INFECTION OF HEALTHCARE WORKERS: IDENTIFYING POTENTIAL TRANSMISSION PATHWAYS OF MERS-COV IN HOSPITALS IN SAUDI ARABIA

by

Modhi Ali S. Alshammari

A Master's Thesis Submitted to the Faculty of the

MEL AND ENID ZUCKERMAN COLLEGE OF PUBLIC HEALTH

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

WITH A MAJOR IN ENVIRONMENTAL HEALTH SCIENCES

In the Graduate College

THE UNIVERSITY OF ARIZONA

2016

STATEMENT BY AUTHOR

The thesis titled *Infection of Healthcare Workers: Identifying Potential Transmission Pathways of MERS-CoV in Saudi Arabia Hospitals* prepared by Modhi Alshammari has been submitted in partial fulfillment of requirements for a master's degree at the University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this thesis are allowable without special permission, provided that an accurate acknowledgement of the source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: Modhi Alshammari

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

Mary Kay O'Rourke
Associate Professor, Public Health

04/20/2016
Date

ACKNOWLEDGMENTS

First, I would like to express my deep appreciation to my advisor, Dr. Mary Kay O'Rourke, for her continuous support of my pursuits in the master's program, for her patience, motivation, and immense knowledge. Her guidance helped me throughout the entirety of the program and the writing of this thesis.

Second, I would like to thank my committee members, Dr. Kelly Reynolds and Dr. Marc Verhougstraete. I would also like to thank all of my professors in the department of Community, Environment & Policy and the Program of Environmental Health Sciences for their encouragement and endless support.

Third, I would like to thank all those who helped me during the data collection process in Saudi Arabia, especially the workers at the Ministry of Health, as well as those who worked in the three hospitals.

Fourth, I would like to say a very special thank you to Dr. Martha Underwood, who edited my thesis chapter by chapter and did the final review of the APA requirements; Dr. Abdulnasser A. Alhusaini, who always offered great suggestions to me; and Dr. Sonmi Jo, who reviewed the section on statistical analysis and results.

Finally, and above all, I would like to thank my brothers, my brothers-in-law, my sisters, my sisters-in-law, my parents, my parents-in-law, all my relatives, and all my friends for their support, encouragement, best wishes, and prayers.

DEDICATION

To my father, Ali S. Alshammari; my mother, Dalal S. Alshammari; my husband, Abdulnasser A. Alhusaini; my daughter, Tasneem A. Alhusaini; and my coming baby for their love, support, and prayers…

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

An outbreak of Middle East Respiratory Syndrome (MERS) among healthcare workers in Saudi Arabia in 2012 led to an investigation of hand-hygiene behaviors among healthcare professionals. Direct contact with patients is a major pathway for MERS, a droplet virus, which refers to a virus that lays on surfaces. This study investigated factors associated with respiratory disease transmission (e.g., MERS) in hospital settings among healthcare workers (i.e., physicians and nurses). I developed a 16-item checklist based on three sources: the CDC standards, the WHO Five Moments for Hand Hygiene, and Boyce and Pittet's (2002) guidelines of hand hygiene. I used those 16 items in both direct-observation and self-reported questionnaire formats. The checklist addressed three time frames of contact: before, during, and after contact with patients, devices, and surrounding surfaces. Hand-hygiene behaviors surrounding these time frames were assessed.

The study also explored healthcare workers' beliefs about hygiene practices by comparing personal reports of hand hygiene assessed by questionnaire to observed actual hand-hygiene practices. The study was a cross-sectional research design and was conducted in the outpatient examination rooms and emergency departments of three hospitals (public, private, and military) in the Eastern region of Saudi Arabia. The total sample size included 87 physicians and nurses who were recruited while on duty during the researcher's observation periods.

To provide clear results, I used two independent sample *t*-tests to test each of the 8 hypotheses. I found that no statistically significant differences were found among health-care workers when observing their behaviors of hand-hygiene practices. However, when using the self-reported questionnaire data, I found statistically significant differences between physicians' and nurses' hand-hygiene practices before, during, and after interacting with patients. Also, I

found statistically significant differences between male and female hand-hygiene practices during interacting with patients, and I found statistically significant differences between health-care workers in public and military hospitals hand-hygiene practices during interacting with patients. For the primary hypothesis, I used Pearson correlation to determine the relationship between healthcare workers' reports of hand-hygiene practices, and observed healthcare workers behaviors of hand-hygiene practices. I found that no statistically significant correlation between the two data collection instruments.

To provide a further analysis, a multivariate analysis of covariance (MANCOVA) was used to examine whether healthcare workers' hand-hygiene practices before, during, and after were different while controlling for their gender, department, and hospital type. I found that no statistically significant differences were found when observing the healthcare workers behaviors of hand-hygiene practices. However, when using the self-reported questionnaire data, I found that nurses and females reported better hand-hygiene than physicians and males. From these data, I conclude healthcare workers understand the importance of hand-hygiene and fail to appropriately implement the practice.

Keywords: *Saudi Arabia, hand-hygiene compliance, healthcare workers, and Coronavirus*.

CHAPTER I: INTRODUCTION AND LITERATURE REVIEW

Healthcare System in Saudi Arabia

In the 1940s, Saudi Arabia was slowly becoming the largest oil producer in the world, and the population shifted from working in traditional professions to jobs in the government or oil companies. Political leaders established a free public healthcare system to maintain a healthy society. In the past 62 years, the healthcare system in Saudi Arabia accomplished many important goals. Life expectancy of Saudi citizens rose from 45.67 in 1960 to 75.5 in 2012 (The World Bank, 2016). In 2015, the government of Saudi Arabia spent more than 42.67 billion dollars on the healthcare system.

Today, there are 244 public hospitals and many other private and military hospitals across the country. In Saudi Arabia, of the country's 81,532 doctors, 24% are Saudi, and of the 165,324 nurses, 37% are Saudi. These figures equate to approximately 26 doctors and 54 nurses for every 10,000 citizens (Ministry of Health [MOH] 2016). In the United States, 4.6 primary care physicians were available per every 10,000 citizens, while 6.55 specialists were available per 10,000 citizens (WHO, 2016).

The Main Goals of the Ministry of Health

In 1950, the government of Saudi Arabia established the Ministry of Health with specific structures and goals (see Appendix A: Saudi Arabia Ministry of Health Structure). Two of the main goals of the Ministry of Health are to operate and guide hospitals across the country and to manage any rising public health issues. In the following section, I will explain and highlight these two goals.

One of the responsibilities of the Ministry of Health in Saudi Arabia is to establish and operate all public hospitals as well as to mentor private hospitals. Public hospitals in Saudi

Arabia provide free healthcare services for all citizens, and can be found in communities across the country; however, private for-profit hospitals require payment for their healthcare services and they usually target employees of companies and non-citizens. The Ministry of Health in Saudi Arabia controls the public hospitals and provides other hospitals (military and private) with operational certificates. The Ministry of Defense controls the military hospitals and establishes at least one military hospital in each major city for the treatment of their employees and their families. Nonetheless, under the Ministry of Health, there are seven main deputies who work independently of each other. All deputies report to the Minister of Health. For example, the Finance and Administration Deputies report either directly or via the Vice Minister to whom the Public Health and Medical Supply deputies report.

The Ministry of Health is also responsible for public health issues, maintaining reports about disease incidence and coordinating necessary responses. To maintain accurate reports about disease outbreaks, there are specific procedures that hospitals and doctors must follow. Briefly stated, doctors must report to the hospital, and then the hospital reports to the Deputy of Public Health. In response to those reports, the Ministry of Health collects data and takes specific action on each issue. For example, in the case of Middle East Respiratory Syndrome (MERS), the Ministry of Health acted to stop the spread of the virus by mandating hospital quarantines, establishing a public hotline to report any incidents, and providing information about the virus. It also offered public education to citizens and healthcare workers about the spread of the virus and how best to protect oneself.

Middle East Respiratory Syndrome (MERS)

Middle East Respiratory Syndrome (MERS) is a type of coronavirus discovered in Saudi Arabia in 2012 (Pavli, Maltezou & Tsiodras, 2014). The MERS-CoV has a cellular receptor

called CD26, which is also known as dipeptidyl peptidase 4 or DPP4. The engagement of CD26 with the MERS-CoV spike protein mediates viral attachment to host cells and virus-cell fusion, which in turn, can initiate infection (Lu, G, 2013). This infection was first reported in 2012 when "…a novel β coronavirus was isolated from a Saudi Arabian patient in Jeddah, who had died of severe pneumonia and multiple organ failure" (Kharma, et al., 2015, p. 164).

In the 1960s, a human coronavirus was first isolated and detected in the nasal cavities of patients with common colds. Prior to this discovery, primary infections were found in the upper respiratory and gastrointestinal tracts of mammals and birds. The main symptoms of coronavirus infection are fever, cough, and shortness of breath. Most human infections derive from human-to-human contact, with two exceptions which spread from animals to humans: Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS). To identify the potential animal source of MERS-CoV, Azhar, et al., (2014) took nasal swabs from a patient confirmed as having the MERS-CoV, as well as swabs from one of his nine camels. These swabs tested positive for MERS-CoV ribonucleic acid (RNA) (have you said what this is yet?). Azhar, et al., found that the full genome sequences of the two isolated samples were identical. These researchers also explain that "…serologic data indicated that MERS-CoV was circulating in the camels but not in the patient before the human infection occurred" (Azhar, et al., p. 2499).. Finally, these researchers concluded that this particular fatal case was transmitted through close contact with an infected camel.

In the SARS outbreak of 2003 in China, 8,098 people were infected and 744 died (CDC, 2016). Since 2004, there have been no known cases of SARS. However, in Saudi Arabia alone, the MERS coronavirus has infected a total of 1,310 people and 556 died (MOH, 2016). In contrast to SARS, MERS continues its spread in the region. Since 2012, 43% of the cases of

MERS in Saudi Arabia were contracted in healthcare facilities; among those, 12% were healthcare workers while 31% were patients; 41% were primary cases, 14% were acquired through household contact, and 3% were unclassified (MOH, 2016). "A significant fraction of MERS cases were linked to healthcare settings, ranging from 43.5% for the outbreak in Jeddah, Saudi Arabia, in 2014, to 100% for both the outbreaks in Al-Hasa, Saudi Arabia, in 2013, and the outbreak in South Korea in 2015" (Chowell, et al., 2015).

Since MERS appears mostly in healthcare settings, I will describe three studies of major clusters of MERS cases found there. First, Assiri and colleagues (2014), described a cluster of health care-acquired MERS infections in Alhasa, Eastern Saudi Arabia, between April 1 and May 23, 2013. Twenty-three patients were identified; among those, 21 cases were virus transmission via person-to-person in different health care facilities, and 2 of those cases were healthcare workers. Second, Oboho and colleagues (2015), described patients with MERS-CoV infected in Jeddah, Western Saudi Arabia, between January 1, through May 16, 2014. In this time frame, 255 patients with laboratory-confirmed MERS infection were identified, 93 of whom died. Eighty-one were healthcare workers, and 109 patients had contact with a health care facility. Therefore, 74% of infection cases were acquired in healthcare facilities during this outbreak. Third, the Minister of Health, Dr. Abdulaziz bin Saad, reported 53 patients with MERS infection at one hospital in Riyadh between July and August of 2015. Among those reported by Dr. Saad, 36 acquired the disease at the hospital; and 4 of them were healthcare workers and 17 died (Alriyadh, 2015). Currently, MERS poses a huge potential life threat to Saudi healthcare workers because "…most of the human-to-human infections were acquired in healthcare settings" (Al-Tawfiq & Memish, 2014). These outbreaks prompt current researchers to study the virus anatomically and epidemiologically (See Appendix B: MERS Cases by Date of Reporting

2014-2016).

Transmission of Virus in Hospitals

Viruses can be transmitted in many ways, including direct contact with an infected person or surface. The exact manner of transmission of coronaviruses has not yet been identified; however, most researchers agree that it is primarily transmitted from human to human with very low respiratory transmission rate (Al-Tawfiq & Memish, 2014). Because MERS is a droplet virus, researchers assume that it is mainly transmitted by contact with surfaces or patients already infected with the virus. Hulkower, et al., (2011) conducted a study to identify the best germicides that would eliminate coronaviruses. In their study, Hulkower, et al., identified two surrogate coronaviruses: mouse hepatitis virus (MHV) and transmissible gastroenteritis virus (TGEV). Among six different germicides, the researchers found that only ethanol reduced infectivity of the coronaviruses by >3-log10 after 1 minute.

