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Compliance with Hand-hygiene Guidelines among Healthcare Workers, Kingdom of Saudi Arabia, 2017

by

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Hubert Department of Global Health

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An abstract of the thesis was submitted to the Faculty of the Rollins School of Public Health at Emory University in partial fulfillment to the requirements for the degree of

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Abstract

Objectives: Evaluate the impact of previous and current Ministry of Health (MoH) hand-hygiene programs to improve healthcare workers (HCWs) compliance with WHO *My Five Moments* guidelines by measuring compliance rates in the Kingdom of Saudi Arabia (KSA) . These findings will inform the Infection Prevention and Control program (IPC) in the KSA MoH to improve adherence.

Methods: This is a secondary, observational study using MoH data for the first quarter of 2017 on observed, hand-hygiene practices among KSA MoH HCWs. Data were obtained from 173 MoH healthcare facilities across all 13 regions of KSA for the first quarter of 2017. Hand-hygiene compliance was assessed using the WHO *Hand Hygiene Observation Form* in three main units: Intensive Care Unit (ICU), Emergency Rooms (ERs) and Hemodialysis Unit (HU) as well as other healthcare facility unites.

Results: We included 84,083 opportunities (observations) collected from 173 KSA MoH healthcare facility. The overall hand-hygiene compliance rate among MoH HCWs was 77%. The highest compliance was observed among nurses (79%), in small (<100 beds) healthcare facilities (80%), and HU (81%). The poorest compliance was observed among physicians (75%), in large (>200 beds) healthcare facilities, and in ERs (73%).

Conclusion: Continuous hand-hygiene education, training, and monitoring plus an adequate infrastructure are key elements to improve hand hygiene practices. Our study estimated the overall compliance rate among KSA MoH HCWs to be 77%. Despite improvements we recommend both the creation of a digital data-entry and analyses system and special attention paid to educational campaigns for the identified predictors of poor hand-hygiene compliance.

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Chapter 1 Introduction

Hand-hygiene is a general term that refers to any action of hand cleansing through handwashing, antiseptic hand wash, antiseptic hand rub or surgical hand antisepsis. Since the mid 1800s, published studies by Ignaz Semmelweis and others have established that diseases can be transmitted to patients via the hands of healthcare workers (HCWs). Furthermore, these studies have established the superior efficacy of cleansing hands with antiseptic agents (e.g., alcohol-based products) over washing with soap and water[11, 12].

Hand-hygiene has long been recognized as the most important method in decreasing cross-transmission and preventing healthcare-associated infections (HAIs) and the subsequent spread of multi-drug resistant (MDR) pathogens[24]. However, observational studies on hand-hygiene compliance rates by HCWs globally show poor compliance rates, with an average of 40% [13, 24].

In order to help reduce the global burden of HAIs, the World Health Organization (WHO) launched the *First Global Safety Challenge—Clean Care is Safer Care*—in 2005, with hand-hygiene promotion as the cornerstone of the program[31]. The importance of hand-hygiene was further emphasized in the *Save Lives: Clean Your Hands* WHO initiative in 2009. In order to standardize the best utilization of hand-hygiene practices as well as transform guidelines into practices, the WHO has introduced the concept of *My Five Moments For Hand Hygiene*. This concept was designed to aid in understanding, training, monitoring and reporting hand-hygiene compliance in healthcare facilities[32].

As a WHO member state, the Kingdom of Saudi Arabia (KSA) has registered their commitment to improving infection prevention and control in healthcare facilities.

Following the ministerial pledge to the First Global Patient Safety Challenge in 2005, two different healthcare facilities in KSA were selected to participate in the pilot testing for the implementation of the WHO Hand Hygiene Improvement Strategy. In 2009, KSA renewed its commitment to hand-hygiene as part of the global campaign – *SAVE LIVES: Clean Your Hands*. Since 2005, most healthcare facilities across the country have joined the national campaign to implement and promote WHO's Hand Hygiene Improvement Strategy[13].

