



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Knowledge and information sources on standard precautions and infection control of health sciences students at King Saud bin Abdulaziz University for Health Sciences, Saudi Arabia, Riyadh



Abdullah Khubrani^{a,*}, Meshal Albeshar^a, Abdulah Alkahtani^a, Faisal Alamri^a,
Majid Alshamrani^b, Emad Masuadi^c

^a King Abdullah International Medical Research Center, King Saud bin Abdulaziz University for Health Sciences, College of Medicine, Ministry of National Guard Health Affairs, Saudi Arabia

^b King Abdullah International Medical Research Center, King Saud bin Abdulaziz University for Health Sciences, Department of Infectious Diseases, Ministry of National Guard Health Affairs, Saudi Arabia

^c King Abdullah International Medical Research Center, King Saud bin Abdulaziz University for Health Sciences, Department of Medical Education, Ministry of National Guard Health Affairs, Saudi Arabia

ARTICLE INFO

Article history:

Received 24 June 2017

Received in revised form 24 October 2017

Accepted 30 October 2017

Keywords:

Education

Hygiene

Infection control

Standard precautions

Medical students

Saudi Arabia

ABSTRACT

Background: Only one study has been conducted in Saudi Arabia to assess medical students' knowledge of standard precautions (SPs) and infection control (IC). In this study, we examined knowledge of SPs and IC among clinical students attending the King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia.

Methods: In this cross-sectional study, we targeted clinical students from the following five colleges: Medicine (fifth and sixth years); Dentistry (second semester of the third, fourth, fifth, and sixth years); Applied Medical Sciences (third and fourth years); Nursing (third and fourth years); and Pharmacy (third, fourth, and fifth years). The data collection instrument was an adopted 41-item questionnaire that measured knowledge of SPs and IC in five domains. A score of ≥ 24 (60%) indicated sufficient knowledge. **Results:** The participants comprised 129 students (67 men). The proportions of participants from each college were: Medicine, 58.1% ($n = 75$); Dentistry, 14% ($n = 18$); Applied Medical Sciences, 13.2% ($n = 17$); Nursing, 10.9% ($n = 14$); and Pharmacy, 3.9% ($n = 5$). Most students (73.6%) demonstrated sufficient knowledge (men, 67.2% and women, 80.6%). The highest scores were obtained for the domains "general concept of SPs", "hand hygiene", and "personal protective equipment", whereas the lowest scores were obtained for "disposal of and injuries from sharp objects" and "health-care providers' care". The main information source was formal curricular teaching.

Conclusions: In Saudi Arabia, students' knowledge of SPs and IC is satisfactory, with no significant differences between the sexes or between colleges. Thus, formal curricular teaching is an effective way to increase students' knowledge of SPs and IC.

© 2017 The Authors. Published by Elsevier Limited on behalf of King Saud Bin Abdulaziz University for Health Sciences. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Infection control (IC) practices have been developed to prevent and control hospital-acquired infections among patients and health-care providers. IC is classified into standard precautions

(SPs) and expanded precautions (EPs). SPs are implemented in all patients regardless of their diagnosis. SPs include hand hygiene, appropriate handling of bodily fluids and waste, and prevention of injuries with sharp objects. In contrast, EPs are applied in specific situations depending on the mode of disease transmission, i.e. contact, droplet, and airborne precautions [1].

Little is known about health-care students' knowledge of SPs and IC in Saudi Arabia. A recent literature review revealed that only one study, conducted in 2012 at the King Faisal University, Al-Ahsa, Saudi Arabia, has examined knowledge of SPs among Saudi-Arabian medical students in their clinical years [2]. The researchers reported that participants' knowledge was low, and

* Corresponding author.

