It is important that health care workers have good knowledge, attitudes and practices (KAP) towards MERS-CoV, especially in Mecca because of the MERS-CoV threat during hajj and umrah. This study aimed to assess KAP of health care providers in public hospitals in Mecca about MERS-CoV infection and evaluate the effectiveness of a health education intervention to improve KAP. KAP was assessed among 281 participants using a self-administered questionnaire who then underwent the health education intervention using a combination of methods. After 3 months, 188 participants responded to the post-intervention evaluation. Significant post-intervention improvement was found in the median scores for knowledge (P < 0.05) and attitude, and in 188 cases. The median score increased from 20 to 28 points.
Introduction

Novel coronavirus, MERS-CoV, is a particular strain different from any other known human coronavirus. It can cause severe acute respiratory illness in humans and transmission is possibly zoonotic (1). As of 2 February, 2016, 1638 laboratory-confirmed cases have been reported to the World Health Organization (WHO) from 26 different countries with 587 related deaths (2,3).

With the gradually increasing number of reported cases, international concern is high about the possibility for this virus to move around the world. Therefore, all countries in the world need to ensure that their health care workers (HCWs) are aware of the virus and the disease it can cause. Furthermore, all countries in Middle East region need to demonstrate how vigilant and prepared they are to prevent international spread of this infection and to support the timely release of research findings. They must put in place enhanced public health surveillance for identifying suspected cases using the WHO-recommended case definition and investigation protocols in order to protect both global health and the wellbeing of the local community (4,5).

In Saudi Arabia, MERS-CoV infection is of great concern at governmental and public levels
because the number of infected individuals and deaths is increasing despite extensive work that has been done and is ongoing. This includes a wide range of interventions related to prevention and control procedures, research studies, special measures for people working with animals, risk communications and community engagement, and national, ministerial and international coordination for the investigation and management of cases in the country (5).

From June 2012 to 23 February, 2016, the Ministry of Health of Saudi Arabia reported a total of 1297 confirmed cases with MERS-CoV infection accounting for about 79% of the global cases; of these, 554 cases died (43%) accounting for 94% of total global deaths (6). As regards probable source of infection, since January 2015, 32% of cases acquired the infection in a health care setting, while 12% of infected cases were HCWs (6).

Based on the available data and WHO’s risk assessment, no sustained human-to-human transmission within communities has been documented and there is no evidence of airborne transmission. However, MERS-CoV is a relatively new disease and there are large gaps in our knowledge including the epidemiological pattern, characteristics of the virus and clinical features (5).

Careful monitoring of the current situation is crucial, particularly in the absence of any prophylactic vaccines or curative treatment and the lack of experience in control measures. There is a concern about possible increased numbers of human infections and deaths during the annual hajj where about 2 million pilgrims come together at the holy places in Saudi Arabia (Mecca and Medina) and throughout the year-round during umrah when about 6million pilgrims arrive. Until now, little is known about the severity and transmission of this virus in mass gatherings, although no cases have been confirmed during and after hajj. However, special measures need to be taken for pilgrims returning home. On the other hand, during umrah, several cases have been detected and one of the risk factors was a history of visiting a health care setting in Mecca (7).

Health care providers in Mecca hospitals are at risk of infection through occupational exposure to suspected cases during umrah and hajj. They are also expected to participate in health education activities on the infection, particularly if they have relevant information which can be given to patients, and through them, to their families and members of the community. It is important therefore that they have adequate and correct knowledge, attitudes and practices (KAP) towards MERS-CoV.
The aim of this study therefore was to evaluate the effect of a health education intervention to improve KAP towards MERS-CoV among health care providers in public hospitals in Mecca.

Methods

Study design and setting

This was a quasi-experimental intervention study conducted from September 2014 to October 2015 in public hospitals in Mecca, namely: King Abdul Aziz Hospital, King Faisal Hospital, Al-Nour Specialist Hospital, Ajyad Hospital and Hera General Hospital. It was a continuation of a study with previously published data on the KAP of health care workers in these hospitals (8). In this part participants were given a health education intervention and their KAP re-evaluated after the intervention.

