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Risk management and infection control preparedness of Saudi healthcare facilities to overcome the COVID-19 pandemic

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ABSTRACT

Objective: To evaluate the preparedness of Saudi healthcare facilities to handle the coronavirus disease 2019 (COVID-19) pandemic.

Methods: Between April and June 2020, a cross-sectional study was conducted among Saudi hospitals using an online-administered English-language questionnaire by the Saudi Commission for Health Specialties. The questionnaire evaluates all aspects of risk management, infection control and preventative programmes that should be known and practised by all healthcare workers (HCWs). All HCWs in Saudi hospitals designated to accept patients with COVID-19 were involved in the study.

Results: In total, 161 HCWs responded to the survey. General understanding of hospital risk management plans and infection prevention measures was found to be outstanding (80.4%), with no differences in responses by gender, education or occupation. Some differences in responses were found by age group and years of working experience. Most responses were from hospitals located in the Central Province (72.7%) and governmental hospitals (88%), and most provided family services (68%). Furthermore, the results showed that medical professionals received adequate training, which is recognized as the baseline for effective risk management and infection control and prevention procedures, policies and recommendations.

Conclusions: Notwithstanding small differences between HCWs, this study found that all HCWs in Saudi hospitals had excellent knowledge of risk management plans and pandemic sub-plans of infection control and prevention policies, procedures and principles, which has aided the health authorities in Saudi Arabia in mitigating COVID-19 effectively.

Introduction

Healthcare facilities play a critical role in national and local responses to crises, including communicable disease outbreaks and/or pandemics in all developed and developing countries (Seto et al., 2010; WHO, 2014; Al-Tawfiq et al., 2016). The majority of measures which are mandatory to prepare for epidemics/pandemics also apply to the management of other crises, such as disasters, or can be altered to do so. Plans for recognition and handling of epidemics/pandemics, and update and implementation capacity of these plans, are required for every hospital (Rebmann, 2010). The Centers for Disease Control and Prevention (CDC) and World Health Organization (WHO) guidelines can be utilized by hospitals that lack their own response plans in order to begin the planning process and modify their response plans to an epidemic/pandemic (Rebmann, 2010). Of note, infection prevention and control is a continuous hospital activity in which all healthcare workers (HCWs) and units participate. Access to, and training in, infection control protocols is necessary for all healthcare providers (Gerberding, 2006). This decreases the transmission of healthcare-

associated infections, and subsequently enhances the safety level of patients, staff and visitors. In addition, this increases the efficiency of hospital responses to an epidemic/pandemic, and decreases the risk of the hospital amplifying the epidemic/pandemic (Gerberding, 2006; Rebmann, 2010). Coronavirus disease 2019 (COVID-19) is currently considered a pandemic situation. Internationally, as of 6:30 p.m. CEST on 19 May 2020, 4,735,622 confirmed cases of COVID-19, including 316,289 deaths, had been reported to WHO (Nguyen et al., 2020; WHO 2020a). From 2 March 2020 to 6:30 p.m. CEST on 19 May 2020, there had been 59,854 confirmed cases of COVID-19 in Saudi Arabia, including 329 deaths (WHO 2020a,b). In Saudi Arabia, compliance with strict infection prevention control protocols is well established in many healthcare facilities (Ministry of Health, Saudi Arabia, 2020a,b). As patients with COVID-19 have been reported within Saudi Arabia, the Ministry of Health (MOH) has intensified observation and infection control measures. All suspected cases are inspected, mainly at points of entry, and confirmed cases are directly isolated and treated (Al Yousuf et al., 2002; Barry et al., 2020; Ministry of Health, Saudi Arabia, 2020a,b). The MOH has allocated 25 institutions for the treatment of patients with

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COVID-19, with up to 80,000 hospital beds and 8000 intensive care unit beds. In total, 2200 beds have been designated for isolation and quarantining of suspected cases of COVID-19 (WHO, 2015; Ministry of Health, Saudi Arabia, 2020a,b).