E-mail addresses: khubrani079@ksau-hs.edu.sa, dr.aboOod99@gmail.com (A. Khubrani), albeshar012@ksau-hs.edu.sa (M. Albeshar), alkahtani027@ksau-hs.edu.sa (A. Alkahtani), Amre006@ksau-hs.edu.sa (F. Alamri), alshamranima2@ngha.med.sa (M. Alshamrani), masuadie@ksau-hs.edu.sa (E. Masuadi).

that self-directed learning and informal bedside practices were the main sources of knowledge. In contrast, many studies have addressed this crucial aspect of IC worldwide. In 2008, a study conducted at Rouen University, Normandy, France, reported differing levels of knowledge for different categorized domains (e.g., hand hygiene, nosocomial infection, and SPs) [3]. The study targeted four specialties (Medicine, Nursing, Radiography, and Physiotherapy). The best scores were related to SPs, and the university curriculum was the primary source of students' knowledge. Another study conducted in 2014 at the University of Tirana, Tirana, Albania, demonstrated that students in four specialties (Medicine, Physiotherapy, Radiography, and Nursing) had a moderate knowledge of IC [4]. Formal, in-class training was their main information source.

Students at the King Saud bin Abdulaziz University for Health Sciences (KSAU-HS) experience early exposure to clinical practice. The diverse colleges of the KSAU-HS include Medicine, Dentistry, Applied Medical Sciences, Nursing, and Pharmacy. Academic lectures and procedural skill sessions on IC are part of the curricula of all KSAU-HS colleges. During the clinical phase, students are at an elevated risk of becoming infected or transmitting diseases to patients and their colleagues. In addition, the risk of sharp object injuries is constant [1,5,6].

Knowing and practicing SPs and IC are crucial for the safety of both health-care workers and patients. Hand hygiene is the most practical and cost-effective method of reducing infection transmission [7,8]. Although hand hygiene is crucial and simple, compliance with hand hygiene practice is suboptimal among health-care providers (<40%) [9,10]. Consequently, in this study, we assessed knowledge of SPs and IC among clinical students attending colleges of the KSAU-HS and identified their primary information source.

Materials and methods

Design and setting

This cross-sectional study utilized a questionnaire to assess students' knowledge. The KSAU-HS was formally established in 2005 in response to positive feedback about postgraduate programs in various medical fields offered by the National Guard Health Affairs, Riyadh, Saudi Arabia, since the mid-1980s. The main campus of the KSAU-HS is in Riyadh, with two additional campuses in Jeddah and Al-Ahsa. This study took place at the Riyadh campus in 2017 at the following colleges: Medicine, Dentistry, Applied Medical Sciences, Nursing, and Pharmacy.

Participants

In this study, the target population was clinical health sciences students in the following years of study: Medicine (fifth and sixth years); Dentistry (second semester of the third, fourth, fifth, and sixth years); Applied Medical Sciences (third and fourth years); Nursing (third and fourth years); and Pharmacy (third, fourth, and fifth years). The total number of clinical students across all five colleges was 655. We included students of both sexes; however, we excluded students from the Health Informatics College and students in the basic science or preparatory phases of their designated colleges. We analyzed the data using Raosoft software (Raosoft, Inc., Seattle, WA, USA) with a margin of error of 5% and a confidence interval of 95%. Similar to the response distribution obtained from the study conducted at King Faisal University (26.7%), the sample size in this study was 207 students. The participants were selected using convenience sampling.

Data collection process

The proposals for this study began on January 19, 2017. Ethics approval was granted by the King Abdullah International Medical Research Center, Riyadh, Saudi Arabia, on February 27, 2017. E-form questionnaires with a brief introduction about the study's aims and importance were emailed to participants on February 29, 2017, and re-sent to non-respondents on March 4, 2017. The consent form was attached. Data collection was completed on May 13, 2017, and 129 responses were obtained.

The adopted questionnaire examined demographic data, information sources, and five domains consisting of 41 items measuring students' knowledge of SPs and IC. Demographic information included sex, college, and year. The five domains comprised: general concept of IC and SPs (five questions); hand hygiene (10 questions); personal protective equipment (PPE; nine questions); disposal of and injuries from sharp objects (eight questions); and health-care providers' care (nine questions). The questions were closed-ended true/false (34 questions) or multiple-choice questions (seven questions). Each correct answer was worth one point (maximum score, 41 points). The information source question was asked prior to the questions about the five domains. The questionnaire was in English, which is the formal teaching language at the KSAU-HS.