However, in spite of the positive attitude of the country towards improving infection control and prevention in general and hand-hygiene in particular, published research on hand-hygiene compliance rates in KSA are extremely rare. Therefore, through this research, we aim to evaluate the impact of the Ministry of Health's (MoH) hand-hygiene promotion campaigns by measuring hand-hygiene compliance rates among HCWs in the majority of MoH healthcare facilities that have been applying WHO hand-hygiene guidelines. Furthermore, the study will also assess factors that influence the compliance to the WHO's *My Five Moments for Hand Hygiene* in MoH healthcare facilities in KSA.

Chapter 2 Literature Review

Healthcare-acquired Infections (HAIs)

Healthcare facilities are environments where susceptible and infected patients congregate. Infected patients carry microorganisms where staff or admitted patients could be exposed and infected. Therefore, during hospitalization, patients may be exposed to a variety of microorganisms that could result in healthcare-acquired infections (HAIs), also known as “nosocomial” infections and defined as infections affecting patients in hospitals or other healthcare facilities that were not incubating or present at the time of admission. Nosocomial infections sometimes appear in patients after discharge from the healthcare facility. In such cases, patients acquired the infection at the healthcare facility, but onset of symptoms appeared after discharge [1].

Organisms causing nosocomial infection are acquired through several mechanisms. Those present in normal flora may cause infection if present to sites outside their natural habitat or through inappropriate antibiotic therapy. These infections can be acquired through transmission of flora from another patient or hospital staff member via direct contact, air droplets, or contaminated equipment [2].

However, the infection after exposure depends on both the characteristics of the microorganisms and host. For example, antimicrobial resistance, virulence, and infective dose are factors. Further, multiple host factors can influence the development of nosocomial infections, including patient susceptibility, environmental factors, and bacterial resistance. Factors that influence patient susceptibility includes age, immune status, underlying diseases, and invasive therapeutic or diagnostic interventions.

Many admitted patients receive antimicrobials, while some require a broad spectrum antibiotic therapy. The widespread use of prophylactic and therapeutic antimicrobials is a major determinant in the development of multi-drug microbial resistance which may become endemic in hospitals. Hence, this may result in an increase in the risk of HAIs with multi-drug resistant (MDR) bacterial strains.

Global Burden of HAIs

HAIs have a global impact affecting developed and under-served countries. A World Health Organization (WHO) survey of four WHO regions (Europe, Eastern Mediterranean, South-East Asia, and Western Pacific), on average, reported 8.7% of hospitalized patients acquired nosocomial infections. However, disparities exist in HAIs prevalence between developed and under-served countries. While HAI's prevalence in the European and Western Pacific regions was estimated to be 7.7% and 9%, respectively, the Eastern Mediterranean and South-East Asia regions showed an estimated prevalence of 11.8% and 10%, respectively. Surgical wounds, urinary tract infection and lower respiratory tract infection were the most common documented HAIs [2].

HAIs are one of the leading causes of death globally. They cause functional disability, emotional stress, and sometimes lead to disabling conditions. Patients who develop a nosocomial infection sometimes must increase their duration of hospitalization. Nosocomial infections directly impact not only patients, but also the healthcare system. In the United States (US), there are an estimated 2 million HAIs annually, resulting in an approximate mortality rate of 5% (90,000)[3]. Further, the economic cost of nosocomial infections is considerable. According to the U.S. Centers for Disease Control and

Prevention (CDC), the total cost of nosocomial infections was estimated to be 28—33 billion US dollars [4].