From June 2012 to 23 February 2016, Saudi Arabia created special guidelines based on WHO standards to combat viral propagation, based on past experience with other coronaviruses such as Middle East respiratory syndrome (WHO, 2015; Ministry of Health, Saudi Arabia, 2020a,b). During the yearly hajj pilgrimage, Saudi Arabia has gained competence in managing large crowds and disaster preparedness (Alotaibi et al., 2017; Barry et al., 2020). To control the spread of COVID-19, the MOH is interacting with the public through all possible channels, especially social media, and has created a guide on COVID-19 to give Saudi citizens and residents access to facts and precautions about COVID-19 in 12 languages (Ministry of Health, Saudi Arabia, 2020a,b). Measures to involve the public in prevention and control activities and to combat misinformation about the disease have expanded significantly (Alotaibi et al., 2017; Ministry of Health, Saudi Arabia, 2020a,b). The aim of this study was to assess risk management and infection control readiness in healthcare facilities in Saudi Arabia in order to contain the COVID-19 pandemic. This study also analysed the preparedness of Saudi health facilities to deal with the COVID-19 pandemic.

Methods

Study design

This cross-sectional study used a survey method, applying a structured online English questionnaire to the hospitals designated by the Saudi MOH to receive COVID-19 cases between April and June 2020. The questionnaire included questions on risk management and infection control readiness for Saudi health facilities to combat the COVID-19 pandemic. Written informed consent was obtained from the King Saud University Research Ethics Standing Committee (Ref No: KSUHE20184).

Study population

Based on a previous review (Al-Hanawi et al., 2019), the total number of HCWs in Saudi Arabia is approximately 350,000, of whom approximately 200 work in infectious disease departments. As such, a sufficiently representative sample with an error rate of 5% and a confidence level of 95% should have 132 participants (<https://select-statistics.co.uk/calculators/sample-size-calculator-population-proportion/>). Questionnaires were distributed to HCWs at health centres designated by the Saudi MOH to care for patients infected with COVID-19. Healthcare providers from hospitals in all provinces of Saudi Arabia were included. In total, 164 responses were collected, of which 161 were analysed and three were excluded. The response rate was 80.5%.

Inclusion criteria

This study included all HCWs in Saudi hospitals, regardless of nationality or department.

Exclusion criteria

Incomplete questionnaires and responses from non-healthcare-oriented workers were excluded.

Data analysis

Statistical Package for the Social Sciences Version 23.0 was used to conduct the statistical analysis (IBM Corp., Armonk, NY, USA). Chi-squared test, Mann–Whitney test and Kruskal–Wallis test were used when applicable. Linear regression analysis and Pearson’s correlation

coefficient (r) were utilized to assess associations and correlation, respectively, to identify relationships.

Results

The study sample included 161 subjects; their sociodemographic characteristics are shown in Table 1. The study sample included 89 males and 72 females; a significant difference was found between age groups ($P<0.0001$) but not between genders, as males and females were included in similar numbers. More than half of the respondents were aged between 31 and 40 years (50.3%), 26.7% were aged 20–30 years, and 23% were aged >40 years. The majority of the sample (42.2%) were graduates, with 39.8% holding a Master’s degree or above; professionals with fellowships accounted for 12.4% of the sample, and approximately half of the respondents were Doctors of Medicine (49.7%). All subgroups contained similar percentages of males and females; however, the distribution of years of working experience showed a significant difference ($P<0.0001$).

The background characteristics of the healthcare facilities designated to receive patients with COVID-19 were analysed (Table 2). Nearly all hospitals were government hospitals (90%), and the minority were private hospitals (11%); this difference was significant ($P\leq0.002$). There were significant ($P<0.0001$) differences in the types of care provided by different facilities; most of the hospitals provided family health services, including maternity and paediatric care (67.1%), inpatient care (88.2%) and had isolation units (87.6%). The hospitals that received questionnaires were mainly located in the Central Province (72.7%), which was significantly over-represented ($P<0.0001$) compared with other provinces.