Patients with MERS can present with mild and atypical symptoms, making it hard to identify the virus from the initial medical visit. Notwithstanding the MERS mode of transmission or a patient's observed symptoms, there are certain precautions healthcare workers should take to protect themselves and other patients. Standard precautions are basic infection control practices intended to be applied to the care of all patients in all health care settings, regardless of the suspected or confirmed presence of an infectious agent. These practices include:

1. Hand hygiene before and after patient contact;
2. Use of appropriate personal protective equipment (gloves, gowns, masks, eye protection) when contact with body fluids is anticipated;
3. Adequate cleaning, disinfection, or sterilization of patient care equipment before use with another patient; and

4. Respiratory etiquette: placing a mask on patients with coughs, encouraging patients to cover their cough and to perform hand hygiene (Sampathkumar, 2014)

"Hand hygiene is a major component of standard precautions and one of the most effective methods to prevent transmission of pathogens associated with health care" (WHO, 2006). The MERS outbreak in Saudi Arabia raises questions about hand hygiene compliance among many researchers (Pavli, Tsiodras, & Maltezou, 2014), specifically about the exposure potentials and hygiene protocols followed by healthcare workers. Hand-hygiene practice refers to washing hands by using plain soap and water, using water alone, or hand-rubbing with an alcohol-based solution. Many studies agree on the importance of infection-control practices in limiting the transmission of disease (Sampathkumar, 2014; Pavli, Tsiodras & Maltezou, 2014; Al-Tawfiq & Memish, 2014). The CDC and Saudi Arabia Hand-Hygiene Protocols are listed in Table 1.

Table 1. CDC and Saudi Arabia Hand-Hygiene Protocols Including When Hands Should Be Washed

CDC	Saudi Arabia
• Before touching a patient • Before any clean or aseptic procedure • Before contact with the patient's surroundings • After body fluid exposure risk • After touching a patient • After touching a patient's surroundings, including contaminated items or surfaces • After removal of a medical mask	• Before contact with the patient or their immediate care environment • Before performing an aseptic task (e.g., insertion of IV or urinary catheter) • Before removing gloves • After contact with blood, body fluids, or contaminated surfaces • After removing gloves • After touching the patient or the patient's immediate environment

Note: These protocols (indicating when hands should be washed) were adapted from the CDC and the Ministry of Health in Saudi Arabia

Hand-hygiene compliance among healthcare workers is well-studied by questionnaire (Sax, et al., 2007; Harris, et al., 2000; Darawad, et al.,2012), direct observation (Bischoff, et al, 2000; Duggan, et al, 2008), and a combination of questionnaire and observation (Caglar, et al, 2010; Creedon, 2005). Bischoff, et al. (2000) observed healthcare workers for 1-hour intervals at different times of day, finding that "hand-washing compliance before and after defined events was 9% and 22% for health care workers in the medical ICU and 3% and 13% for health care workers in the cardiac surgery ICU, respectively" (p. 1017). On the other hand, Sax, et al. (2007), using a questionnaire to measure healthcare workers' hand-hygiene compliance, found that "physicians estimated their rate of hand hygiene adherence to be 80%, nurses estimated their rate of adherence to be 90%, and nursing assistants estimated their rate of adherence to be 90%" (p. 1270). Both studies used the CDC five point of contact as the guideline for their questionnaire and observation data collection tools.

In Harris, et al.'s (2000) study, researchers examined three things about hand-washing

among healthcare workers: (a) self-assessments of compliance, (b) opinions about the importance of hand-washing, and (c) opinions about different interventions to inquiries compliance. These researchers found that 73% of workers reported that they wash their hands enough, with 14% reporting always washing hands before patient contacts; 67% of healthcare workers reporting washing their hands after patient contacts. Using both questionnaire and observation data, Caglar et al. (2010) conducted a study using the Centers for Disease Control (CDC) and the prevention guideline. During the observational phase, they looked at whether or not hand-washing was done in situations that required hand washing. During the questionnaire phase, they asked the observed healthcare workers about their compliance, finding that 62% of nurses and 52% of physicians wash their hands when it is required. However, physicians have a higher percentage using the correct technique. Caglar et al.'s study indicates that hand hygiene after the procedure was significantly higher than the hand hygiene before procedure.

In a study conducted in the Middle East by Darawad, et al. (2012) in a governmental hospital in Jordan, researchers explored Jordanian nurses' hand-hygiene beliefs, attitudes, and compliance, and they examined the predictors of hand-washing compliance. Survey study design was used to collect data from nurses and nursing assistants in Jordan, who reported 74% compliance rate. On the other hand, Duggan, et al. (2008) used only the observation method to examine hand-hygiene compliance before and after a Joint Commission on Accreditation of Healthcare Organizations (JCAHO) visit. At baseline, they found a 90% compliance rate. They also found that hand-hygiene compliance was better among non-MD staff compared with attending physicians or medical trainees. However, Creedon (2005) used both questionnaire and observation methods to measure compliance before and after implementing a hand-hygiene program. Creedon found that "…study participants complied with hand-washing guidelines at a

rate of 51% (baseline) prior to delivery of a hand-hygiene program and 83% afterwards" (p. 312), and his intervention program extended for 6 weeks, after which 4 more weeks were needed for the researcher to accurately collect post-program evaluations.

Statement of Purpose

This study examined specific factors (i.e., hand-hygiene practices) associated with the potential transmission of Middle East Respiratory disease (MERS) in hospital settings. The primary hypothesis addressed by this research is that no differences will be found between healthcare workers' reports of hygiene practices and observations of actual behavior. Exploratory evaluations are also undertaken even though data are limited and reused to address them. Exploratory analysis can help define future work.

Exploratory Hypotheses

$H_{0/1}$: No observational differences will be found between hand-hygiene practice of physicians and of nurses (a) total, (b) before, (c) during, and (d) after contact with patients, devices, and surrounding surfaces.

$H_{0/2}$: No observational differences will be found between hand-hygiene practice of emergency room healthcare workers and of outpatient departments (a) total, (b) before, (c) during, and (d) after contact with patients, devices, and surrounding surfaces.

$H_{0/3}$: No observational differences will be found between hand-hygiene practice of male and of female healthcare workers (a) total, (b) before, (c) during, and (d) after contact with patients, devices, and surrounding surfaces.

$H_{0/4}$: No observational differences will be found between hand-hygiene practice of public hospital and military hospital healthcare workers (a) total, (b) before, (c) during, and (d) after contact with patients, devices, and surrounding surfaces.

$H_{0/5}$: No questionnaire differences will be found between hand-hygiene practice of physicians and of nurses (a) total, (b) before, (c) during, and (d) after contact with patients, devices, and surrounding surfaces.

$H_{0/6}$: No questionnaire differences will be found between hand-hygiene practice of emergency room healthcare workers and of outpatient department (a) total, (b) before, (c) during, and (d) after contact with patients, devices, and surrounding surfaces.

$H_{0/7}$: No questionnaire differences will be found between hand-hygiene practice of male and of female healthcare workers (a) total, (b) before, (c) during, and (d) after contact with patients, devices, and surrounding surfaces.

$H_{0/8}$: No questionnaire differences will be found between hand-hygiene practice of public and of military healthcare workers (a) total, (b) before, (c) during, and (d) after contact with patients, devices, and surrounding surfaces.

CHAPTER II: METHODOLOGY

Research Method

This study employed an overall mixed-method research design assessing both quantitative and qualitative data (Fraenkel, Wallen, & Hyun, 1993). A cross-sectional design was used to evaluate data collected from a population, at specific points in time (Checkoway, Pearce, & Kreibel, 2004). This type of design was the most suitable for a targeted investigation "of nonfatal diseases or physiologic responses to work place exposures … that may involve clinical examinations, symptom surveys, or direct biological or physical measurements" (Checkoway, et al.). Checkoway, et al. asserted that cross-sectional studies are ideal for evaluation of data that would not ordinarily be gathered on a routine basis. Because the collection of hygiene practice and compliance data is rarely investigated in hospitals, this study warranted a cross sectional design. I collected quantitative observation data using a dichotomous scale and questionnaire data using a five-level Likert scale (Allen, & Seaman, 2007) to measure each participant's hand-hygiene reports and behavior. I conducted structured observations and recorded supplemental notes and responses to open-ended questions related to the spread of MERS in Saudi Arabia.

Setting

I conducted the study in hospitals in Eastern Saudi Arabia, with approval of study design and instruments by the University of Arizona Institutional Review Board (UA-IRB). The Saudi healthcare workers gave consent to the researcher for on-site observations during work-hour. Because this project was directed under the University of Arizona, authorization was required and obtained from the Institutional Review Board (IRB) after careful review of the project proposal (i.e., Protocol Number 15-06-CPH, see Appendix C: Institute Review Board [IRB] Approval). Further, the Ministry of Health or hospital owner, the infection control departments

or responsible physician group, and the heads of each of the hospitals granted approval for performing this research in each hospital (see Appendices D, E, and F). Specific characterizations of each hospital are provided below:

Public hospital. A public hospital in a major city in Eastern Saudi Arabia with several outpatient clinics, such as dermatologic, internal, and orthopedic medicine was selected. The hospital has a capacity of 500 beds, and committees addressing disease control and organ transplants were integral parts of the hospital infrastructure.

Military hospital. A public institution that housed fewer outpatient departments than the public hospital, but unlike the private hospital, it also had disease control and organ transplant committees with 132 beds.

Private hospital. A private hospital in a major city of Eastern Saudi Arabia contained several outpatient clinics, such as internal medicine, maternity, otorhinolaryngology (ENT), and an emergency room. The hospital had only treatment rooms and 10 beds.

Participant Recruitments

Nurses and medical doctors were recruited from the outpatient and emergency room departments at each hospital. The outpatient clinic supervisor provided a list of all the physicians and nurses assigned to work during the observation period. The sample population was recruited through meetings with each healthcare worker on duty at each designated hospital. During a weeklong visit at each setting, all healthcare workers were explained the premise of the study, and permission was obtained to observe healthcare workers' hand-hygiene practices and administer the questionnaire. All doctors and nurses on duty in the emergency room were asked to participate. At the military hospital, the researcher specifically accompanied infection control personnel to gain access to healthcare workers on duty.

Instruments

Healthcare worker (i.e., physicians and nurses) hand-hygiene practices were evaluated before, during, and after interacting with patients, devices, and surrounding surfaces in Saudi Arabian hospitals. Data collection was done using three different methods: (a) direct-observation of the healthcare workers' hand-hygiene practices during work-hours, (b) self-reported questionnaires of the healthcare workers' beliefs about their hand-hygiene practices, and (c) general field notes.

Observation Checklist. An observation instrument containing 16 items was developed based on three sources: the CDC standards, the WHO's Five Moments for Hand Hygiene in Health Care, and published guidelines by Boyce and Pittet (2002). The observation checklist contained 16 different questions grouped into 3 patient-related time dependent categories: (a) contact with a patient prior to entrance into an examination room (i.e., high risk for cross-transmission), (b) contact during the exam (i.e., low risk for cross-transmission), and (c) contact

with a patient upon exit from an examination room (i.e., medium risk for cross-transmission). (See Appendices G and H.)

Self-Reported Questionnaire. The researcher reworded the 16 items from the observation sheet, making the statements active with a five-point Likert scale (i.e., Never, Rarely, Every Once in a While, Sometime, and Always). After each observation, healthcare workers completed a self-evaluation questionnaire about hand-hygiene practices corresponding with items on the observation sheet. See Appendices I and J.

General Field Notes. Field notes were used only in the analysis of the observation and questionnaire outcomes.

Procedure

Eighty-seven participants (46 medical doctors and 41 nurses) were recruited, providing a minimum of 30 participants per group as required by the study design, a selection of sufficient sample size meeting the analytical requirement of random recruitment (i.e., $N \geq 30$). I recorded and observed the hand-hygiene practices of each participant using the checklist.