Data analysis

Excel[®] (Microsoft Corp., Redmond, WA, USA) was used for data entry, and SPSS version 24 (IBM Corp., Armonk, NY, USA) was used for data management and analysis. The cutoff for sufficient knowledge of SPs and IC was 24/41 (60%), consistent with the study conducted at King Faisal University [2]. Thus, a score of 23 or lower was considered to reflect insufficient knowledge. The chi-squared test was used to assess the relationship between knowledge and categorical variables expressed as percentages and frequencies (e.g., knowledge and speciality). The *t*-test was used to assess the difference between knowledge and quantitative values expressed as means and standard deviation (e.g., domain and sex). The significance level was set at $p < 0.05$.

Results

One hundred twenty-nine students responded (67 men and 62 women). The proportions of participants from each college were as follows: Medicine, 58.1% ($n = 75$); Dentistry, 14% ($n = 18$); Applied Medical Sciences, 13.2% ($n = 17$); Nursing, 10.9% ($n = 14$); and Pharmacy, 3.9% ($n = 5$).

The sources of information on IC and SPs reported by the students comprised: self-directed learning, 48.8% ($n = 63$); informal practical learning in the ward (e.g., at bedside), 58.9% ($n = 76$); formal curricular teaching, 66.7% ($n = 86$); and IC courses, 58.9% ($n = 76$). For this question, participants could choose more than one source.

The percentage of respondents with sufficient knowledge on IC and SPs was 73.6% ($n = 95$): 67.2% ($n = 45$) of men and 80.6% ($n = 50$) of women. There was no significant difference between the sexes in knowledge of SPs and IC ($p = 0.082$). The correct response rates for each question are provided in Table 1.

Differences between the sexes in the correct response rates for each domain are shown in Table 2. General concepts of SPs were answered correctly 81.6% of the time, followed by hand hygiene (68.2%), PPE (66.5%), disposal of and injuries from sharp objects (54.5%), and health-care providers' care (53.05%).

Students' knowledge of SPs and IC at each college is shown in Table 3. Students' knowledge of SPs and IC at each college was as fol-

Table 1
The five domains of questions and their correct response rates.