Knowledge about risk management preparedness to manage COVID-19

For any healthcare facility to be prepared to face any emergency or risk, such as the COVID-19 pandemic, an emergency response plan should be constructed with effective mechanisms to be implemented and adjusted based on any risk. Table 3 shows significant responses ($P<0.0001$), with an average of 75% of all respondents stating that their hospital has a flexible and well-implemented risk management plan. Plans were executed by the committee responsible for developing the hospital emergency risk management programme in 68.3% of

Table 1
Sociodemographic characteristics of respondents.

Characteristics	n (%)	P-value
Gender		
Female	72 (44.7%)	0.207 ^a
Male	89 (55.3%)	
Age (years)		
20–30	43 (26.7%)	<0.0001 ^b
31–40	81 (50.3%)	
>40	37 (23%)	
Education level		
Bachelor’s degree	68 (42.2%)	<0.0001 ^b
Master’s degree or higher	64 (39.8%)	
Board/fellowship	20 (12.4%)	
Diploma degree	9 (5.6%)	
Occupation		
Medical doctor	80 (49.7%)	<0.0001 ^b
Nurse	43 (26.7%)	
Pharmacist	27 (16.8%)	
Allied health professional	11 (6.8%)	
Working experience (years)		
<5	31 (19.3%)	<0.0001 ^b
5–10	73 (45.3%)	
11–20	38 (23.6%)	
>20 years	19 (11.8%)	

^a By binomial test.
^b By Chi-squared test.

Table 2
Characteristics of the healthcare facilities.

	n (%)	P-value
Type of facility/managing authority		
Government hospital, MOH	75 (46.6%)	<0.0001 ^b
Government hospital, other	68 (42.2%)	
Private hospital	18 (11.2%)	
Location of facility		
Central Province	117 (72.7%)	<0.0001 ^b
Southern Province	10 (6.2%)	
Western Province	22 (13.7%)	
Eastern Province	8 (5%)	
Northern Province	4 (2%)	
Services available and utilization		
Family health services including maternity and paediatric care	108 (67.1%)	<0.0001 ^a
Adolescent-only health services	74 (46%)	0.344 ^a
Inpatient care	142 (88.2%)	<0.0001 ^a
Facilities with beds for overnight observation	125 (77.6%)	<0.0001 ^a
Facilities with isolation units	141 (87.6%)	<0.0001 ^a

^a By binomial test.

^b By Chi-squared test.

Table 3
Knowledge of healthcare workers about risk management preparedness to overcome the coronavirus disease 2019 (COVID-19) pandemic.

Risk management criteria	Yes	No	Don't know	P-value ^a
I. Hospital emergency response plan				
a. Mechanisms and implementations	82.6	6.2	11.2	<0.0001
1. Hospital Emergency Committee responsible for developing the hospital emergency risk management programme	68.3	9.9	21.7	<0.0001
2. Command Group established by the Hospital Emergency Committee	66.5	8.7	24.8	<0.0001
3. Knowledge, practice, capabilities and capacities within the hospital	75.8	10.6	13.7	<0.0001
4. Hospital provides general and specialized services alongside the pandemic emergency	81.4	8.7	9.9	<0.0001
b. Pandemic COVID-19 sub-plan	74.5	10.6	14.9	<0.0001
1. Existing sub-plans and capacity to cope with pandemic.	72.7	13.0	14.3	<0.0001
2. Have capacity to cope with the health demands	77.6	11.2	11.2	<0.0001
3. Adaptation to COVID-19, and adaptation to the specific challenges of the COVID-19 pandemic	65.8	9.3	24.8	<0.0001
II. Hospital personnel				
1. Awareness of COVID-19 pandemic	77.0	10.6	12.4	<0.0001
2. Trained to perform the necessary actions in any emergency	69.6	14.3	16.1	<0.0001
3. Staff physical and social needs are considered	58.4	32.9	8.7	<0.0001
4. Training in implementing the hospital emergency response plan	72.7	9.9	17.4	<0.0001
III. Hospital effective coordination				
1. Effective coordination between departments	75.8	9.3	14.9	<0.0001
2. Facility coordinates effectively with different hospitals and health authorities	69.6	8.7	21.7	<0.0001
3. Facility coordinates effectively with local infrastructure providers	67.1	8.7	24.2	<0.0001
4. Suppliers and infrastructure providers implement infection prevention and control measures	72.0	10.6	17.4	<0.0001
IV. Availability of appropriate resources in sufficient quantities, with effective plan	67.1	17.4	15.5	<0.0001