Participants

The target population, sample size and selection are described previously (8). Briefly, the sample included all health care providers (physicians, specialists, technicians and nurses) in emergency departments in Mecca public hospitals. Inclusion criteria were: working only in emergency departments, direct contact with patients, and willingness to be involved in the study and complete the questionnaire (available on request from the authors).

In the pre-test, we used convenience sampling to find respondents through distribution of a total of 500 questionnaires, taking into consideration drop-outs in the post-test. In the pre-test, the total response rate was 56% representing 281 out of 500 distributed questionnaires. Among participants who completed the health education intervention, 188 out of 281 (response rate of 66.9%) completed the post-intervention evaluation.

Data collection

Data were collected using a self-administered questionnaire. Construction, content and scoring of the questionnaire are explained in detail in the previously published paper (8). Briefly, the questionnaire included: 21 questions on knowledge with an overall score of 28 (range 0–28), categorized as good knowledge (score ≥ 21) or poor knowledge (score

The cumulative KAP score represents the sum of the 3 scores (i.e. 47 points, range 0–47), which was categorized as good cumulative KAP (score > 35) or poor cumulative KAP (score

Each questionnaire, in both pre- and post-tests, was evaluated for missing data at the time of submission and corrected in the presence of the respondent to make sure each question was answered.
Analysis of the pre-intervention data is described previously (8). We identified certain areas where participants had less knowledge, negative attitudes and/or poor practices to be covered during the health education intervention.

**Health education intervention**

In coordination with training and education centres in each hospital, all available participants were given the first health education session about the epidemiology of MERS-CoV infection immediately after they completed the questionnaire for the first time. The second session was held after 1 week and was on prevention and control measures. Both sessions (60 minutes each) were based on the most recent available data with a summary take-home message about protecting oneself from infection. The sessions included presentations, brainstorming, interactive discussion and a short video. Based on pre-test observations, to provide knowledge and reinforce attitudes by feedback, we developed 5 large banners and distributed posters, brochures and pamphlets in both Arabic and English on different epidemiological aspects and prevention and control measures prepared from the WHO, Centers for Disease Control and Prevention, Atlanta and Saudi Ministry of Health media websites (1–3,5,6). As commitment to proper infection prevention and control measures would result in a decrease in the risk of occupational exposure to infection, we emphasized the infection control measures through demonstrations of proper handwashing techniques, cough etiquette, use of personnel protective equipment and safe disposal of contaminated objects with the help of infection control unit in each hospital. In addition, with the help of the training and education centre in each hospital and with the support and supervision of local health authorities, short health education messages were sent regularly as reminders to the mobile telephones of the participants using WhatsApp for 2 months after the intervention. In addition, the banners, posters, brochures and educational videos were continuously presented on television screens distributed in different parts of each hospital. As requested by the health authorities, all these services were available to the whole hospital team and not only to the target group.

**Post-test evaluation**

We measured the change in the KAP of the participants about 3 months after the intervention using the same self-administered questionnaire used in the pre-test.

**Ethical considerations**

The study was approved by the bioethics committee at Umm Al-Qura University (project # 43409062), the research ethical committee at Al-Noor Specialist Hospital (No. 51226730247) and the Directorate of Health Affairs. Verbal consent was obtained from respondents before participation in the study; the objectives and benefits of the study were explained to the participants and they were assured of the confidentiality of the data.
Statistical analysis

SPSS, version 19.0 was used for data analysis. Fisher exact tests were used to compare qualitative variables. The data were not normally distributed and accordingly median and non-parametric tests were used: Mann–Whitney test for dichotomous variables and Kruskal–Wallis test when there was more than 2 subgroups of respondents. All P-values were two-tailed, assuming a significance level of $P < 0.05$.