HAIs in WHO's Eastern Mediterranean Regional Office (EMRO)

Globally, the WHO Eastern Mediterranean Regional Office (EMRO) reports one of the highest prevalence rates for nosocomial infections. Many countries in the region report a prevalence of 12% – 18% [2]. According to WHO/EMRO, the prevalence of HAIs in the Middle East was estimated to be 11.8%, compared to 7.7% and 9% in the European and Western Pacific regions[2]. However, this may underestimate the true prevalence and burden of HAIs, as there are only a few reports and studies that discuss this issue in EMRO. Some EMRO countries (including the Kingdom of Saudi Arabia [KSA]) have been actively developing infection control and prevention (ICP) programs.

In 1980, the Gulf Co-operation Council (GCC) mandated the development of ICP programs for all members. KSA – a member state – initiated an ICP program that covered 15 hospitals by 1980 and extended to include all Ministry of Health (MoH) hospitals by 1987 [5].

Studies on the prevalence of HAIs in governmental and private hospitals in KSA are rare[6]. However, published studies show a lower prevalence of HAIs in KSA healthcare facilities compared to neighboring countries[3] [5]. In one study (from 2006) in a tertiary-care center in KSA, the prevalence of HAI's was estimated to be 8% [5].

Kingdom of Saudi Arabia (KSA)

KSA is located in the southwestern side of the Asian continent and constitutes the majority of the Arabian Peninsula, with a land area of 2 million kilometers. The total population of KSA is estimated to be 32 million; 60% are Saudi citizens, while 40% are

immigrants. Life expectancy at birth is 75 years (in 2015), exceeding regional and global estimates, 68 and 71 years, respectively[7] [8].

The defining feature of KSA is the annual Muslim pilgrim (Hajj) to the holy mosque in Mecca city. Each year, around 1.8 million pilgrims travel to Mecca and stay from 11 – 20 days. This annual event requires extensive resources, planning, and coordination among all governmental organizations to ensure safety. As a key element to safety, the MoH updates its ICP policies annually to align with up-to-date knowledge of current global outbreaks[8]. The large number of worldwide visitors each year to Mecca could increase HAI incidence.

Another concern that poses challenges to ICP in KSA is the emergence of the Middle East Respiratory Syndrome Corona Virus (MERS-CoV). The majority of reported laboratory-confirmed human cases in KSA resulted from transmission in healthcare facilities[9]. In fact, more than half of reported MERS-CoV cases in 2014 were attributed to “systemic weaknesses in infection control” [10].

Hand-Hygiene

Hand-hygiene refers to any action of hand cleansing through either handwashing, antiseptic hand wash, antiseptic hand rub, or surgical hand antisepsis. Since the mid 1800s, published studies by Ignaz Semmelweis and others established that diseases could be transmitted to patients via the hands of healthcare workers (HCWs). Further, these studies established the superior efficacy of cleansing hands with antiseptic agents (e.g., alcohol-based products) over washing with soap and water[11, 12]. In 1847, Semmelweis noticed that the maternal mortality rates, due to puerperal fever, were higher in the clinic attended by physicians compared to the other clinic attended by midwives

(16% vs 7%). He observed that HCWs went directly to the delivery rooms after performing autopsies. Despite washing their hands with soap, disagreeable odor was noted on HCWs hands. Semmelweis hypothesized that certain “cadaverous particles” were transmitted from the autopsy room to the patients through the hands of HCWs and caused puerperal fever. He then recommended that every HCW wash their hands with chlorinated lime, an antiseptic agent, before patient contact, especially after conducting autopsies. As a result, a dramatic decline was noted in the mortality rate (3%) among the most affected hospital unit compared to 16% prior to chlorinated lime introduction[11]. Semmelweis’ finding was the first evidence that antiseptic agents are more efficient in reducing nosocomial germ transmission than washing hands with soap and water.

Nosocomial pathogens are transmitted between patients through HCWs hands through the following five steps[13].