^a By Chi-squared test.

cases ($P < 0.0001$), and approximately 66.5% of respondents stated that their hospital has a well-established command group in the hospital emergency committee ($P < 0.0001$). One of the most important aspects of the risk management plan during an epidemic emergency is an effective coordination strategy, both between departments (75.8% confirmed) and between different hospitals and health authorities (69.6% confirmed that their facility coordinated effectively during the COVID-19 pandemic). Additionally, 67.1% of respondents stated that their facilities coordinated effectively with local infrastructure providers; 72% stated that their facility managed supplies and infrastructures by implementing infection prevention and control measures during the COVID-19 pandemic; and 67.1% stated that appropriate resources were available in sufficient quantities, with effective management and usage plans.

Regarding the level of knowledge, practice, capabilities and capacities within the hospital, there was a significant response ($P < 0.0001$), with agreement from approximately 76% of respondents, alongside 81.4% who stated that the risk management plan included a plan for the hospital to continue to provide general and specialized services while addressing the pandemic emergency. A significant proportion of respondents (74.5%, $P < 0.0001$) indicated that the risk management plan included a pandemic emergency sub-plan specific to COVID-19, with 72.7% noting that existing sub-plans provided sufficient capacity to cope

with the pandemic, 77.6% stating that existing sub-plans provided sufficient capacity to cope with all health demands, and approximately 66% reporting that their hospital risk sub-plan was adapted to COVID-19 and the specific challenges during the COVID-19 pandemic. Awareness of hospital personnel related to risk management as needed to deal with a pandemic emergency such as COVID-19 was confirmed by a significant proportion of respondents (approximately 77%, $P < 0.0001$); 70% reported having training to perform the necessary actions in any emergency, and 73% reported being trained to implement the emergency risk plan during the COVID-19 pandemic. However, only 58.4% stated that their facility sufficiently considered their physical and social concerns related to the burden of covering a pandemic emergency.

Knowledge about infection prevention control preparedness to combat COVID-19

The components of the hospital emergency response plan include infection control measures and COVID-19 sub-plans developed based on the hospital's emergency risk assessments (Table 4). In total, 74.5% of subjects stated that their hospitals have protocols and measures in place to cope with the COVID-19 pandemic, such as infection prevention control risk plans, and 71.4% of the plans include containment measures for

Table 4
Knowledge of healthcare workers about infection control preparedness relevant to the coronavirus disease 2019 (COVID-19) pandemic.