Measurement of Variables and Operational Definitions

Hand Hygiene across Three Conditions

The three conditions of hand hygiene were before, during, and after contact with the patient. Items from each index were summed and averaged to create a hand-hygiene index corresponding to each condition. The items of the numbered checklist were divided as follows:

Before: A1, A2, A6 and A7

During: A5, A10, B1, B2 and B6

After: A3, A4, A8, A9, B3, B4 and B5

Healthcare Workers Evaluated

Physicians. These healthcare workers have at least a Bachelor's degree in medicine, have completed a one-year internship, and have earned a professional license to practice medicine in Saudi hospitals from the Saudi Commission for Health Specialties (SCHS). I recruited 46 physicians (21 from the public hospital, 9 from the private hospital, and 16 from the military hospital).

Nurses. These healthcare workers have attained a nursing diploma, have completed a one-year internship, and have earned a professional license to practice nursing in Saudi hospitals from the SCHS. I recruited 41 nurses (14 from the public hospital, 9 from the private hospital, and 18 from the military hospital).

Data Screening and Initial Analysis

Handling Missing Data

All healthcare workers were provided work time to complete the questionnaire after being informed of the importance of research, and having the questionnaire items translated when needed. However, only 61% of the observed healthcare workers returned self-completed questionnaires. To minimize the impact of missing data, some hypotheses were designated as exploratory (see Introduction). Methodologists and statisticians have recommended alternative ways to handle missing data, such as replacing the missing value with a mean score; Tabachnick and Fidell (2013) recommended removal of cases with missing values. Data lacking both self-assessment and observations were excluded when testing the primary hypothesis, so only data from the healthcare workers who were actually observed by the researcher and data from questionnaires completed by healthcare workers were analyzed.

Assessing the Normality

The distributions of the Saudi healthcare workers' hand-hygiene practices before, during, and after interacting with patients, medical devices, and surrounding surfaces were assessed for normality by examining the skewness (distributional symmetry) and kurtosis (peakedness around the mean relative to a normal distribution) values of the index scores calculated for each condition (Tabachnick & Fidell, 2013). Studies based on human behavior do not always exhibit skewness and kurtosis values of zero (i.e., perfect normal distribution). Some methodologists and statisticians have recommended thresholds of ± 1.00 (George & Mallery, 2003; Morgan, Griego, & Gloeckner, 2001) as indicative of departures from normality. Another method for determining skewness and kurtosis is to multiply the standard error by three and use this value as a threshold, with absolute values of skewness and kurtosis that fall below the threshold indicating the assumption of normality has been met. In Appendix K, Tables A and B demonstrate the skewness and kurtosis of the data.

Data Analysis

SPSS software version 21 was used to evaluate the exploratory hypotheses, using two independent sample *t*-tests. To test the primary hypothesis, Pearson correlation was used to explore to what extent healthcare workers' beliefs about hand-hygiene practices, as obtained by the questionnaire, and their actual behavior of hand-hygiene practices, as observed by the researcher, were correlated. To provide further analysis, a multivariate analysis of covariance (MANCOVA) was used. When using MANCOVA, the healthcare worker (physician or a nurse) was the independent variable. The practice of hand hygiene measured under three conditions (before, during, and after) was the dependent variable. Statistical analysis controlled for

department (emergency rooms or outpatient department), hospital type (public, private, or military), and gender (male and female).

CHAPTER III: RESULTS

Participants

Sixty-one percent (n=53) of the observed participants (n=83) completed the questionnaire. There was no specific recruitment procedure regarding which patients each healthcare worker was treating, since this study required no observations of the patient, his/her characteristics, reason for hospital visit, or diagnosis. The human subjects selected for participation in the study are summarized in Table 2:

Table 2. Participant Information

Hospital	Observation			Questionnaire		
	Physicians	**Nurses**	**Total**	**Physicians**	**Nurses**	**Total**
Public	20	14	34	12	3	15
Private	8	9	17	5	5	10
Military	16	16	32	12	16	28
Total	**44**	**39**	**83**	**29**	**24**	**53**

Descriptive Statistics

Before answering the hypothesizes, an overview of the data in descriptive statistics is presented. Tables 3 (observations) and 4 (self-reports) include the minimum score, maximum score, mean, and standard deviation of all variables, based on the observation data and questionnaire data. Visual representations of the overall findings are shown in Figures 1 and 2. Figure 1 depicts the scaled compliance scores (from 0 to 1) of variables observed with bar graphs. Figure 2 also displays bar graphs of the mean values of the Likert scores obtained from the self-report questionnaires (see *Figures* 1 and 2).

In general, compliance scores before contacting patients among all variables were lower than compliance scores during and after contact with patients. Moreover, compliance scores during and after contact with patients were comparable to each other, except for the mean

compliance score observed in the private hospital. In contrast, the mean scores derived from the self-report questionnaire data were compared across conditions of patient contact. Additionally, based on the questionnaire data, all healthcare workers generally believed that they were compliant with hand-hygiene procedures. Further interpretation of Figures 1 and 2 leads us to conclude that physicians appear to be more self-aware about their hand-hygiene practices than nurses.

Table 3. Descriptive Statistics for All Variables Based on the Observation Data (Before, During, and After)

			Saudi Healthcare Workers' Hand-Hygiene Practices, *N* = 83											
			Before				**During**				**After**			
Variable	**Condition**	***N***	***Min***	***Max***	***M***	***SD***	***Min***	***Max***	***M***	***SD***	***Min***	***Max***	***M***	***SD***
Occupation	**Physician**	**44**	.00	.50	.06	.13	.00	.40	.10	.11	.00	.71	.10	.15
	Nurse	**39**	.00	.50	.04	.11	.00	.50	.13	.13	.00	.50	.10	.15
Department	**Emergency**	**21**	.00	.50	.03	.11	.00	.50	.14	.14	.00	.50	.11	.16
	Outpatient	**62**	.00	.50	.05	.13	.00	.40	.11	.11	.00	.71	.10	.15
Gender	**Male**	**31**	.00	.50	.07	.17	.00	.40	.13	.12	.00	.71	.14	.19
	Female	**52**	.00	.50	.03	.09	.00	.50	.11	.11	.00	.50	.08	.12
Hospital	**Public**	**34**	.00	.50	.04	.10	.00	.40	.11	.12	.00	.71	.11	.16
	Private	**17**	.00	.08	.005	.02	.00	.40	.11	.10	.00	.24	.03	.07
	Military	**32**	.00	.50	.09	.16	.00	.50	.12	.12	.00	.54	.13	.16

Note: *N* = Total sample size; *n* = Sample size in each condition; *Min* = Minimum; *Max* = Maximum; *M* = Mean; *SD* = Standard Deviation.

Table 4. Descriptive Statistics for All Variables Based on the Questionnaire Data (Before, During, and After)

Variable	Condition	*n*	Saudi Healthcare Workers' Hand-Hygiene Practices, *N* = 83											
			Before				During				After			
			Min	*Max*	*M*	*SD*	*Min*	*Max*	*M*	*SD*	*Min*	*Max*	*M*	*SD*
Occupation	**Physician**	**29**	1.00	5.00	3.68	1.1	.60	4.80	3.73	.93	1.00	5.00	4.2	1.0
	Nurse	**24**	3.00	5.00	4.46	.62	3.40	5.00	4.52	.47	3.14	5.00	4.6	.53
Department	**Emergency**	**12**	2.25	5.00	4.12	.90	.60	5.00	3.90	1.2	1.00	5.00	4.2	1.2
	Outpatient	**41**	1.00	5.00	4.01	1.0	2.20	5.00	4.15	.73	2.00	5.00	4.4	.74
Gender	**Male**	**21**	1.00	5.00	3.79	1.1	.60	5.00	3.79	1.1	1.00	5.00	4.2	1.1
	Female	**32**	1.25	5.00	4.19	.89	3.20	5.00	4.29	.60	2.71	5.00	4.5	.63
Hospital	**Public**	**15**	1.25	5.00	3.75	1.2	.60	4.80	3.53	1.1	1.00	5.00	4.0	1.2
	Private	**10**	2.50	5.00	4.20	.67	3.40	5.00	4.30	.63	3.14	4.86	4.5	.51
	Military	**28**	1.00	5.00	4.13	1.0	2.40	5.00	4.32	.61	2.00	5.00	4.5	.68

Note: *N* = Total sample size; *n* = Sample size in each condition; *Min* = Minimum; *Max* = Maximum; *M* = Mean; *SD* = Standard Deviation.

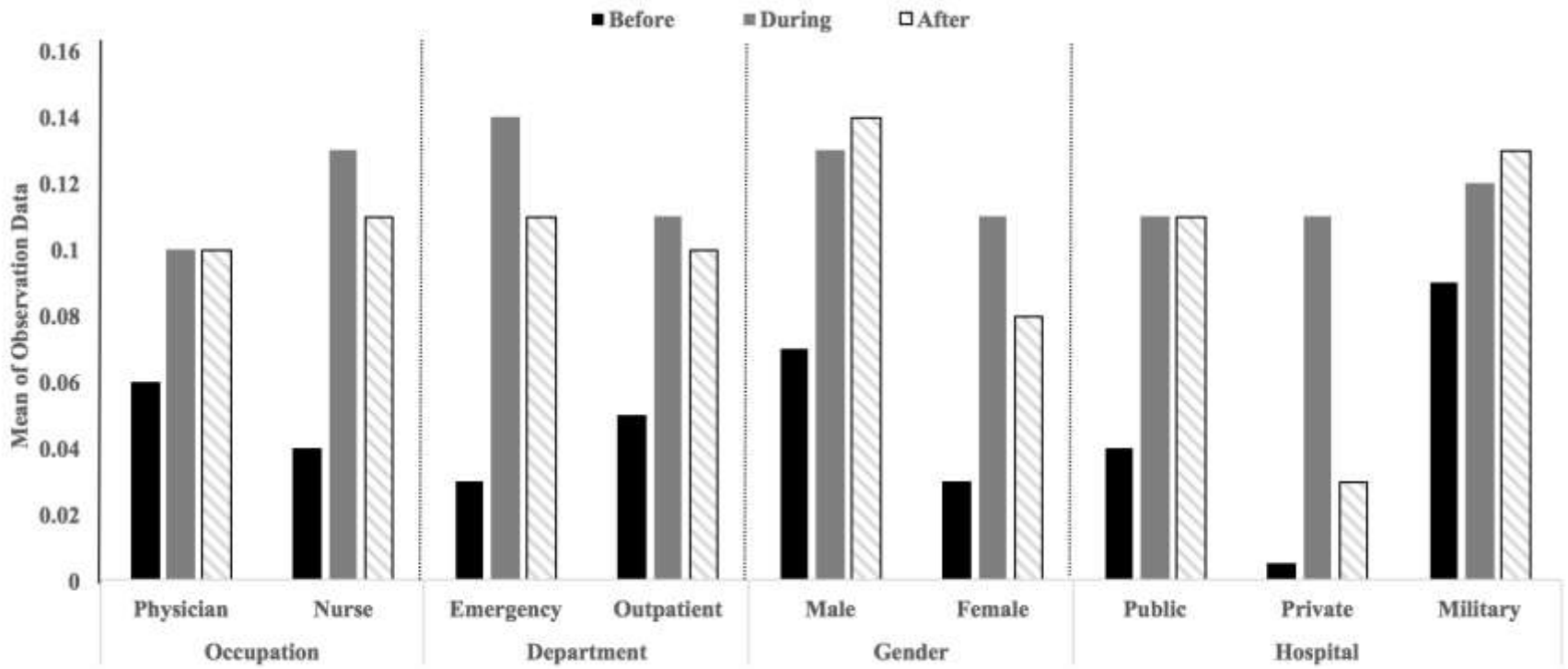


Figure 1: Comparing the Mean Scaled Compliance Scores of All Variables Based on the Observation Data

Note: Mean observation scores between 0 and 1, with 1 being compliance 100% of the time.

