: Riyadh (561), Dammam (294), Bisha (132), Buraidah (317), Unizah (134), Ar Rass (328), Madinah (149), Taif (123), Kharj (258), Zulfi (42), Baha (63), and Quwaiyah (88). Samples were screened by RT-qPCR for MERS-CoV using the upE primer/probe set. The screening results for samples from both types of waterpipes representing several regions within Saudi Arabia were negative for the presence of MERS-CoV RNA (Table 1).

4. Discussion

MERS-CoV is a novel coronavirus (CoV) isolated in 2012 from a patient admitted to the hospital with kidney failure and acute pneumonia. The zoonotic transmission of MERS-CoV is believed to be from camels to humans, evident by several studies clarifying the camels' role as a reservoir host of MERS-CoV (Azhar et al., 2014; Briese et al., 2014).

Like most coronaviruses, the nature of MERS-CoV transmission and infection is thought to be through the respiratory secretions, mainly droplet nuclei of an infected person (i.e. coughing). Human-to-human transmission is evident by the occurrence of clusters seen for cases from many countries including Italy, Jordan, France, Tunisia, the United Kingdom, South Korea and Saudi Arabia supporting the ability of the virus to transmit amongst humans

Table 1
Waterpipe samples examined from different cities in the Kingdom of Saudi Arabia.

City	Tobacco Type		Total
	Jurak	Moassel	
Riyadh	88	473	561
Dammam	90	204	294
Bisha	46	86	132
Buraidah	5	312	317
Unizah	13	121	134
Ar Rass	172	156	328
Madinah	42	107	149
Taif	37	86	123
Kharj	18	240	258
Zulfi	30	12	42
Baha	48	15	63
Quwaiyah	-	88	88
Total	556	1933	2489

(Hijawi et al., 2013; Chan et al., 2013; Drosten et al., 2014, 2015; Assiri et al., 2013; Guery et al., 2013; Abroug et al., 2014; Raj et al., 2014; Park et al., 2015). Secondary cases of infection also occur among healthcare workers which is attributed to weaknesses in infection control measures at these facilities (WHO, 2014; Drosten et al., 2014; Park et al., 2015).

Interestingly, due to infrequent direct contact between humans and camels, several recorded primary cases in Saudi Arabia were classified as primary cases with unknown exposure or source of infection; thus, the route of transmission of the virus have not been ruled out. While airborne and droplet transmission have been suggested, a role of tools, instruments, and appliances associated with respiratory secretions that are shared or re-used by several individuals should not be eliminated.

The risk of transmission of infectious microbial agents through smoking waterpipes is high because smokers cough into hoses and moisture in tobacco smoke promotes the survival of microorganisms inside waterpipe hose. Moreover, most cafés tend not to clean the waterpipes after each smoking session because washing and cleaning waterpipe parts is labor intensive and time consuming. It is therefore, not surprising, that waterpipe smokers are exposed to microorganisms that may be harmful to health (Koul et al., 2011; Daniels and Roman, 2013).

Among the important pathogens that are transmitted through waterpipe hoses is *Mycobacterium tuberculosis*. Waterpipes and mouthpieces have been implicated in an outbreak of pulmonary tuberculosis in Queensland, Australia (Urkin et al., 2006; Munckhof et al., 2003). El-Barrawy et al. (1997) related infection with *Helicobacter pylori* to waterpipes smoking in Egypt. The risk of transmission of hepatitis C virus through waterpipes smoking was also demonstrated by Habib et al. (2001). Other viruses that can be transmitted are: Epstein-Barr virus (EBV), herpes simplex virus and respiratory virus (Knishkowsky and Amitai, 2005). Fungal infections have also been reported to be waterpipes transmitted diseases, when a patient with acute myeloid leukemia showed invasive infection with *Aspergillus* sp. (Szyper-Kravitz et al., 2001).

We did not detect MERS-CoV RNA in waterpipe hoses in several regions within Saudi Arabia where MERS-CoV cases were recorded. We cannot, however, exclude the possibility that this failure reflects inadequate sampling. Irrespective of the negative results of our survey, the public health risk of waterpipe smoking should not be underestimated. Close contact between camel workers and individuals coming for waterpipe smoking should be investigated and evaluated. For instance, we noticed several camel transportation trucks parked outside a café during one of our field visits to Bisha (on a highway to Riyadh city). The practice amongst elderly men who smoke Jurak of sharing hoses also poses a risk of communicable diseases other than MERS-CoV. Accordingly, we recommend the replacement of reusable hoses with “one-time-use” hoses or consumer use of their own hoses. Close inspection to assure the appropriate cleaning and sanitization of waterpipe components (i.e. autoclaving or air drying), not only to avoid transmission of MERS-CoV but also other respiratory pathogens should also be adopted.

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