Infection prevention control	Yes	No	Don't know	P-value ^a
V. Infection control plans and measures				
1. Protocols and measures to cope with COVID-19 pandemic	74.5	6.8	18.6	<0.0001
2. Plan to contain the pandemic situation	71.4	6.2	22.4	<0.0001
3. Back-up plan and/or local communication plan	65.8	7.5	26.7	<0.0001
4. Prioritization and adaptation of work routines and systemic response during COVID-19	72.0	5.6	22.4	<0.0001
National and local policies and decisions for Covid-19 pandemic	80.7	6.8	12.4	<0.0001
4. Strategy to implement appropriate measures	79.5	8.7	11.8	<0.0001
5. All-hazards hospital emergency response plan that specifies the measures for pandemic	65.8	9.3	24.8	<0.0001
6. Incident Command Group with incident action plan developed to report any incidence of COVID-19	65.2	10.6	24.2	<0.0001
VI. Hospital personnel				
5. Involvement of all staff members in infection prevention and control protocol in normal and pandemic situations	70.8	13.0	16.1	<0.0001
6. Training to fulfil their roles in implementing the hospital's emergency response in infection prevention and control	69.6	14.3	16.1	<0.0001
7. Guidelines on standard precautions for infection prevention for COVID-19 knowledge of basic protective measures against COVID-19	80.7	6.8	12.4	<0.0001

^a By Chi-squared test.

the COVID-19 pandemic. Moreover, 66% reported that their risk plan involves a back-up plan and local communication plan, and 72% stated that the hospital plan included measures to prioritize and adapt work routines and systemic responses during the COVID-19 pandemic. Prevention and control measures are essential to contain a pandemic, and must incorporate not only local policies and decisions but also national policies. These national and local policies encompass a variety of strategies, and approximately 80% of respondents in all Saudi hospitals agreed that appropriate measures (all-hazard specific measures) were taken to address the COVID-19 pandemic, with 65% developing incidence action plans with a dedicated command group to report any cases of COVID-19. In 70–80% of cases, respondents stated that the infection control management plans included all staff members in infection prevention and control protocols in normal and pandemic situations, in addition to training staff to achieve their roles in implementing the hospital's emergency response in infection prevention and control according to a set of process flow guidelines on standard precautions for infection prevention for COVID-19 and knowledge of basic protective measures against any pandemic.

General knowledge about facility preparedness to contain COVID-19

The association of different variables (age, gender, education, occupation, working experience and facility type) with the level of knowledge of respondents regarding their facilities' risk management and infection prevention control preparedness was investigated. Correlation was found between hospital personnel/infection prevention control and infection control plans and measures and hospital personnel/risk management, with $r=0.825$ ($P<0.0001$) and $r=0.808$ ($P<0.0001$), respectively (Table 5). In addition, a strong positive relationship was identified between the existence of infection control plans, measures and mechanisms and how well these measures were implemented ($r=0.819$, $P<0.0001$). Additionally, a good positive relationship was found between hospital personnel/infection prevention control and good implementation of all measures ($r=0.738$, $P<0.0001$). A good positive correlation was observed between infection control plans and measures and both COVID-19 pandemic sub-plans and hospital personnel/risk management ($r=0.782$ and $r=0.757$, respectively; $P<0.0001$). A good positive correlation was shown between hospital personnel/risk management and mechanisms and implementation of the COVID-19 pandemic plan, and COVID-19 pandemic preparedness ($r=0.792$ and $r=0.731$, respectively; $P<0.0001$). Similar correlation was observed between mechanisms and implementation of the COVID-19 pandemic plan ($r=0.741$, $P<0.0001$). Additionally, moderate positive correlations were found between hospital personnel/infection prevention control and both pandemic COVID-19 sub-plan and effective hospital effective coordination [$r=0.678$ ($P<0.0001$) and $r=0.623$ ($P<0.0001$), respectively]. A weak positive correlation was found between hospital personnel/infection

prevention control and availability of resources with an effective plan ($r=0.416$, $P<0.0001$).

Finally, the multiple linear regression analysis (Table 6) shows that the hospital emergency response plan has significant correlation with mechanism and implementation ($P\leq 0.014$) and with hospital emergency response COVID-19 pandemic sub-plan ($P\leq 0.039$). There was a weak significant correlation with effective coordination ($P\leq 0.037$), and no significant correlation with knowledge and involvement of hospital personnel in the risk management plan ($P\leq 0.055$), or the availability of resources with an effective plan ($P\leq 0.071$). For infection control plans, there was strong correlation with the application and implementation of infection control measures ($P\leq 0.016$) and the knowledge, involvement and training of all hospital personnel ($P\leq 0.022$) in all infection prevention and control procedures to combat the COVID-19 pandemic.