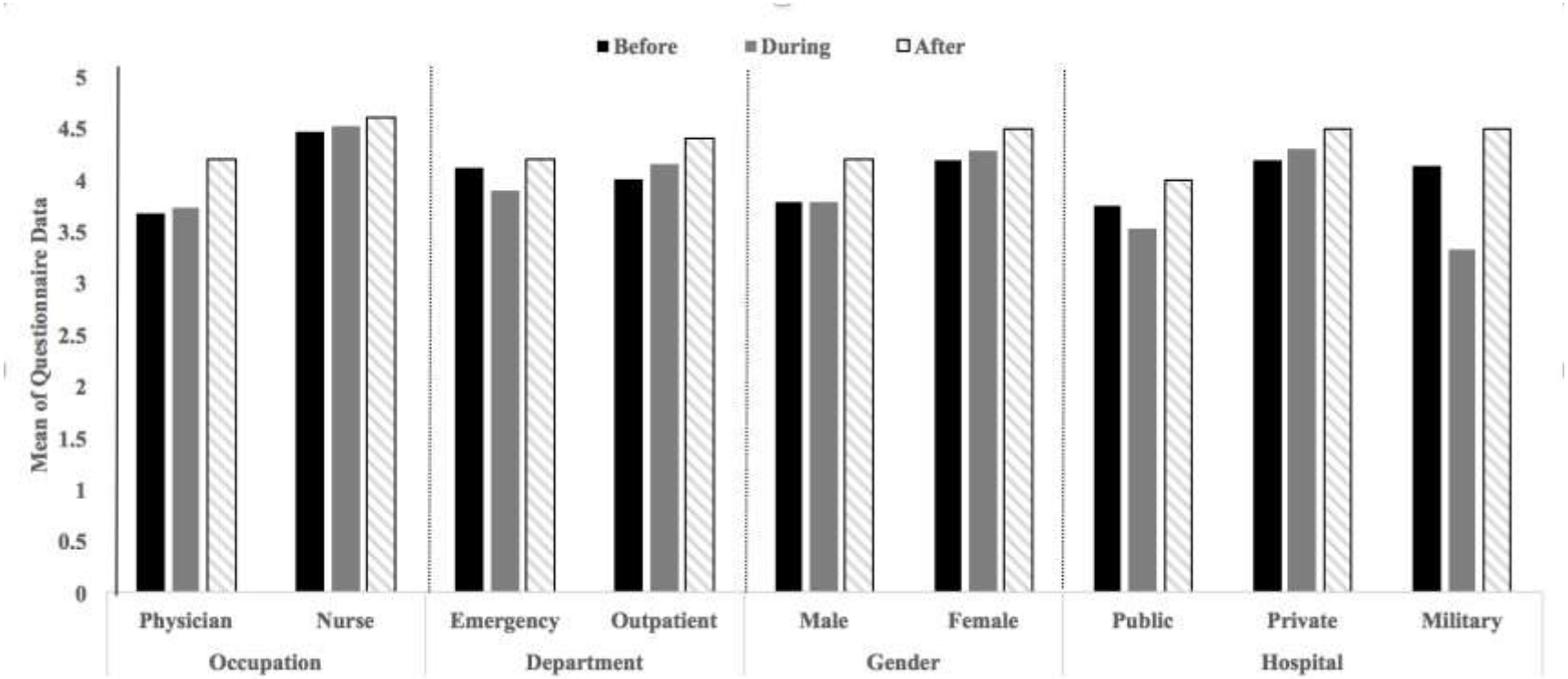


Figure 2: Comparing the Means of all Variables Based on the Questionnaire Data

Note: Mean questionnaire scores between 0 and 5, with 5 meaning compliance 100% of the time.

Primary Hypothesis

No differences will be found between healthcare workers' reports of hygiene practices and observations of actual behavior.

To evaluate the primary hypothesis, Pearson correlation was used to examine the relationship between healthcare workers' beliefs about hygiene practices, obtained by the questionnaire, and healthcare workers' actual behavior of hand-hygiene practices, per researcher observations. Because the data have already been transformed from categorical and nominal to scale, a Spearman correlation was not used. The results of the Pearson correlation indicated that the healthcare workers' beliefs of hygiene practices and healthcare workers' actual behaviors did not correlate, ranging from $r = -.01$ to $r = -.20$ (see Table 7). Some of the qualitative data (i.e., the researcher's field notes) can be used to explain these findings in the discussion section.

Table 5. Inter-Correlations among the Observation and Questionnaire Data about the Hand-Hygiene Practices (Before, During, After, and Total)

Measurement	Hand-Hygiene	Observation				Questionnaire			
		1. Before	**2. During**	**3. After**	**4. Total**	**5. Before**	**6. During**	**7. After**	**8. Total**
Observation	**1. Before**	1							
	2. During	-.13	1						
	3. After	.00	.50**	1					
	4. Total	.28*	.70**	.89**	1				
Questionnaire	**5. Before**	-.05	-.01	.01	-.01	1			
	6. During	-.19	-.01	.08	-.02	.56**	1		
	7. After	-.20	-.11	.03	-.09	.68**	.79**	1	
	8. Total	-.17	-.06	.05	-.05	.82**	.88**	.94**	1

Note: ** = Correlation is significant at the .01 level (2-tailed); * = Correlation is significant at the .05 level (2-tailed). The shaded area shows no correlation between questionnaire responses and observations.

Exploratory Hypotheses

Hypotheses 1-4

No statistically significant differences were found for Hypotheses 1to 4 during any of the contact time frames. Thus, these null hypotheses were accepted (see Table 5).

Hypotheses 5-8

Based on the self-report questionnaires, significant differences were found between physicians' and nurses' hand-hygiene practices across the three time frames of contact with patients, devices, and surrounding surfaces. Thus, this null hypothesis (H_{05}) was rejected. Moreover, there were no significant differences between the scores associated with Hypothesis 6 between the questionnaire scores of the emergency room workers and outpatient department healthcare workers across the three time frames (see Table 6, Section B). Statistical differences did occur between the scores of males and females, and also with the scores of pubic and military hospitals during contact with the patients. However, there were no statistical differences with the two other time frames (see Table 6, Sections C and D).

Table 6. Two Independent Sample t-Tests of the Observational Data (Before, During, After, and Total) on Hand-Hygiene Practices

Section A: Physicians and Nurses							
Hand Hygiene	**Physicians Descriptive Statistics**		**Nurses Descriptive Statistics**				
	M	***SD***	***M***	***SD***	***df***	***t***	***p***
Before	.06	.14	.04	.12	81	.69	.49
During	.10	.11	.14	.13	81	-1.32	.19
After	.10	.16	.11	.15	81	-.17	.87
Total	.27	.27	.29	.26	81	-.37	.72
Section B: Emergency Room and Outpatients							
Hand Hygiene	**Emergency Room Descriptive Statistics**		**Outpatients Descriptive Statistics**				
	M	***SD***	***M***	***SD***	***df***	***t***	***p***
Before	.04	.12	.06	.13	81	.73	.47
During	.15	.14	.11	.12	81	-1.1	.28
After	.12	.16	.10	.15	81	-.35	.73
Total	.30	.26	.28	.27	81	-.33	.73
Section C: Male and Female							
Hand Hygiene	**Male Descriptive Statistics**		**Female Descriptive Statistics**				
	M	***SD***	***M***	***SD***	***df***	***t***	***p***
Before	.08	.17	.04	.1	81	-1.36	.18
During	.13	.13	.11	.12	81	-.72	.47
After	.14	.19	.09	.13	81	-1.57	.12
Total	.35	.31	.24	.23	81	-1.93	.06
Section D: Public and Military							
Hand Hygiene	**Public Descriptive Statistics**		**Military Descriptive Statistics**				
	M	***SD***	***M***	***SD***	***df***	***t***	***p***
Before	.04	.12	.09	.17	81	-1.48	.14
During	.11	.13	.13	.13	81	-.52	.60
After	.12	.17	.13	.16	81	-.39	.70
Total	.27	.26	.24	.30	81	-1.21	.23

Note: *M* = Mean; *SD* = Standard Deviation; *df* = Degree of Freedom; *t* = t-statistic; *p* = probability value.

Table 7. Two Independent Sample t-Tests of the Questionnaire Data (Before, During, After, and Total) on Hand-Hygiene Practices

Hand Hygiene	Physicians Descriptive Statistics		Nurses Descriptive Statistics				
	M	***SD***	***M***	***SD***	***df***	***t***	***p***
Section A: Physicians and Nurses							
Before	3.68	1.13	4.47	.63	51	-3.04	.004
During	3.74	.94	4.53	.48	51	-3.72	.000
After	4.17	1.01	4.65	.54	51	-2.10	.041
Total	10.19	4.57	13.65	1.51	51	-3.56	.001
Section B: Emergency Room and Outpatients							
Before	4.13	.91	4.01	1.05	51	-.34	.737
During	3.90	1.20	4.15	.74	51	.89	.376
After	4.23	1.19	4.44	.75	51	.75	.456
Total	11.32	4.54	11.75	3.85	51	.34	.733
Section C: Male and Female							
Before	3.80	1.14	4.20	.90	51	1.42	.163
During	3.79	1.08	4.29	.61	51	2.17	.035
After	4.19	1.11	4.52	.63	51	1.39	.171
Total	11.69	2.90	11.57	4.53	51	-.20	.842
Section D: Public and Military							
Before	3.75	1.15	4.13	1.03	41	-1.12	.27
During	3.53	1.12	4.32	.61	41	-2.99	.005
After	4.05	1.22	4.53	.69	41	-1.67	.103
Total	10.63	4.06	12.13	3.90	41	-1.23	.227

Note: *M* = Mean; *SD* = Standard Deviation; *df* = Degree of Freedom; *t* = t-statistic; *p* = probability value.

I already presented data analysis using two independent samples t-test. However, in this section more sophisticated analysis is provided. For the observational data, a multivariate analysis of covariance (MANCOVA) was used to examine whether healthcare workers: physicians (n = 44) and nurses (n = 39), were different in their hand-hygiene practices when using the direct-observation sheet for the physicians before (M = .06, SD = .13), during (M = .10, SD = .11), and after (M = .10, SD = .15); and for the nurses before (M = .04, SD = .11), during (M = .13, SD = .13), and after (M = .10, SD = .15). The covariate variables were departments, gender, and hospital types. The results show no significant statistical differences between physicians and nurses in their hand-hygiene practices when using the direct-observation, F (3, 76) = .769, p = .515, η^2 = .029.

For the questionnaire data, a multivariate analysis of covariance (MANCOVA) was used to examine whether healthcare workers' physicians (n = 29) and nurses (n = 24) were different in their hand-hygiene practices when using the self-report questionnaire as the physicians before (M = 3.68, SD = 1.13), during (M = 3.73, SD = .93), and after (M = 4.17, SD = 1.01); and as the nurses before (M = 4.46, SD = .62), during (M = 4.52, SD = .47), and after (M = 4.65, SD = .53). The covariate variables were departments, gender, and hospital types. The results show statistically significant differences between physicians and nurses in their hand-hygiene practices when using the self-report questionnaire (F (3, 46) = 3.04, p = .038, η^2 = .17). The pairwise comparisons (i.e., Bonferroni) were applied to identify in which time of interacting with patients (i.e., before, during, or after) the physicians and nurses were different. The results show statistically significant differences between physicians and nurses before (p = .034) and during (p = .026) interactions, but there was no statistically significant difference between physicians and nurses after (p = .235) interaction.

CHAPTER IV: DISCUSSION

Study Strengths

The study presented here addresses two omissions over previous studies. First, the data collection has greater validity since three observation methods (i.e., direct-observation, self-reported, and fields-notes) were used. This mixed method design increased the validity of the outcomes and presents an idea of the situation in Saudi Arabia regarding healthcare worker's hygiene practices. The results of this study increase the awareness of hand hygiene issues in healthcare settings. Hospital administration, infection control and healthcare workers can use the result of this study to identify gaps in the previous study regarding hand hygiene. The literature contained no specific study that focused on infection-control practices among healthcare workers in Eastern Saudi Arabia.

Findings

This study has three main findings. First, per my observations, hand hygiene compliance among healthcare workers in Saudi Arabia was 27% and 29% for physicians and nurses respectively, with no statistical difference. This is considered to be low compliance; however, this finding is consistent with the literature. Second, for the self-report questionnaires, nurses reported higher hand-hygiene compliance than physicians. Similarly, Harris et al. (2000) found that physicians reported a lower compliance with hand-hygiene when compared to non-physicians. Third, healthcare workers' beliefs based on questionnaire responses and the actual behavior based on the researcher's observations did not correlate, indicating that the healthcare workers think that they are more compliant than they actually are. Another explanation could be that there may not have been adequate facilities for good hand-hygiene practices in the examination rooms.