1. Organisms must be present on patient skin or in an animate environment. Certain skin areas are known to be heavily colonized by a number of organisms such the *S. aureus* and Klebsiella species. The inguinal or perineal areas tend to be most commonly affected, but also other areas such as extremities, trunk, and axillae are frequently colonized. Due to the daily shedding of squames containing viable microorganisms, the immediate patient environment (gowns, bed linens or bedside furniture) could easily be contaminated with patient flora.
2. Organisms must be transferred to the hands of HCWs. Many patient-care activities could result in transmission of organism from patients and a patient’s environment to HCW hands. An epidemiologic investigation of Vancomycin-resistance

enterococci (VRE) showed that 41% of HCWs hands were contaminated with VRE after patient contact and before applying antiseptic hand-hygiene solution[14].

3. Organisms must survive for several minutes on HCW hands. As mentioned, contaminated HCWs hands could be the vehicle for pathogen spread. Several studies have shown that HCW hands are progressively colonized with potential pathogens as well as commensal flora during patient care. In addition, microorganism contamination was found to increase linearly with time on ungloved hands during patient care[15] [13].
4. Defective hand cleaning must occur for microorganisms to be transmitted despite hand cleansing; handwashing by HCW must be inefficient, omitted, or the hand hygiene product is inappropriate[13]. Although studies that discuss the adequacy or inadequacy of hand cleansing using biological proof are few, from these studies we can draw the conclusion that HCW hands remain contaminated with pathogens [16]. A study by McNeil *et* al., (2006) demonstrated a greater chance of recovering microorganisms from HCW nails when using alcohol-based gel compared to antimicrobial soap[16].
5. Contaminated HCW hands must come in contact with the patient or a patient's inanimate environment. Contaminated HCW hands are usually the cause of cross-transmission of organisms. A study by Harrison *et* al., (2003) showed contaminated hands could transmit pathogens to the paper dispenser and vice versa[17]. However, certain factors may influence pathogen transmission (e.g., type of organism, moisture level, size of inoculum) [13].

Hand hygiene and the acquisition of HAIs

Despite the paucity of studies, there is substantial evidence that antiseptic, HCW hand-hygiene practices by reducing the HAI incidence [13]. In Semmelweis' work in 1847, considered an intervention trial, it was demonstrated that the mortality rate among mothers delivering at healthcare facilities was lower when HCWs cleansed their hands with antiseptic solution compared to cleaning with soap and water. Semmelweis' finding was the first evidence that antiseptic agents are more efficient in reducing nosocomial germ transmission than washing hands with soap.

In 1960, an investigation sponsored by the U.S. National Institutes of Health (NIH) and the Office of the Surgeon General studied the impact of hand-hygiene on *S. aureus* transmission among infants in a hospital nursery[18]. The incidence of *S. aureus* infection was compared among infants cared for by nurses who washed their hands between patient contacts to those who did not. The result was astonishing—around 92% of infants who were handled by unwashed hands acquired the organism and more rapidly than infants handled by hands washed with antiseptic solution[19]. Since then, several trials have studied the impact of hand-hygiene on HAIs and demonstrated the superior efficacy of hand washing with antiseptic solution compared to washing with plain soap and water[20, 21].

Outbreak investigations have also demonstrated the association between HAIs and poor hand-hygiene. For example, studies by Fridkin SK (1996) and Vicca AF (1999) found that difficulties such as understaffing and overcrowding have been consistently linked to poor hand-hygiene adherence by HCWs, which eventually facilitates infection transmission[22, 23].

Hand-hygiene has long been recognized as the most important method in preventing nosocomial infection and the subsequent spread of MDRS pathogens[24]. However, observational studies on hand-hygiene compliance rates by HCWs globally show poor compliance rates with an average of 40% [13, 24]. Several factors have been attributed to HCW poor compliance to hand-hygiene guidelines. For example, in a systematic review by V.Erusmus *et* al., (2013), being a doctor was consistently associated with poor adherence[24]. In addition, a lower compliance rate was found to vary based on activity levels, healthcare units and time of the day/week[13, 24]. Other factors included …

- Activities with high risk of cross-transmission
- Understaffing or overcrowding
- High patient-to-nurse ratio and more shifts per day
- High number of opportunities for hand-hygiene per hour of patient care [13, 15]

However, although several publications have studied risk factors for hand-hygiene non-adherence, results remain inconclusive[24].