Discussion

The rapid spread of COVID-19 globally led to an elevated incidence of infection. COVID-19 has a higher rate of transmissibility than previous coronaviruses, and affects multiple organs. The lack of awareness of hospital infection control and worldwide air travel facilitated rapid global dissemination (Gu and Korteweg, 2007). WHO declared COVID-19 an international pandemic (WHO 2020a,b) and advised countries to adopt certain protective measures to control outbreaks of the disease (WHO 2020a,b); almost all countries have adhered to all these measures. However, there has been some variation in when and how these measures were applied. Quarantine, closing of all public activities, adopting telecommuting and virtual learning, and halting all international air travel were the leading measures (WHO, 2015). In Saudi Arabia, since the beginning of the COVID-19 pandemic, the MOH has operated a Command and Control Centre for COVID-19 for careful monitoring of the current situation (Meo, 2020, Ministry of Health, Saudi Arabia, 2020a,b), which is particularly important given the absence of any prophylactic vaccines or curative treatment (WHO, 2015, 2020). All protective safety measures were initiated as soon as the pandemic was announced, and equal healthcare rights were granted to the entire Saudi population (Saudi citizens and expatriates), despite the very low number of reported cases of COVID-19 in the country compared with the global incidence. Daily updates were performed through the Saudi CDC and Wegaya to ensure that healthcare providers and the public were educated and updated about the disease (Ministry of Health, Saudi Arabia, 2020a,b). Unified management procedures and protocols for all healthcare facilities were mandated and tracked (Ministry of Health, Saudi Arabia, 2020a,b). The objective of this research was to determine the level of preparedness of Saudi healthcare facilities to combat the COVID-19 pandemic, as well as the level of preparedness awareness among HCWs in general, as different public health policies, including some mandatory protective measures, were implemented in recent months.

Table 5
Associations between age, gender, education, occupation, location of facility, type of facility and risk management measures and infection control.

Variables		n	Risk management measures					Infection control	
			Hospital emergency response plan (mechanisms and implementations) P-value	Hospital emergency responsesub-plan	Hospital personnel	Hospital effective co-ordination	Availability of resources, with effective plan	Infection control plans and measures	Hospital personnel
Gender ^a	Female	72	0.167	0.585	0.654	0.880	0.316	0.877	0.803
Age (years) ^b	Male	89							
	20–30	43	0.08	0.061	0.021 ^c	0.018 ^c	0.041 ^c	0.010 ^c	0.004 ^c
	31–40	81							
	41–50	28							
Education ^b	>50	9							
	Bachelor's degree	68	0.105	0.263	0.800	0.374	0.307	0.201	0.195
	Master's degree or higher	64							
Occupation ^b	Board/fellowship	20							
	Diploma degree	9							
	Medical doctor	80	0.182	0.151	0.577	0.233	0.072	0.179	0.603
	Nurse	43							
	Pharmacist	27							
Working experience (years) ^b	Allied health professional	11							
	<5	31	0.024 ^c	0.370	0.357	0.385	0.581	0.030 ^c	0.012 ^c
	5–10	73							
	11–20	38							
Type of facility ^b	>20	19							
	Government hospital, MOH	75	< 0.0001 ^c	0.004 ^c	0.011 ^c	0.040 ^c	0.162	0.010 ^c	0.020 ^c
	Government hospital, other	68							
Facility with isolation units ^a	Private hospital	18							
	Yes	142	0.001 ^c	0.005 ^c	0.015 ^c	0.223	0.026 ^c	0.002 ^c	0.005 ^c
Facility with beds for overnight observation ^a	No	19							
	Yes	125	0.006 ^c	0.001 ^c	<0.0001 ^c	0.009 ^c	<0.0001 ^c	<0.0001 ^c	0.014 ^c
Facility routinely provides inpatient care ^a	No	36							
	Yes	142	0.016 ^c	0.002 ^c	0.171	0.135	0.091	0.014 ^c	0.014 ^c
Adolescent-only health services ^a	No	19							
	Yes	74	0.719	0.664	0.370	0.608	0.894	0.559	0.820
Family health services including maternity and paediatric care ^a	No	87							
	Yes	108	0.136	0.988	0.169	0.722	0.318	0.458	0.269
	No	53							