When comparing the results from data collected in the public hospital to the military hospital data, I found no statistical differences per my observations. This is of note because the public hospital had a dedicated MERS hand-hygiene campaign, while the military hospital only had annual seminars about hand-hygiene practice. Prior to collecting data, I theorized that the public hospital staff would have higher rates of compliance; however, the analysis does not confirm my theory. Antoniak's (2004) findings supported this idea in which changes in hand-hygiene behavior were not sustained beyond the period of educational intervention. In other words, research has shown that education is not significantly effective. Worth mentioning is that the descriptive statistics from the private hospitals showed the lowest compliance rate, possibly due to the absence of hygienic resources, like alcohol-based hand sanitizers, in the examination rooms. In the private hospital, hand sanitizers were only observed to exist in hallways.

Limitations

One of the most important limitations of this study was that there was only one observer of the hand-hygiene practice per each healthcare worker observation. It was very difficult for just one researcher to adequately measure the proper protocol of hand hygiene, i.e., duration and technique. I recommend that future researchers use either video recording or more than one observer to collect a more accurate representation of the data. Another limitation of this study derives from the sampling procedure. Because data collection was limited to the Eastern region of Saudi Arabia, the results are not generalizable to the entire country.

Reflection

When I became interested in studying MERS, emerged in Saudi Arabia in 2011, I learned that this contagious virus transmitted by animal-to-human (mainly by camels) contact. To give a historical context, in 2009 a beauty competition of flocks of camels was established in Saudi

Arabia (i.e., Um Rgaiba). This new pastime generated extreme interest from people across the country, and therefore the monetary value of camels significantly increased. For instance, in 2008, one camel was only worth a few thousand dollars, and today, a camel could be worth more than one million dollars. By the end of 2011, the zeal for Um Rgaiba was so great, Saudi people started importing camels from other countries, such as Australia, where there had been an uncontrollable population growth of wild camels causing major environmental problems such as destruction of the ecosystems. To address this problem, the Australian government reduced the number of wild camels by either killing them or exporting them to Middle Eastern countries, with the largest export of wild camels going to Saudi Arabia.

Knowing this history, I speculate that MERS has surfaced in Saudi Arabia via the imported wild camels from Australia. MERS would go unnoticed in Australia because these were wild animals with no human contact. This epidemiological theory needs to be investigated in the future. Without proper resources and funding, investigating this MERS/wild camel theory would be an impossible task for a novice researcher. Therefore, I decided to study human-to-human transmission of MERS in hospital settings because accessibility for observation and application of questionnaires to healthcare workers regarding their hand-hygiene practices was achievable. Scientific research has proven that hand-hygiene is an important tool and the most effective way to prevent the spread of infectious diseases (Darawad, et al.,2012). Caglar et.al (2010) conducted an extensive literature review about hand hygiene practice among healthcare workers and found that the data indicated only 12.9% to 56% were compliant. Unfortunately, hand-hygiene practices in Saudi hospitals have not been investigated and no published articles were found. Thus, this present study is the first to investigate healthcare workers' hand-hygiene practice in the Eastern region of Saudi Arabia.

The study was particularly challenging for me, as a woman, due to Saudi Arabian cultural expectations and limitations. I collected the data during the summer of 2015, the season in which many administrative staff of the Ministry of Health were on vacation, and obtaining approval for the data collection was exceptionally difficult. Transportation was another major difficulty for me as a female researcher. The Saudi Arabian government does not permit women to drive, and there is no public transportation system in the country accessible to women. This was a huge barrier, having to rely on hired drivers to transport me among the hospital settings. This, in turn, adversely affected the recruitment number. Also, healthcare workers, both physicians and nurses, were not accustomed to a researcher observing them at work, resulting in initial distrust and concerns about my presence in the examination room. Although there were many obstacles to a successful data collection process, over a period of two months I was able to complete the task.

New Direction for Intervention of Hand-hygiene

Throughout the study, I observed many unexpected behaviors that infection control personnel at all hospitals need to note and address. For example, on one observation, a healthcare worker washed her hands, then used a tissue to close the water handle, and then used the same tissue to clean nearby surfaces. On other observations, I noted a few healthcare workers who did not follow proper alcohol application protocol. These behaviors contributed to the lack of hand-hygiene compliance. What causes these behaviors needs to be studied from a behavioral perspective in order to improve hand-hygiene practices among health workers.

A best practice for studying behavior is using the A-B-C model, a behavioral method thoroughly presented in Umbreit, Ferro, Liaupsin and Lane's (2007) book entitled, *Functional*

Behavioral Assessment and Functional Based Intervention. The A-B-C model has three components:

- **Antecedent**. The conditions prior to the occurrence of the behavior (i.e., setting the environment).
- **Behavior**. An action that is (a) measurable, (b) observable, and (c) repeated (i.e., performance).
- **Consequence**. The condition that affects the occurrence of the behavior, either resulting in an increase or a decrease (i.e., reinforcement or punishment).

In the case of healthcare workers, antecedents include performing a behavior because of specific conditions. These conditions could vary from personal health issues, poor work conditions, inadequate training, lack of time, and/or having a unsupportive supervisor. Consequences include what would happen to the worker if he/she choose to follow proper procedure, e.g., remaining healthy, getting supervisor recognition, and patient satisfaction. Consequences for not following hand-hygiene protocol can include getting infected by a virus, receiving supervisory reprimands, and getting patient complaints. Researchers can use the A-B-C model to identify actual reasons for lack of hand-hygiene compliance regardless of many campaigns and educational programs.

According to the A-B-C model, in order to change or build a behavior, researchers need to examine and manipulate the antecedents and/or consequences. However, what is happening now in the occupational health sciences in Saudi Arabia is not effective because efforts to improve the behavior of hand-hygiene practice are simply driven by more educational and training programs. Manipulating the antecedents and the consequences would automatically affect the targeted behavior, e.g., hand-hygiene practice. Either choosing to reject hand-hygiene

protocol or to comply with hand-hygiene protocol is not an isolated decision. Due to the conditions before or after the behavior occurs, the healthcare worker makes this choice. The healthcare worker may not even realize either of those conditions. However, future researchers should investigate whether teaching healthcare workers to understand and acknowledge these conditions will ultimately result in better hand-hygiene practices.

In conclusion, I found no statistically significant correlations between healthcare workers' reports of hand-hygiene practices and observed behaviors of hand-hygiene practices. Additionally, I found that there were no statistically significant differences among the two health-care workers (i.e., nurses and physicians) when observed. However, there were statistically significant differences when comparing the self-reported questionnaire data to observations of physicians' and nurses' hand-hygiene practices. These results demonstrate that healthcare workers likely understand the importance of hand-hygiene, but fail to practice appropriate hand-hygiene in routine activities.

To improve hand-hygiene practice rates, I recommend engineering and administrative controls. For engineering control, the physician should move from one patient room to another patient room, with sanitization of the examination room after each exam, instead of the Saudi Arabian model in which each physician has his/her own examination room and patients are examined successively in this room. By physicians being required to change examination rooms, it would be a reminder for the physicians to implement hand-hygiene upon entry into each new room. For administrative controls, the appointments should be more structured with adequate time allotment, so health care workers have enough time to utilize suggested hand-hygiene practices. Future researchers must address surrogate viral studies coupled with the tracking of these surrogate viruses in order to fully investigate the transmission and portability of viruses.

This is crucial for public health researchers to fully understand pathogen movement around health care environments as well as the role of hand-hygiene on reducing infection in order to create more focused and effective interventions.

REFERENCES

Al-Tawfiq, J. A., & Memish, Z. A. (2014). Middle East respiratory syndrome coronavirus: epidemiology and disease control measures. *Infection and Drug Resistance*, *7*, 281.

Allen, I. E., & Seaman, C. A. (2007). Likert scales and data analyses. *Quality Progress*, *40*(7), 64.

Alriyadh. (2015). Recording 17 deaths and 53 cases of infection coronavirus at (Health Guard). Retrieved from http://www.alriyadh.com/1075804

Antoniak, J. (2004). Handwashing compliance. *The Canadian nurse*, *100*(7), 21-25.

Assiri, A., McGeer, A., Perl, T. M., Price, C. S., Al Rabeeah, A. A., Cummings, D. A., ... & Madani, H. (2013). Hospital outbreak of Middle East respiratory syndrome coronavirus. *New England Journal of Medicine*, *369*(5), 407-416.

Azhar, E. I., El-Kafrawy, S. A., Farraj, S. A., Hassan, A. M., Al-Saeed, M. S., Hashem, A. M., & Madani, T. A. (2014). Evidence for camel-to-human transmission of MERS coronavirus. *New England Journal of Medicine*, *370*(26), 2499-2505.

Bischoff, W. E., Reynolds, T. M., Sessler, C. N., Edmond, M. B., & Wenzel, R. P. (2000). Handwashing compliance by health care workers: the impact of introducing an accessible, alcohol-based hand antiseptic. *Archives of internal medicine*, *160*(7), 1017-1021.

Boyce, J. M., & Pittet, D. (2002). Guideline for hand hygiene in health-care settings: recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. *American Journal of Infection Control*, *30*(8), S1-S46.

Caglar, S., Yldız, S., & Savaser, S. (2010). Observation results of handwashing by health- care workers in a neonatal intensive care unit. International journal of nursing practice, 16(2), 132-137.

Centers for Disease Control and Prevention (CDC). (2007). Infection control standard precautions in health care. Retrieved from http://www.who.int/csr/resources/publications/4EPR_AM2.pdf

Centers for Disease Control and Prevention (CDC). (2016). Severe acute respiratory syndrome (SARS), surveillance and reporting. Retrieved from http://www.cdc.gov/sars/surveillance/index.html

Checkoway, H., Pearce, N., & Kriebel, D. (2004). *Research methods in occupational epidemiology* (Vol. 34). Oxford University Press, USA.

Chowell, G., Abdirizak, F., Lee, S., Lee, J., Jung, E., Nishiura, H., & Viboud, C. (2015). Transmission characteristics of MERS and SARS in the healthcare setting: a comparative study. *BMC medicine*, *13*(1), 1.

Creedon, S. A. (2005). Healthcare workers' hand decontamination practices: compliance with recommended guidelines. Journal of advanced nursing, *51*(3), 208-216.

Darawad, M. W., Al-Hussami, M., Almhairat, I. I., & Al-Sutari, M. (2012). Investigating Jordanian nurses' handwashing beliefs, attitudes, and compliance. American Journal of Infection Control, 40(7), 643-647.

Duggan, J. M., Hensley, S., Khuder, S., Papadimos, T. J., & Jacobs, L. (2008). Inverse correlation between level of professional education and rate of handwashing compliance in a teaching hospital. Infection Control and Hospital Epidemiology, *29*(6), 534-538.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (1993). *How to design and evaluate research in education (Vol. 7)*. New York: McGraw-Hill.

Harris, A. D., Samore, M. H., Nafziger, R., DiRosario, K., Roghmann, M. C., & Carmeli, Y. (2000). A survey on handwashing practices and opinions of healthcare workers. *Journal of Hospital Infection*, *45*(4), 318-321.

Hulkower, R. L., Casanova, L. M., Rutala, W. A., Weber, D. J., & Sobsey, M. D. (2011). Inactivation of surrogate coronaviruses on hard surfaces by health care germicides. *American journal of infection control*, *39*(5), 401-407.

Kharma, M. Y., Alalwani, M. S., Amer, M. F., Tarakji, B., & Aws, G. (2015). Assessment of the awareness level of dental students toward middle east respiratory syndrome-coronavirus. *Journal of International Society of Preventive & Community Dentistry*, *5*(3), 163.

Lu, G., Hu, Y., Wang, Q., Qi, J., Gao, F., & Li, Y.. (2013). Molecular basis of binding between novel human coronavirus MERS-CoV and its receptor CD26. *Nature*, *500*(7461), 227-231.

Ministry of Health (MOH). (2016). MERS-CoV daily update. Retrieved from http://www.moh.gov.sa/en/CCC/PressReleases/Pages/statistics-2016-03-03-001.aspx

Ministry of Health. (2015). Statistical yearly book.

Oboho, I. K., Tomczyk, S. M., Al-Asmari, A. M., Banjar, A. A., Al-Mugti, H., Aloraini, M. S., ... & Swerdlow, D. L. (2015). 2014 MERS-CoV outbreak in Jeddah—a link to health care facilities. *New England Journal of Medicine*, *372*(9), 846-854.