Results

Pre- and post-intervention KAP scores

A total of 188 health care providers were evaluated for changes in their KAP scores before and after the health education intervention. Our results showed a significant post-intervention improvement in their good knowledge score ($P < 0.05$).

Knowledge

Table 1 shows the number of health care providers with good knowledge about MERS-CoV infection before and after the intervention. The number with good knowledge improved after the intervention with regard to knowledge about: reservoir of infection, transmission through renal dialysis, disease manifestations in humans, availability of a vaccine, travel ban to Saudi Arabia, methods of providing health care to patients and time to return to daily activities in case of cure ($P < 0.05$).

Attitudes

Table 2 shows the number of health care providers with positive attitudes about MERS-CoV infection before and after the intervention. The number with positive attitudes increased after the intervention with regard to: negative impact of coronavirus infection on the Saudi Arabian economy, fear of going to public places in case they became infected ($P < 0.05$).

Practices

Table 3 shows the number of health care providers with a good practices in relation infection control before and after the intervention. The number with good infection control practices did not increase significantly after the intervention ($P = 0.168$).

KAP scores among subgroups

Comparison of median KAP scores before and after the intervention among various subgroups of respondents (categorized by age, sex, occupation and years of experience) is shown in Table 4.
The overall median knowledge, attitudes and cumulative scores improved after the intervention (P)

The median knowledge and cumulative KAP scores improved significantly after the intervention among the different subgroups of participants except for physicians and those with experience > 10 years. The median attitudes scores became significantly more positive after the intervention among both age groups and genders and among nurses and those with Discussion

To the best of our knowledge, this is the first intervention study in the western area of Saudi Arabia to raise awareness of health care providers about MERS-CoV through a health education intervention.

Knowledge

The health education intervention helped to raise the knowledge of participants about MERS-CoV in many areas. However, although the present findings were positive overall, some areas merit concern. For example, a large proportion of the health care providers did not have correct knowledge about the incubation period. Some participants before the intervention might not have considered the importance of the incubation period in infectious disease surveillance and control, in diagnosis if laboratory facilities are unavailable and that it is clinically relevant in administration of antiviral medications, which are most effective when given before or immediately after the onset of symptoms (9). Furthermore, our findings related to the recommended action when dealing with a suspected/confirmed case in hospital and for close contacts at home also give rise to concern. Dealing with a suspected/confirmed case is inevitable whether by health care providers at hospital or close contacts at home, and good knowledge and commitment to these recommendations is vital to avoid transmission of infection (10,11).

Attitudes

The health education intervention helped improve some attitudes about MERS-CoV. Studies have shown varying attitudes towards MERS-CoV and other related infections. About three quarters (74.5%) of Japanese HCWs accepted the risk of a potential influenza pandemic, 64.5% were afraid and 26.4% would consider changing their jobs (12). The majority of HCWs in Thailand (90%) accepted the occupational risk of caring for H5N1-infected patients (13). Closure of schools in the case of an H1N1 influenza epidemic was accepted by about 78% of the Saudi Arabian public (14).

The use of personal protective equipment by HCWs at Al Qassim region was reported to be the
most positive attitude when dealing with MERS-CoV (15). In the same context, Thu et al. reported a similar positive attitude of HCWs when dealing with health care-associated infections (16). An Iranian study reported a positive attitude among Iranian HCWs regarding the importance of active participation by health education in prevention programmes (17). However, a negative attitude among HCWs at Al Qassim region was observed regarding the usefulness of active participation in infection control programmes in reducing the prevalence of MERS-CoV (15).

There was some inconsistency with regard to knowledge and attitude responses. Although after the intervention 68% of participants reported good knowledge about the recommendations for dealing with a suspected/confirmed MERS-CoV case in hospital, about 80% believed that handling a coronavirus-infected patient was a threat to their health. This contradicts Green et al.’s suggestion that increased identifiable knowledge results in increased identifiable attitude (18).