MOH, Ministry of Health.

^a By Mann–Whitney *U*-test.

^b By Kruskal–Wallis *H*-test.

^c Cells with a *P*-value ≤ 0.05 were considered significantly different from other groups.

Table 6
Multiple linear regression by subgroup of questions to verify the model.

	Statistics R^2	SEE	F	P-value ^b
Risk management measures				
Hospital emergency response plan; mechanisms and implementations	0.125	2.19	2.401	0.014 ^a
Hospital emergency response COVID-19 pandemic sub-plan	0.108	2.01594	2.034	0.039 ^a
Hospital personnel	0.102	2.19271	1.904	0.055
Hospital effective coordination	0.109	1.92214	2.052	0.037 ^a
Availability of resources, with effective plan	0.097	.75850	1.810	0.071
Infection control				
Infection control plans and measures	0.124	3.73138	2.367	0.016 ^a
Hospital personnel	0.118	1.63626	2.240	0.022 ^a

^a Cells with a P -value ≤ 0.05 were considered significant.

^b By multiple linear regression.

Table 7
Saudi healthcare facilities resources.

Total hospitals in Saudi Arabia	470
MOH hospitals	274
Other governmental hospitals	44
Private hospitals	152
MOH hospital beds	41.835
Other governmental hospital beds	11.581
Private hospital beds	17.428
Total beds in Saudi Arabia	70.844

MOH, Ministry of Health.

Earlier studies on adherence to protective measures in Saudi healthcare facilities demonstrated that the level of information and education is linked to a positive attitude towards infection prevention methods (Nour et al., 2017). Of the 470 hospitals in Saudi Arabia (Ministry of Health, Saudi Arabia, 2016), 25 hospitals (20 primary and five secondary) were designated to receive patients with COVID-19 (Table 7) (Alotaibi et al., 2017; Barry et al., 2020). All designated hospitals responded to this survey; hence, other hospitals were sent questionnaires. The study showed that, at all times, hospitals in Saudi Arabia are in a state of preparedness to contribute fully, competently and successfully in the coordinated health sector response to an emergency, such as an infectious disease outbreak or the COVID-19 pandemic ($P=0.0001$). Hence, the sum of established risk management mechanisms and procedures comprising strategies required to coordinate the hospital's epidemic risk management efforts, including all-hazards emergency risk assessment and specialized epidemic event risk assessment, prevention, readiness, response and recovery to overcome the COVID-19 pandemic, was significant ($P=0.0001$). In addition, infection control measures and procedures to increase the ability of a hospital to respond to an epidemic and minimize the transmission of infections were highly significant ($P=0.0001$), enhancing the safety of all patients and eliminating the risk of the hospital itself amplifying the COVID-19 pandemic. All risk-management- and infection-control-related factors showed significant correlation with age group ($P\leq 0.05$); in particular, older respondents (≥ 31 years) showed more understanding and awareness about their hospital's risk management plan and infection control measures among all aspects related to preparedness to address the COVID-19 pandemic. No difference was found by gender, as males and females gave comparable responses. Additionally, level of education (Master's degree or higher) had no significant impact on the level of knowledge and alertness, as all categories showed equal levels of knowledge. Consistent results were shown for all professional groups, with equivalent levels of understanding and awareness about their hospital's risk management plan and infection control protocol. It is reassuring that there were no differences in terms of gender, education or profession in the level of knowledge or insights about hospitals' risk management plans and infection control procedures used to alleviate the COVID-19 pandemic. Years of working experience was significant ($P\leq 0.009$), as HCWs with experience ≤ 20 years had less knowledge about their hospital's risk