Pavli, A., Tsiodras, S., & Maltezou, H. C. (2014). Middle East respiratory syndrome coronavirus (MERS-CoV): prevention in travelers. *Travel medicine and infectious disease*, *12*(6), 602-608.

Sampathkumar, P. (2014, August). Middle East respiratory syndrome: what clinicians need to know. In *Mayo Clinic Proceedings* (Vol. 89, No. 8, pp. 1153-1158). Elsevier.

Sax, H., Uçkay, I., Richet, H., Allegranzi, B., & Pittet, D. (2007). Determinants of good adherence to hand hygiene among healthcare workers who have extensive exposure to hand hygiene campaigns. *Infection Control & Hospital Epidemiology*, *28*(11), 1267-1274.

Tabachnick, B. G., and Fidell, L. S. (2013). *Using multivariate statistics*, (6th ed). Boston: Allyn and Bacon.

Umbreit, J., Ferro, J., Liaupsin, C., & Lane, K. (2007). Functional behavioral assessment and function-based intervention: An effective, practical approach. Upper Saddle River, NJ: Pearson Merrill Prentice Hall.

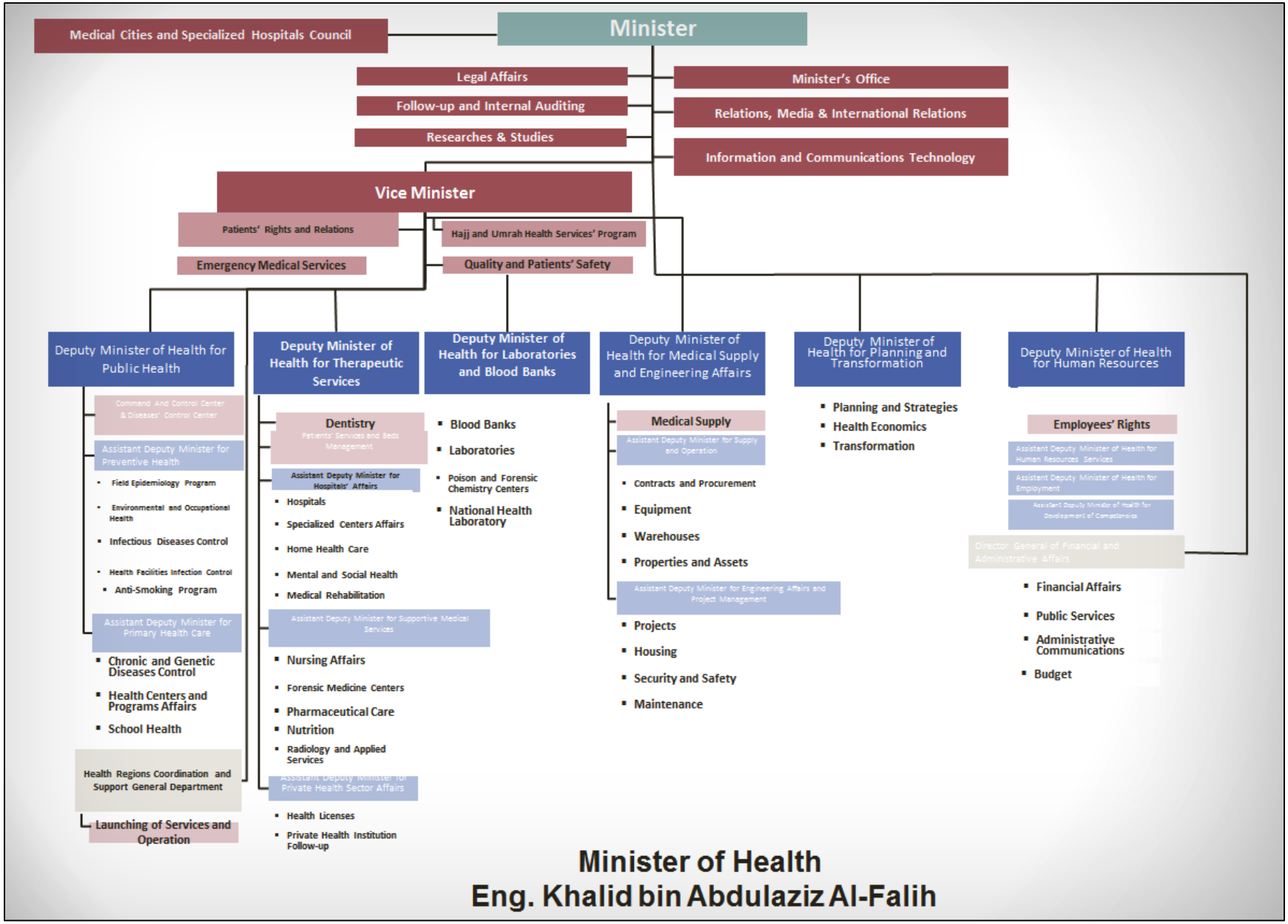
World Health Organization. (2006). Infection control standard precautions in health care. Retrieved June, 2015, from http://www.who.int/csr/resources/publications/4EPR_AM2.pdf

World Health Organization. (2016). Global Health Observatory (GHO) data. Retrieved March, 2016, from http://www.who.int/gho/health_workforce/physicians_density/en/

The World Bank. (2016). Life expectancy at birth, total (years). Retrieved from http://data.worldbank.org/indicator/SP.DYN.LE00.IN/countries/SA--XR?display=graph.

APPENDIX A

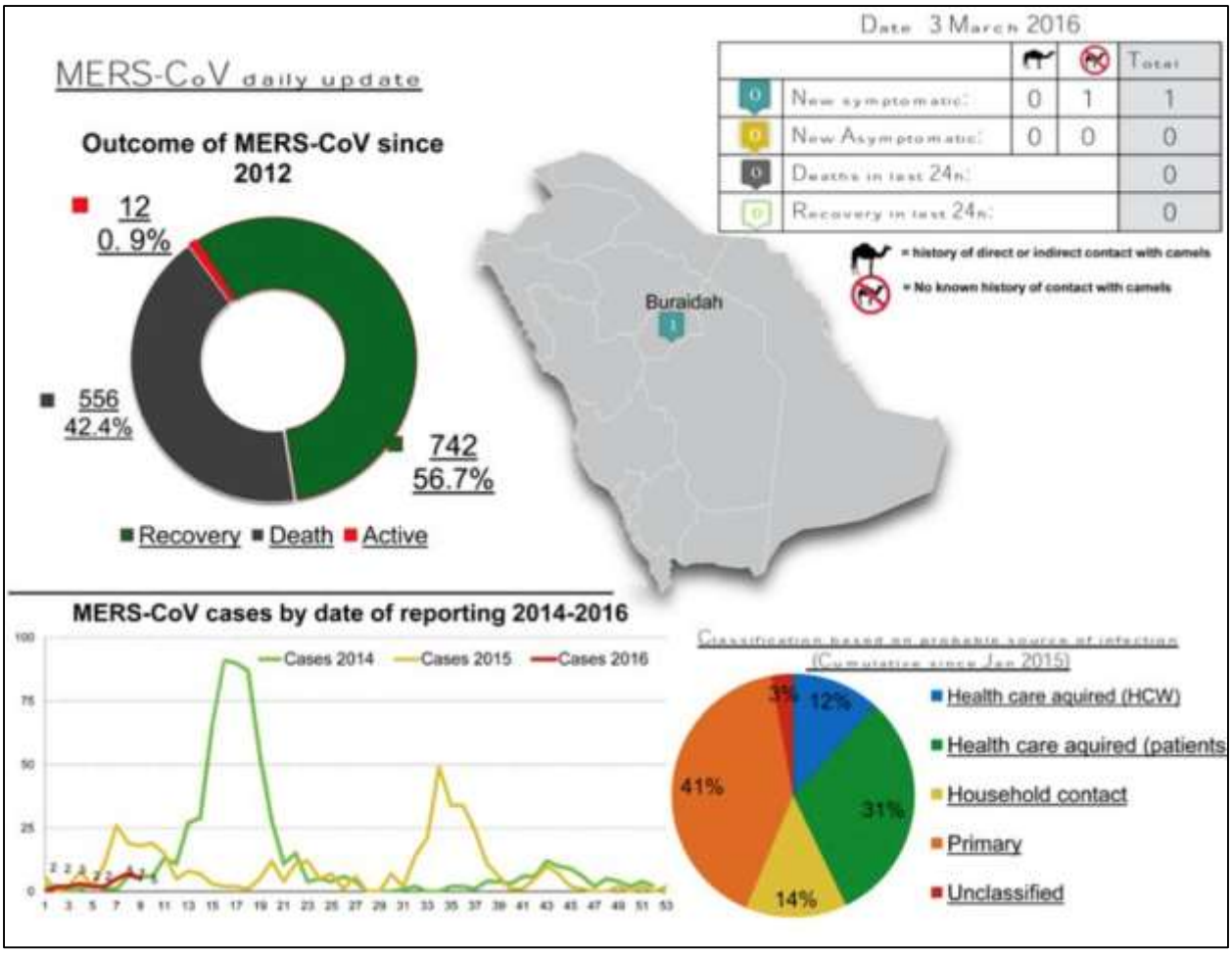
STRUCTURE OF THE MINISTRY OF HEALTH IN SAUDI ARABIA



http://www.moh.gov.sa/en/Ministry/Structure/Pages/WatsNews-2012-04-02-001.aspx

APPENDIX B

MERS CASES BY DATE OF REPORTING 2014-2016


MERS-CoV daily update
Date 3 March 2016
Total
New symptomatic: 0 1 1
New Asymptomatic: 0 0 0
Deaths in last 24h: 0
Recovery in last 24h: 0
= history of direct or indirect contact with camels
= No known history of contact with camels
Outcome of MERS-CoV since 2012
12
0. 9%
556
42.4%
742
56.7%
Recovery Death Active
Buraidah
MERS-CoV cases by date of reporting 2014-2016
Cases 2014 Cases 2015 Cases 2016
Classification based on probable source of infection
(Cumulative since Jan 2015)
3%
12%
41%
31%
14%
Health care aquired (HCW)
Health care aquired (patients
Household contact
Primary
Unclassified

APPENDIX C

INSTITUTE REVIEW BOARD (IRB) APPROVAL

THE UNIVERSITY OF ARIZONA
Mel & Enid Zuckerman College of Public Health

1295 N. Martin Ave.
P.O. Box 245163
Tucson, Arizona 85724
Tel: (520) 626-8315
publichealth.arizona.edu

Date:	8.14.15
Principal Investigator:	Modhi Ali S. Alshammari
Protocol Number:	15-06-CPH
Protocol Title:	Infection of Healthcare Workers: Identifying Potential Transmission Pathways of Coronavirus in Saudi Arabia Hospitals
Determination:	Approved

Exempt 2: Use of tests, surveys, interview, or observation of public behavior.

This submission meets the criteria for exemption under 45 CFR 46.101(b).

- The University of Arizona maintains a Federalwide Assurance with the Office for Human Research Protections (FWA #00004218).
- Exempt projects do not have a continuing review requirement.
- This project should be conducted in full accordance with all applicable sections of the IRB Investigators Manual and you should notify the IRB designee immediately of any proposed changes that affect risk risk level the protocol.
- Amendments to exempt projects that change the nature of the project should be submitted to the Human Subjects Protection Program (HSPP) for a new determination. See the Investigator Manual, 'Appendix C Exemptions,' for more information on changes that affect the determination of exemption. Please contact the HSPP to consult on whether the proposed changes need further review.
- You should report any unanticipated problems involving risks to the participants or others to the IRB.
- All documents referenced in this submission have been reviewed and approved. Documents are filed with the HSPP Office. If subjects will be consented the approved consent(s) are attached to the approval notification from the HSPP Office.

Suzanna Trejo-Robinson

Digitally signed by Suzanna Trejo-Robinson
DN: cn=Suzanna Trejo-Robinson, o=MEZCOPH, ou=Research Office, email=suzanna@email.arizona.edu, c=US
Date: 2015.08.14 13:14:47 -07'00'

UA Institutional Review Board
Member, Designated Reviewer

APPENDIX D

ACADEMIC AFFAIRS LETTER FROM THE MINISTRY OF HIGHER EDUCATION CERTIFYING THE RESEARCHER'S IDENTITY

بسم الله الرحمن الرحيم

Kingdom of Saudi Arabia
Ministry of Higher Education
Cultural Mission To The U.S.A.