Hand-hygiene compliance rates in KSA

Reports and studies on the prevalence of HAIs in governmental and private hospitals in KSA are rare[6]. However, reported prevalence in the literature ranges from 7% to 48%. In a retrospective study by M. Abdel-Fattah (2005) in one military hospital, it was found that 668 (48.3%) out of 1,382 admitted patients developed a nosocomial

infection[25]. In another study done by H. Balkhy (2006) in a tertiary care center in KSA, the prevalence of HAIs was estimated to be 8%[5].

Published research on hand-hygiene compliance rates in KSA is extremely rare. The overall compliance rate in these studies have minimal variation, estimated to be between 40% to 68%[26-29]. In addition, non-adherence to hand-hygiene guidelines were found to be varied among hospital units and type of profession. Nurses were found to be more inclined to perform hand-hygiene compared to physicians (52% vs 42%)[26, 28]. In addition, several studies have linked improved compliance by HCWs to hand-hygiene guidelines after proper awareness intervention[29]. However, studies have found that hand-hygiene compliance usually improved when HCWs know they are under observation, also known as the "Hawthorne Effect" [30].

WHO**'s** *My Five Moments* for Hand Hygiene

In order to help reduce the global burden of HAIs, WHO launched the *First Global Safety Challenge—Clean Care is Safer Care*—in 2005 with hand-hygiene promotion as the cornerstone of the program[31]. The importance of hand-hygiene was further emphasized in the *Save Lives: Clean Your Hands* WHO initiative in 2009. In order to standardize the best utilization of hand-hygiene practices as well as transform guidelines into practice, WHO introduced the concept of *My Five Moments for Hand Hygiene*. This concept was designed to aid understanding, training, monitoring, and reporting hand-hygiene compliance in healthcare facilities[32]. This concept was developed as a user-centered concept to help HCWs as well as patients in recognizing when hand-hygiene should be applied[33]. To make easier for recollection, the five moments were numbered according to habitual care flow[13]:

Moment 1. Before touching the patient

Moment 2. Before a clean/aseptic procedure

Moment 3. After body fluid exposure risk

Moment 4. After touching the patient

Moment 5. After touching patient surroundings

As a WHO member state, KSA registered their commitment to improving IPC in healthcare facilities. Following the ministerial pledge to the First Global Patient Safety Challenge in 2005, two different healthcare facilities in KSA participated in a pilot for the implementation of the WHO Hand Hygiene Improvement Strategy. In 2009, KSA renewed its commitment to hand-hygiene as part of the global campaign – *SAVE LIVES: Clean Your Hands*. Since 2005, most healthcare facilities across the country joined the national campaign to implement and promote WHO's Hand Hygiene Improvement Strategy[13]. In spite of the positive attitude of the country towards improving IPC in general and hand-hygiene in particular, studies that evaluate the efficacy of these measures in the country are rare. Therefore, through this research we aimed to measure hand-hygiene compliance rates in the majority of MoH healthcare facilities that currently apply WHO guidelines on hand-hygiene.

Chapter 3 MANUSCRIPT

Methods

Data Source

Since 2005, most MoH healthcare facilities across the country joined the national campaign to implement and promote the WHO Hand Hygiene Improvement Strategy[9]. The MoH is actively involved in hand-hygiene promotion, training, and monitoring hand-hygiene practices among the KSA MoH HCWs. A strong hand-hygiene educational program widely diffused to all MoH healthcare facilities to cover all HCWs. In addition, training sessions were held to assigned infection control personnel in each facility to observe and report hand-hygiene practices among HCW. Using the standardized World Health Organization approach for direct observation *Five Moments for Hand Hygiene*, data were collected by direct observation of HCW delivering routine care.