**Practices**

Generally, the self-reported infection control practices of the participants in relation to MERS-CoV infection were good both before and after the intervention, although this was not the ideal way of measuring practices.

These results support the findings of a study in Saudi Arabia which reported a high level of compliance with infection control practices among HCWs, with no difference between doctors and nurses (19), and a study in Taiwan which reported good compliance among infection control nurses with hand washing guidelines (20). However, a Vietnamese study reported only a few correct responses to items about hand hygiene and the use of surgical masks (16), and a study in Saudi Arabia found that about 60% of the Saudi Arabian public took few self-reported precautionary measures regarding swine flu (14).

Our results should be interpreted with caution, particularly with regard infection control practices which were self-reported and not actually observed. Some participants may not express their real thoughts, beliefs and understandings and this may have an effect on their responses (21).

**Participant characteristics and KAP scores**

Knowledge and cumulative KAP scores significantly improved after the intervention in both age groups and genders, in all occupations except physicians, and in all years of experience except > 10 years. Attitude scores also improved significantly overall and in both age groups and
genders, in nurses and in those with

Because of the multifaceted nature of the intervention, it is difficult to determine to what extent the individual strands of the intervention (health education sessions, provision of knowledge, feedback of results, hands-on demonstration and reminder services) may have contributed to the overall improvement that occurred. This supports the theory that, in order to achieve behavioural change, attention must be paid to all the factors that predispose, reinforce and enable behaviour and not just to a single factor (18).

Some studies have reviewed the effects of health education on KAP of HCWs at various time intervals. In India, assessing post-education KAP scores showed that the best scores were achieved in the first post-education assessment conducted 6 months after the intervention. However, improvement declined in the second assessment at 12 months and dropped still further in the third assessment after 24 months (30). On the other hand, other studies found that passing time did not negatively affect KAP and it can even improve KAP if education is continuous (31,32). Thus, continuous education, efficient in-service training, monitoring and evaluation of HCW practices play an important role in retention of knowledge and application of infection control practices (33).

It is important to interpret our results in the context of potential study limitations. First, our study was conducted only among health care providers in public hospitals and does not represent the private sector or other HCWs such as patient supporters and cleaners. Second, information was obtained from health care providers who were on duty during the study. Those not on duty were excluded and information on their characteristics and their possible responses is unknown. In addition, because of various constraints, we could not gather all the health team simultaneously for the educational intervention. So the number of post-intervention participants was markedly lower. Third, there may have been reporting bias; the participants who received the health education intervention may be more likely to report practices consistent with proper infection control procedures (social desirability bias). Fourth, participants could have acquired different levels of knowledge through other means, e.g. mass media, books, articles or conferences, which would have influenced their responses and the study results. Fifth, the 3-month post intervention period was relatively short and the long-term effect of the intervention should be investigated. Sixth, the effect of the intervention may diminish over time. So, periodic repetition of educational programmes may help maintain health care providers’ awareness of MERS-CoV. Finally, our study did not include a control group who did not receive the education intervention. This would have increased the power of the study and reduced bias.

In spite of the limitations, our study highlighted some gaps in the KAP of health care providers in Mecca and showed that the health education intervention, using different methods, succeeded in improving knowledge, attitudes and cumulative scores. The positive results of this
intervention and the extent of the current MERS-CoV threat during the hajj and umrah seasons support efforts to continuously implement health education intervention programmes for health care providers, especially in Mecca. Rigorous evaluation of these programmes would be of great value.

Acknowledgements

The authors would like to thank the Institute of Scientific Research and Revival of Islamic Heritage at Umm Al-Qura University for the financial support.

Funding: Institute of Scientific Research and Revival of Islamic Heritage at Umm Al-Qura University, Mecca (project # 43409062).

Competing interests: None declared.

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