المملكة العربية السعودية
وزارة التعليم العالي
الملحقية الثقافية بالولايات المتحدة الأمريكية

Academic Affairs

Official Letter

The Saudi Arabian Cultural Mission at the United States of America certifies that the student MODHI ALI S ALSHAMMARI civil id [redacted] is a scholarship student whom is sponsored by the Ministry of Higher Education for a(n) (Master) degree since 09/11/2014, the student named above is still on the scholarship until 31/08/2016.

This letter was given to the student to present to (- Whom It May Concern) for certification purposes without any obligation and/or liability on our office.

Assistant Cultural Attaché
for Academic Affairs

Mohammed Alomar, PhD

8500 Hilltop Road • Fairfax, Virginia 22031 • (703) 573-7226 • (703) 573-2244 • Fax: (703) 573-2595
Web Site: www.sacm.org • E-Mail: sacmusa@sacm.org

APPENDIX E

APPROVAL FROM GENERAL DIRECTORATE OF HEALTH AFFAIRS IN EASTERN PROVINCE DIRECTED TO THE PUBLIC HOSPITAL

وزارة الصحة
Ministry of Health
7000873336

المديرية العامة للشؤون الصحية بالمنطقة الشرقية
General Directorate of Health Affairs in Eastern Province
إدارة التخطيط والتدريب
التخطيط والبحوث

الرقم ٤١/٦٢/٢٦٧٩٠٦٠
التاريخ ١٤٣٦/١٠/١٩
المرفقات
الموضوع

من	مدير ادارة التخطيط و البحوث بصحة الشرقية	الأستاذ / عبدالعزيز بن محمد الضويحي
إلى	مجمع الدمام الطبي	
صورة الى	ادارة التخطيط والبحوث	
الموضوع	تسهيل مهمة الباحثة	

السلام عليكم ورحمة الله وبركاته.

إشارة إلى الخطاب المقدم من الطالبة / موضي علي الشمري والمبتعثة من قبل وزارة التعليم العالي لدراسة ماجستير تخصص صحة مجتمع بجامعة (اريزونا في الولايات المتحدة الامريكية)، وترغب بعمل بحث كجزء هام لإتمام مرحلة الماجستير و عنوان البحث :
" صحة العاملين في المستشفيات بالمملكة العربية السعودية " ، والبحث يتطلب جمع بيانات من خلال توزيع الاستبانة، وحيث أنها ستتفذ جزء من دراستها لدى ادارتكم .

نامل من سعادتكم الاطلاع والتوجيه حيال تسهيل مهمة الباحثة بما يضمن أن لا يكون هناك أي تأثير على خدمة المراجعين خلال قيامها بمهام البحث (بموافقة جهة عمل العاملة)

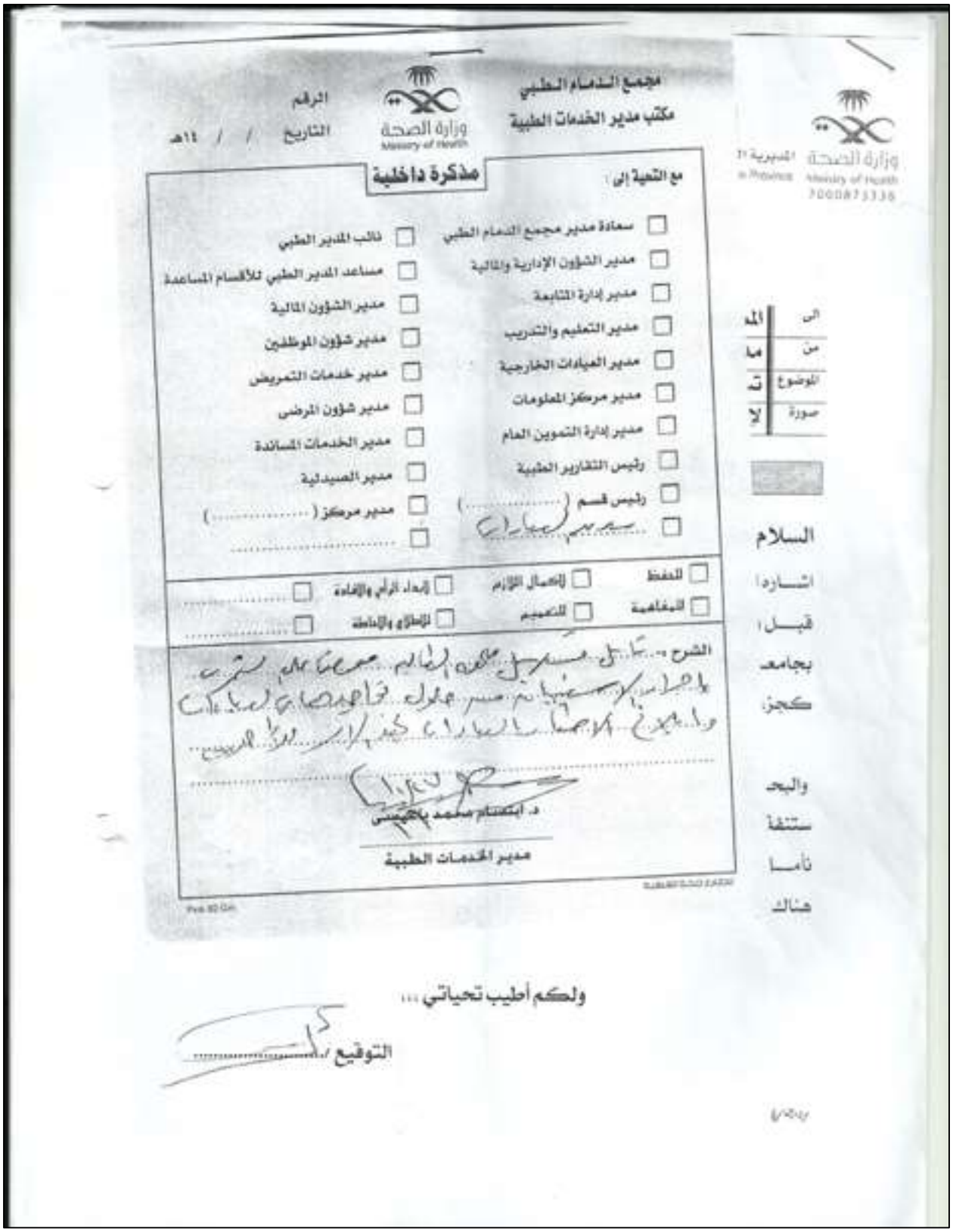
وتقبلوا أطيب تحياتي وتقديري،

التوقيع / ١٤٣٦/١٠/١٩

صورة لإدارة التخطيط والبحوث
حسين الشرفا (١١٥) في ١٤٣٦/١٠/١٩هـ

APPENDIX F

APPROVAL FROM GENERAL DIRECTOR OF THE PLANNING AND DEVELOPMENT DEPARTMENT AT THE PUBLIC HOSPITAL DIRECTED TO THE OUTPATIENTS DEPARTMENT SUPERVISOR



مجمع الدمام الطبي
مكتب مدير الخدمات الطبية

وزارة الصحة
Ministry of Health

الرقم
التاريخ / / ١٤هـ

مذكرة داخلية

مع التحية إلى :

- ☐ سعادة مدير مجمع الدمام الطبي
- ☐ مدير الشؤون الإدارية والمالية
- ☐ مدير إدارة المتابعة
- ☐ مدير التعليم والتدريب
- ☐ مدير العيادات الخارجية
- ☐ مدير مركز المعلومات
- ☐ مدير إدارة التموين العام
- ☐ رئيس التقارير الطبية
- ☐ رئيس قسم (.....)
- ☐ .....

- ☐ نائب المدير الطبي
- ☐ مساعد المدير الطبي للأقسام المساعدة
- ☐ مدير الشؤون المالية
- ☐ مدير شؤون الموظفين
- ☐ مدير خدمات التمريض
- ☐ مدير شؤون المرضى
- ☐ مدير الخدمات المساندة
- ☐ مدير الصيدلية
- ☐ مدير مركز (.....)
- ☐ .....

- ☐ للحفظ
- ☐ للمتابعة
- ☐ للإعمال اللازم
- ☐ للتعميم
- ☐ إعداد الرأي والإفادة
- ☐ للإطلاع والإحاطة
- ☐ .....
- ☐ .....

الشرح :

د. ابتسام محمد باجنيدي

مدير الخدمات الطبية

وزارة الصحة
Ministry of Health

السلام
اشاره
قبل
بجامعه
كجز
واليد
ستنفذ
نامـا
هناك

ولكم أطيب تحياتي ...

التوقيع /

وزارة الصحة
Ministry of Health
70000873336
المديرية العامة لشؤون الصحية بالمنطقة الشرقية
General Directorate of Health Affairs in Eastern Province

الى	المكرم // مدير العيادات الخارجيه	المحترم
من	مديرة التخطيط والتطوير	الدكتورة / كاميليا بنت حمزه سندي
الموضوع	تسهيل مهمه باحثه	
صورة	لادارة التخطيط والتطوير	

موضي علي الشمري

السلام عليكم ورحمة الله وبركاته ...

اشاره الى خطاب المقدم من الطالبه المذكور اسمها اعلاه والمبتعثه من قبل وزارة التعليم العالي لدراسة ماجستير تخصص صحة مجتمع بجامعة (أريزونا في الولايات المتحدة الأمريكية وترغب بعمل بحث كجزء هام لاتمام مرحلة الماجستير وعنوان البحث :

صحة العاملين في المستشفيات بالمملكة العربية السعوديه -

والبحث يتطلب جمع بيانات من خلال توزيع الأستبانه وحيث انها ستنفذ جزء من دراستها لدى ادارتكم

نأمل منكم الاطلاع وتسهيل مهمة الباحثه بما يضمن ان لايكون هناك أي تأثير على خدمة المراجعين خلال قيامها بمهام البحث.

ولكم أطيب تحياتي ...

التوقيع .....

APPENDIX G

OBSERVATION SHEET

Subject number_____

Observation's Sheet for Physician and Nurse

First, please, fill in the blanks, check the boxes, draw the seating diagram, and write notes:

- Observation Date: / / 2015 **- Observer Name:**	**Observation Seating Diagram (Drawing and/or Note)**
- Hospital Number: **- Hospital Status:** **Public ☐ Private ☐ Military ☐**	
- Department: **Emergency-R ☐ Out-Patients ☐**	
- Physician Number: **- Physician Gender:** **M ☐ F ☐ U ☐**	
- Nurse Number: **- Nurse Gender:** **M ☐ F ☐ U ☐**	
Start Time : AM / PM	**End Time : AM / PM**

Second, please, look for these behaviors while you are observing, and check the behavior (✓) when you observe it.

#	- A - Observed Behaviors for Hand Hygiene	Physician	Nurse
1	He/she washes his/her hands for 40 to 60 seconds before contacting patient.		
2	He/she washes his/her hands for 40 to 60 seconds before handling devices.		
3	He/she washes his/her hands for 40 to 60 seconds after contacting patient.		
4	He/she washes his/her hands for 40 to 60 seconds after removing gloves.		
5	He/she washes his/her hands for 40 to 60 seconds after touching patient's surroundings.		
6	He/she rubs his/her hand by alcohol for 20 to 30 seconds before contacting patient.		
7	He/she rubs his/her hand by alcohol for 20 to 30 seconds before handling devices.		
8	He/she rubs his/her hand by alcohol for 20 to 30 seconds after contacting patient.		
9	He/she rubs his/her hand by alcohol for 20 to 30 seconds after removing gloves.		
10	He/she rubs his/her hand by alcohol for 20 to 30 seconds after touching patient's surroundings.		

#	- B - Observed Behaviors for PPE	Physician	Nurse
1	He/she wears gloves when touching patients.		
2	He/she changes gloves between procedures.		
3	He/she removes gloves immediately after use.		
4	He/she removes gloves following the recommended removal technique.		
5	He/she disposes of gloves properly.		

6	He/she wears a surgical or procedure mask.		

Third, please, write your comments below. But, make sure to write the category letter and behavior number next to each comment. You may also write your general comments if you have some.