Observations were made during the first quarter of 2017 by well-trained infection control personnel in each facility. Since January 2017, MoH healthcare facilities are required to report hand-hygiene observation data using a standardized WHO collection excel sheet to KSA MoH Infection Prevention and Control (IPC). Observation data for this study were obtained from IPC registry, MoH, Riyadh.

Study Design

Observational hand-hygiene data for the first quarter of 2017. Data were obtained from Infection Prevention and Control (IPC) registry at the KSA MoH. The 85,000 measured opportunities represent 173 MoH healthcare facilities across all 13 regions of KSA. Hand-hygiene compliance was assessed using the WHO Hand Hygiene Observation Form in 3 main units: Intensive Care Unit (ICU), Emergency Rooms (ERs) and Hemodialysis Unit (HU) as well as other healthcare facility units.

Study Variables

There are seven variables included in the study:

- Profession (physicians, nurses/midwives, auxiliary, other)
- Units (ICU, ERs, HU, other)
- Hand-hygiene Moments (Moment1, Moment2, Moment3, Moment4, Moment5)
- Hand-hygiene Action (Hand-wash, Hand-rub, No Action)
- Shift Time (morning, afternoon, night)
- Number of beds (<200, 100-200, >200)
- Date by month

Ethics

This study was based on secondary data without any personal identifiers; it did not meet the category of human subject research.

Results

We analyzed 84,083 opportunities (observations) collected from 173 MoH healthcare facility across the 13 KSA regions. The overall hand-hygiene compliance rate among MoH HCWs was 77%, which falls just above the hand-hygiene compliance rate reported in the literature (40% – 68%). The moment the observer identified an indication, it was counted as an opportunity. The compliance rate was calculated by the total number a hand-hygiene actions (either hand rubbing or hand washing) completed, divided by the total number of opportunities the health care professional had to complete a hand health action. When further examining the makeup of the hand-hygiene actions, it was determined that hand rubbing with an alcohol-based formula was used more often than hand washing with soap and water. The frequency of each action performed with hand rubbing was 47% and hand washing 30% (Table 1). No hand-hygiene action was performed 23% of the time a health care worker had the opportunity.

Table 1. Hand-hygiene Actions by Healthcare Workers, Kingdom of Saudi Arabia, 2017

Action	Frequency	%
Hand rubbing with alcohol-based formula	39,305	47
Hand washing with soap and water	25,586	30
Total	64,891	77

Table 2. Compliance among Healthcare Workers, by Unit, Profession, Hospital Size, Shift Time, and WHO *My Five Moments For Hand Hygiene*, Kingdom of Saudi Arabia, 2017

Variables		Opportunities	Compliance (%)
Unit	ICU[1]	33,940	78
	ERs[2]	19,552	74
	HDU[3]	10,545	81
Profession	Physician	20,433	75
	Nurse/midwife	35,438	79
	Auxiliary	2,616	78
	Other	6,339	73
Hospital size	Large	38,638	76
	Medium	11,818	78
	Small	14,390	81
Month (2017)	January	18,290	77
	February	18,716	77
	March	20,016	77
	April	7,541	78
Shift time	Morning	55,191	77
	Afternoon	6,933	78
	Evening	204	91
	Night	2,115	80
WHO 5 Moments	1	23,969	74
	2	12,764	77
	3	13,199	82
	4	25,256	83
	5	16,980	75

1. Intensive Care Unit, 2. Emergency Rooms, 3. Hemodialysis Unit

Compliance rates based on study variables, first by the type of hospital unit showed (Table 2). The main three units were examined during the observations; the Emergency Room, Hemodialysis Units, and Intensive Care units. The ER units come in with the lowest hand health compliance rate at 73%. The highest compliance rate was noted in hemodialysis units, with an 81% while the compliance rate at the Intensive Care Units were 77%.