management plan compared with those with >20 years of experience, who may have acquired this knowledge over time, practice or involvement. However, all groups were shown to be significantly knowledgeable ($P\leq 0.030$) about infection control measures. Both governmental and private hospitals demonstrated statistical superiority ($P\leq 0.05$) in terms of all aspects of risk management planning, except the availability of resources, which showed no significance. This could be due to resource mismanagement at the start of the COVID-19 pandemic, which was adjusted and monitored by the MOH's critical measures and recommendations to all healthcare settings to preserve compliance with best practice guidelines, and take local resources into account to support all hospitals during the pandemic (Meo, 2020; Ministry of Health, Saudi Arabia, 2020a,b). All hospital classifications revealed significant P values, ranging from ≤ 0.026 to 0.001, in regard to all parts of isolation units and delivering overnight and inpatient care as risk management and infection control measures. One exception was the effective coordination of these isolation units and inpatient care, which might be due to the limited bed capacity of each hospital; however, the MOH operates a Command and Control Centre that has implemented protocols and guidelines to solve this issue by operative communication between all hospitals and quarantine-specified locations for non-critical cases (WHO 2020a,b). During the COVID-19 pandemic, all Saudi hospitals showed that significantly ($P\leq 0.001$) increased infection prevention and control awareness, as well as well-implemented measures, are crucial in overcoming the spread of infection in healthcare institutions. Moreover, a significant proportion of respondents ($P\leq 0.05$) stated that their facility added information regarding infection prevention measures to the training provided to all hospital personnel (Alzahrani and Kyratsis, 2017).

Study limitations

This study has a few limitations. The sample size was too small, and a web-based survey approach was used to prevent possible transmission of COVID-19 as the research was conducted during the COVID-19 outbreak. As such, the survey sample comprised volunteer participants who were comfortable using an online system. Therefore, the possibility of selection bias must be considered.

Recommendations

In situations such as the COVID-19 pandemic, it is recommended that health authorities should set a unified risk management plan that is distributed and communicated to all healthcare facilities. A unified risk management plan allows effortless dissemination and follow-up, and helps the public and HCWs to follow the same instructions at any healthcare facility. Guidance on resource allocation, including laboratory testing, and resource management for laboratory and infection control requirements (acquisitions, tracking and monitoring) should also be provided (Ministry of Health, Saudi Arabia, 2020a,b). There are increased demands for surveillance and management of current COVID-19 outbreaks due to the significant influence on the population's men-

tal health produced by the COVID-19 pandemic. Previous studies have found effective suggestions facilitating compliance with control measures by both HCWs and the public (Lau et al., 2007; Sim et al., 2010; Kang et al., 2020; Sun et al., 2020), including educational materials and training that should be personalized to all exposed communities. These materials should include information about preventive measures and practical identification of risks in general language, and should target both HCWs and the public (Sun et al., 2020). Subsequently, the population needs to be educated to communicate to health authorities about any symptoms, and not hide them because of embarrassment or fear, as this may spread the infection further (Ministry of Health, Saudi Arabia, 2020a,b).

Conclusion

WHO has examined and compared aspects of health systems around the world, providing conceptual insights into the complex factors that explain how health systems perform, and offering practical advice on how to assess performance and achieve improvements with available resources. It is reassuring that during critical times, such as the COVID-19 pandemic, all Saudi hospitals and HCWs showed relatively high overall prevalence of knowledge and awareness, as well as effective communication between all parties throughout the country. This has helped the Saudi health system contain the pandemic with minimal losses.

Conflict of interest statement

None declared.

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Data availability statement

Data available on request from the authors.

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