Category letter	Behavior Number	Comment

General Comments

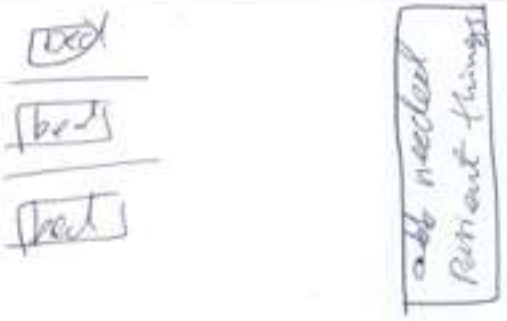
Please, use the back of this sheet to add more comments if you need.

APPENDIX H

OBSERVATION SHEET EXAMPLE

Observation's Sheet for Physician and Nurse

First, please, fill in the blanks, check the boxes, draw the seating diagram, and write notes:

- Observation Date: Aug 9 / 2015 - Observer Name:	**Observation Seating Diagram (Drawing and/or Note)**
- Hospital Number: - Hospital Status: Public ☑ Private ☐ N-Clinic ☐	
- Department: Emergency-R ☐ Family ☐ Pulmonology ☐	
- Observation Location: Patient-R ☐ Emergency-R ☐ Physician-R ☐	
- Physician Number: - Physician Gender: M ☐ F ☐ U ☐	
- Nurse Number: - Nurse Gender: M ☐ F ☑ U ☐	
Start Time 11:30 : AM / PM	End Time 11:47 : AM / PM

Second, please, look for these behaviors while you are observing, and check the behavior (✓) when you observe it.

66

#	- A - Observed Behaviors for Hand Hygiene	Physician	Nurse
1	He/she washes his/her hands for 40 to 60 seconds before contacting patient.		
2	He/she washes his/her hands for 40 to 60 seconds before handling devices.		
3	He/she washes his/her hands for 40 to 60 seconds after contacting patient.		
4	He/she washes his/her hands for 40 to 60 seconds after removing gloves.		
5	He/she washes his/her hands for 40 to 60 seconds after touching patient's surroundings.		
6	He/she rubs his/her hand by alcohol for 20 to 30 seconds before contacting patient.		2
7	He/she rubs his/her hand by alcohol for 20 to 30 seconds before handling devices.		2
8	He/she rubs his/her hand by alcohol for 20 to 30 seconds after contacting patient.		2
9	He/she rubs his/her hand by alcohol for 20 to 30 seconds after removing gloves.		
10	He/she rubs his/her hand by alcohol for 20 to 30 seconds after touching patient's surroundings.		

#	- B - Observed Behaviors for PPE	Physician	Nurse
1	He/she wears gloves when touching patients.		✓
2	He/she changes gloves between procedures.		0
3	He/she removes gloves immediately after use.		1

She moves with the gloves in one hand

	He/she removes gloves following the recommended removal technique.		
4	He/she disposes of gloves properly.		
5	He/she wears a surgical or procedure mask.		✓

Third, please, write your comments below. But, make sure to write the category letter and behavior number next to each comment. You may also write your general comments if you have some.

Category letter	Behavior Number	Comment

General Comments

She wears gloves in one hand only - She handel a needle without gloves,

I think the gloves are large on her

~~She wears~~

Please, use the back of this sheet to add more comments if you need.

APPENDIX I

QUESTIONNAIRE SHEET

Questionnaire for Physician and Nurse

I am a Physician ☐
I am a Nurse ☐

First, please, fill in the blanks, check the boxes.

- Physician Number:

- Physician Gender:
  M ☐ F ☐ U ☐
- Physician Training Specialty:

- Physician Years of Experience:
  Less than 5 Years ☐ Between 5 to 10 Years ☐ More than10 years ☐

- Nurse Number:

- Nurse Gender:
  M ☐ F ☐ U ☐
- Nurse Training Specialty:

- Nurse Years of Experience:
  Less than 5 Years ☐ Between 5 to 10 Years ☐ More than10 years ☐

- Hospital Number:
- Hospital Status:
  Public ☐ Private ☐ Military ☐

- Department:
  Emergency-R ☐ Out-Patients ☐

Second, please check each behavior (✓) based on your typical practices:

#	Behaviors	1 Never	2 Rarely	3 Every once in a while	4 Sometime	5 Always
1	I wash my hands for 40 to 60 seconds before contacting patient.					
2	I wash my hands for 40 to 60 seconds before handling devices.					
3	I wash my hands for 40 to 60 seconds after contacting patient.					
4	I wash my hands for 40 to 60 seconds after removing gloves.					
5	I wash my hands for 40 to 60 seconds after touching patient's surroundings.					
6	I rub my hand by alcohol for 20 to 30 seconds before contacting patient.					

#	Behaviors	1 Never	2 Rarely	3 Every once in a while	4 Sometime	5 Always
7	I rub my hand by alcohol for 20 to 30 seconds before handling devices.					
8	I rub my hand by alcohol for 20 to 30 seconds after contacting patient.					
9	I rub my hand by alcohol for 20 to 30 seconds after removing gloves.					
10	I rub my hand by alcohol for 20 to 30 seconds after touching patient's surroundings.					
11	I wear gloves when touching patients.					
12	I change gloves between procedures.					
13	I remove gloves immediately after use.					
14	I remove gloves following the recommended removal technique.					
15	I dispose of gloves properly.					
16	I wear a surgical or procedure mask.					

15. Approximately, how many patients with flu symptoms do you see per month?

5 to 10 ☐ 10 to 20 ☐ 20 to 30 ☐ More than 30 ☐

16. Approximately, how many patients with corona virus did you see during the last 12 months?

5 to 10 ☐ 10 to 20 ☐ 20 to 30 ☐ More than 30 ☐

Finally, in your opinion, please describe what you believe to be the main causes that make corona virus spread among health-care givers in Saudi Arabia.

Thank you so much for your participation!

Modhi Alshammari

APPENDIX J

QUESTIONNAIRE SHEET EXAMPLE

C-b
Aug 24

Questionnaire for Physician and Nurse

I am a Physician ☑
I am a Nurse ☐

(22)

First, please, fill in the blanks, check the boxes.

- ~~Physician Number:~~

- Physician Gender:
  M ☑ F ☐ U ☐
- Physician Training Specialty:

- Physician Years of Experience:
  Less than 5 Years ☐ Between 5 to 10 Years ☑ More than10 years ☐

- ~~Nurse Number:~~

- Nurse Gender:
  M ☐ F ☐ U ☐
- Nurse Training Specialty:

- Nurse Years of Experience:
  Less than 5 Years ☐ Between 5 to 10 Years ☐ More than10 years ☐

- ~~Hospital Number:~~
- Hospital Status:
  Public ☑ Private ☐ N-Clinic ☐
- Department:
  Emergency-R ☐ Family ☑ Pulmonology ☐

Second, please check each behavior (✓) based on your typical practices:

#	Behaviors	1 Never	2 Rarely	3 Every once in a while	4 Sometime	5 Always
1	I wash my hands for 40 to 60 seconds before contacting patient.				✓	
2	I wash my hands for 40 to 60 seconds before handling devices.					✓
3	I wash my hands for 40 to 60 seconds after contacting patient.					✓
4	I wash my hands for 40 to 60 seconds after removing gloves.					✓
5	I wash my hands for 40 to 60 seconds after touching patient's surroundings.				✓	
6	I rub my hand by alcohol for 20 to 30 seconds before contacting patient.					✓

	Behaviors	1 Never	2 Rarely	3 Every once in a while	4 Sometime	5 Always
7	I rub my hand by alcohol for 20 to 30 seconds before handling devices.				✓	
8	I rub my hand by alcohol for 20 to 30 seconds after contacting patient.					✓
9	I rub my hand by alcohol for 20 to 30 seconds after removing gloves.					✓
10	I rub my hand by alcohol for 20 to 30 seconds after touching patient's surroundings.				✓	
11	I wear gloves when touching patients.					✓
12	I change gloves between procedures.					✓
13	I remove gloves immediately after use.					✓
14	I remove gloves following the recommended removal technique.					✓
15	I dispose of gloves properly.					✓
16	I wear a surgical or procedure mask.				✓	

15. Approximately, how many patients with flu symptoms do you see per month?

5 to 10 ☐ 10 to 20 ☑ 20 to 30 ☐ More than 30 ☐

16. Approximately, how many patients with corona virus did you see during the last 12 months?

5 to 10 ☑ 10 to 20 ☐ 20 to 30 ☐ More than 30 ☐

Finally, in your opinion, please describe what you believe to be the main causes that make corona virus spread among health-care givers in Saudi Arabia.

the main cause is
Not to do the Hygiene
protocols
or the wrong use of it

Thank you so much for your participation!

Modhi Alshammari

APPENDIX K

ASSESSING THE NORMALITY

Table A

Skewness and Kurtosis Values for All Variables Based on the Observation Data (Before, During, and After)

Variable	**Condition**	***n***	**Saudi Healthcare Workers' Hand-Hygiene Practices, *N* = 87**											
			Before				**During**				**After**			
			Skewness		**Kurtosis**		**Skewness**		**Kurtosis**		**Skewness**		**Kurtosis**	
			Stat.	***SE***	***Stat.***	***SE***	***Stat.***	***SE***	***Stat.***	***SE***	***Stat.***	***SE***	***Stat.***	***SE***
Occupation	**Physician**	**44**	2.39	.35	4.94	.70	.95	.35	.34	.70	2.35	.35	6.02	.70
	Nurse	**39**	3.32	.37	11.0	.74	.86	.37	.27	.74	1.32	.37	.55	.74
Department	**Emergency**	**21**	3.53	.50	12.5	.97	.88	.50	.54	.97	1.34	.50	.76	.97
	Outpatient	**62**	2.56	.30	5.95	.59	.93	.30	.24	.59	2.07	.30	4.53	.59
Gender	**Male**	**31**	2.09	.42	2.85	.82	.69	.42	-.40	.82	1.65	.42	2.07	.82
	Female	**52**	3.07	.33	10.8	.65	1.14	.33	1.28	.65	1.65	.33	2.30	.65
Hospital	**Public**	**34**	3.09	.40	10.4	.78	.98	.40	.09	.78	1.85	.40	3.61	.78
	Private	**17**	4.12	.55	17.0	1.1	.87	.55	1.07	1.1	2.48	.55	5.79	1.1
	Military	**32**	1.83	.41	2.07	.81	1.00	.41	.92	.81	1.43	.41	1.29	.81

Note: *N* = Total sample size; *n* = Sample size in each condition; *Stat*. = Statistic; *SE* = Standard Error.

Table B

Skewness and Kurtosis Values for All Variables Based on the Questionnaire Data (Before, During, and After)

Variable	**Condition**	***n***	**Saudi Healthcare Workers' Hand-Hygiene Practices, *N = 87***											
			Before				**During**				**After**			
			Skewness		**Kurtosis**		**Skewness**		**Kurtosis**		**Skewness**		**Kurtosis**	
			Stat.	***SE***	***Stat.***	***SE***	***Stat.***	***SE***	***Stat.***	***SE***	***Stat.***	***SE***	***Stat.***	***SE***
Occupation	**Physician**	**29**	-.96	.43	.00	.84	-1.5	.43	3.18	.84	-1.7	.43	2.53	.84
	Nurse	**24**	-1.2	.47	.64	.91	-1.2	.47	.73	.91	-1.8	.47	2.46	.91
Department	**Emergency**	**12**	-.81	.63	-.14	1.2	-2.1	.63	5.44	1.2	-2.1	.63	4.71	1.2
	Outpatient	**41**	-1.4	.36	1.45	.72	-1.0	.36	.32	.72	-1.8	.36	2.75	.72
Gender	**Male**	**21**	-1.1	.50	.36	.97	-1.5	.50	2.52	.97	-1.8	.50	2.59	.97
	Female	**32**	-1.5	.41	2.6	.81	-.55	.41	-1.2	.81	-1.7	.41	2.00	.81
Hospital	**Public**	**15**	-.82	.58	-.18	1.1	-1.3	.58	2.14	1.1	-1.3	.58	1.21	1.1
	Private	**10**	-1.9	.68	4.99	1.3	-.47	.68	-1.4	1.3	-2.5	.68	6.89	1.3
	Military	**28**	-1.6	.44	2.39	.85	-1.4	.44	2.06	.85	-2.3	.44	6.18	.85

Note: *N* = Total sample size; *n* = Sample size in each condition; *Stat*. = Statistic; *SE* = Standard Error.