On the professional category, as reported by previous publications, nurses/midwives were the most compliant to hand hygiene guidelines with hand hygiene compliance rate of 79%. The compliance rate for each unit based on the professional category showed the poorest compliance rates among “doctors” and “other” professional category with 75% and 72% compliance rate, respectively (Table 3).

Table 3: Adherence with Hand-hygiene Guidelines, by Unit and Profession, Kingdom of Saudi Arabia, 2017

Unit	Doctor (%)	Nurse/midwife (%)	Auxiliary (%)	Other (%)	Total (%)
ICU[1]	71	88	77	73	78
ERs[2]	66	80	66	67	74
HDU[3]	87	88	83	76	82
Total	76	79	78	73	

1. Intensive Care Unit, 2. Emergency Rooms, 3. Hemodialysis Unit

Hospital size does seem to affect the overall compliance rate as well. The highest compliance rate (80%) was observed on small healthcare facilities (less than 200 beds), followed by medium healthcare facilities (100-200 beds), 78% and large healthcare facilities (>200 beds), 75%. However, the result could stem from less patient interaction, allowing for more time to complete hand health actions or greater accountability with

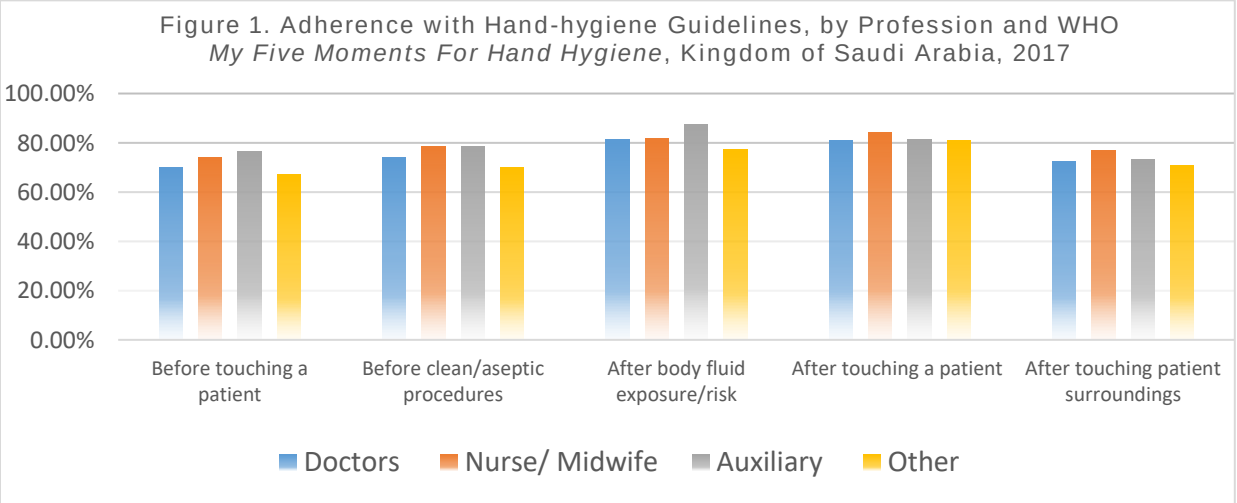
smaller staff. More examination and analysis should be completed to determine the reasons behind smaller hospital's higher compliance rates.

The month of the observations seems to make a difference as well. As the year progresses, the hand health rate is rising showing a positive correlation. This suggest there may be an effect from current promotional and observational programs to bring about awareness of hand health hygiene. Shift time variable was calculated, but little weight can be put on the analysis since 86% of the variables are coded as morning shift. To determine if shift time has an effect on the compliance rate, more data would need to be collected from afternoon, evening and night shifts.

When observing the compliance rate for each opportunity type, HCWs can make improvements at the first moment (before touching the patient) (Table 4). Out of the 32,555 observations for this opportunity, HCWs failed to wash their hands 8,858 times bringing the poorest compliance rate for the opportunities. The highest rate of compliance at 83% was observed for moment 4 (after risk of body fluid exposure). However, rate may be skewed since the variable contains approximately half of the observations of the other variables at only 16,016 opportunities observed.

Table 4. Adherence with Hand-hygiene Guidelines, by Profession and WHO *My Five Moments For Hand Hygiene*, Kingdom of Saudi Arabia, 2017

Moments	Physician (%)	Nurse/midwife (%)	Auxiliary (%)	Other (%)	Total (%)
Before touching a patient	7711 (70)	13358 (74)	803 (77)	2081 (67)	74
Before clean/aseptic procedures	3920 (74)	7197 (78)	389 (78)	1255 (70)	77
After body fluid exposure/risk	4013 (81)	7965 (82)	473 (88)	776 (77)	82
After touching a patient	8239 (81)	13893 (84)	785 (82)	2323 (81)	83
After touching patient surroundings	4676 (72)	9447 (77)	1022 (73)	1820 (71)	75



Discussion

We found the overall hand-hygiene compliance rate among KSA MoH HCWs to be 77%. This falls just above the reported compliance rates in KSA (40% – 68%) in previous studies [26-29]. The higher overall compliance rate may be attributable to the strong hand hygiene promotional program that was widely diffused to all MoH healthcare facilities. In addition, all MoH healthcare facilities are equipped with the adequate infrastructure and reliable supply of hand hygiene products. Alcohol-based handrub products has been adopted by WHO as well as the MoH as the gold standard for HCWs hand hygiene. Studies have found that bedside alcohol-based handrub products increases the compliance among HCWs. The wide availability of alcohol-based handrub products may as well helped in more compliance to hand hygiene. In our study, its estimated that approximately 47% of all HCWs used alcohol-based handrub products compared to 30% who performed hand hygiene by handwashing with soap and water.

Similar to many reported findings in the literature, nurses were found to be more inclined to adhere to hand hygiene guidelines more than physicians. In our study, 79% of all nurses observed were compliant to hand hygiene guidelines compared to 75% compliance rate among physicians. Study by Sax et al (2007) demonstrated that doctors and nurses were found to be more compliant to hand hygiene practices if the practice is easy to perform. In contrast to previous publications, the present study shows a narrow margin in compliance rate between the two professional categories. These results may reflect the positive impact of the promotional campaign as well as the adequate infrastructure and wide availability of alcohol-based hand rub products.

Another predictor of hand hygiene compliance in our study is the number of beds at the healthcare facility. Healthcare facilities were categorized based on number of beds (<100, 100-200, >200) to (small, medium and large), respectively. Compliance rate were found to be in negative correlation with the number of beds. HCWs working at small healthcare facilities were found to be more compliant to hand hygiene practices (80%) compared to HCWs at medium (78%) and large (75%) healthcare facilities.

Hand hygiene compliance rate in this study varied depending on each of the five WHO moments for hand-hygiene. The poorest compliance was observed at the first moment (before touching patient) (74%) and the fifth moment (After touching patient) (75%). This moment has a critical importance from a patient prospective, as hand-hygiene at this moment will prevent colonization and transmission of HAIs by HCWs. Studies on hand-hygiene report similar results on poor compliance at the first and fifth moment. Although HCWs were found to be more compliant to wash their hands *after* patient contact in published reports, our study showed a narrow margin between the two moments. These results may indicate a need to emphasize the moment-specific approach in future teaching/training programs.

Conclusion

Ongoing hand-hygiene education, training, and monitoring as well as adequate infrastructure are key elements to improve compliance with hand-hygiene practices. Our study estimated the overall compliance rate among KSA MoH HCWs to be 77%. Despite improvements, we recommend both the creation of a digital data-entry and analyses system and special attention be paid to educational campaigns for the identified predictors of poor hand-hygiene compliance.

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