| General concept of standard precautions | Number (%) of correct answers |
|---|-------------------------------|
| 1. The main goal of infection control: (option). | 125 (97%) |
| 2. Definition of standard precautions: (option). | 124 (96.1%) |
| 3. All patients are sources of infection regardless of their diagnoses (true). | 92 (71.3%) |
| 4. All body fluids except sweat should be viewed as infection sources (true). | 64 (49.6%) |
| 5. All health-care providers are at risk of occupational infection (true). | 121 (93.8%) |
| Hand hygiene | |
| 1. Hand washing minimizes microorganisms acquired on the hands if soiled (true). | 109 (84.5%) |
| 2. Hand washing reduces the incidence of health care-related infections (true). | 125 (97%) |
| 3. Standard hand washing includes washing of both hands and wrists (true). | 99 (76.7%) |
| 4. In standard hand washing, the minimum duration should be ... (option). | 13 (10.1%) |
| 5. Hand decontamination includes washing the ... with antiseptic soap for 30 s (option). | 35 (27.1%) |
| 6. Alcohol hand rub substitutes hand washing even if the hands are soiled (false). | 87 (67.4%) |
| 7. Hand washing is indicated between tasks and procedures on the same patient (true). | 70 (54.3%) |
| 8. Use of gloves replaces the need for hand washing (false). | 117 (90.7%) |
| 9. Hand washing is indicated after removal of gloves (true). | 108 (83.7%) |
| 10. Hand washing is needed with patients with respiratory infections (true). | 116 (90%) |
| PPE | |
| 1. PPE such as masks and head caps provides protective barriers against infection (true). | 119 (92.2%) |
| 2. Use of PPE eliminates the risk of acquiring occupational infections (true). | 92 (71.3%) |
| 3. PPE is exclusively suitable for laboratory and cleaning staff for their protection (false). | 92 (63.6%) |
| 4. PPE should be used only whenever there is contact with blood (false). | 103 (79.8%) |
| 5. Gloves and masks can be reused after proper cleaning (false). | 116 (90%) |
| 6. Used PPE are to be discarded through regular municipal disposal systems (false). | 34 (26.4%) |
| 7. Gloves should be changed between different procedures on the same patient (true). | 70 (54.3%) |
| 8. Masks made of cotton or gauze are most protective (false). | 53 (41.1%) |
| 9. Masks and gloves can be reused if dealing with same patient (false). | 102 (79.1%) |
| Disposal of and injuries from sharp objects | |
| 1. Used needles should be recapped after use to prevent injuries (false). | 47 (36.45) |
| 2. Used needles should be bent after use to prevent injuries (false). | 83 (64.3%) |
| 3. The sharps container is labeled with: (option). | 78 (60.5%) |
| 4. Soiled sharp objects should be shredded before final disposal (true). | 21 (16%) |
| 5. Sharps injuries should be managed without reporting (false). | 110 (85.3%) |
| 6. Needle-stick injuries are least commonly encountered in general practice (false). | 84 (65.1%) |
| 7. Post-exposure prophylaxis is used for managing injuries from an HIV-infected patient (true). | 68 (52.7%) |
| 8. Immediate management of sharps injuries includes: (option). | 57 (44.2%) |
| Care of health-care providers | |
| 1. Immunization history of health-care providers should be obtained before recruitment (true). | 113 (87.6%) |
| 2. Routine immunizations for health-care providers include HIV, rubella, and rabies (false). | 50 (38.8%) |
| 3. Health-care providers should receive annual influenza vaccination (true). | 37 (28.7%) |
| 4. Health-care providers should be tested annually by tuberculin skin test (true). | 55 (42.6%) |
| 5. The risk of a health-care provider to acquire HIV infection after a needle-stick injury is: (option). | 39 (30.2%) |
| 6. Post-exposure immunization prevents the risk of hepatitis B infection following exposure (true). | 52 (40.3%) |
| 7. For the prevention of hepatitis B, immunizations are recommended for all health-care workers (true). | 106 (82.2%) |
| 8. Following exposure to a patient with 'flu, antibiotics are required to prevent infection (false). | 78 (60.5%) |
| 9. The health-care providers at the highest risk of exposure to tuberculosis include radiologists (true). | 37 (28.7%) |

PPE, personal protective equipment; HIV, human immunodeficiency virus.

Table 2
Differences between the sexes in correct response rates across the five domains.

| Domain | Men | Women | p Value |
|---|-------------|-------------|--------------|
| General concept of standard precautions | 79.7 ± 17.2 | 83.5 ± 16 | 0.192 |
| Hand hygiene | 66.4 ± 15.1 | 70 ± 13 | 0.154 |
| Personal protective equipment | 62.8 ± 22.2 | 70.2 ± 14.7 | 0.027 |
| Disposal of and injuries from sharp objects | 56.5 ± 20.7 | 52.5 ± 20 | 0.262 |
| Health-care providers' care | 53.3 ± 22.5 | 52.8 ± 21.2 | 0.89 |

Table 3
Students' knowledge of infection control and standard precautions at each college.

| Domain | Medicine | Dentistry | Applied Medical Sciences | Nursing | Pharmacy |
|---|-----------|-----------|--------------------------|-----------|-----------|
| General concept of standard precautions | 79.2 ± 19 | 84.4 ± 10 | 85.8 ± 13 | 85.7 ± 9 | 80 ± 1 |
| Hand hygiene | 70 ± 12 | 56.6 ± 19 | 67.6 ± 9 | 72.8 ± 10 | 70 ± 24 |
| Personal protective equipment | 64.8 ± 21 | 67.9 ± 21 | 65.3 ± 13 | 73.8 ± 9 | 66 ± 20 |
| Disposal of and injuries from sharp objects | 56.2 ± 21 | 51.2 ± 18 | 57.5 ± 16 | 52.3 ± 19 | 37.7 ± 21 |
| Health-care providers' care | 56.8 ± 20 | 42.3 ± 21 | 46.3 ± 22 | 62 ± 21 | 32 ± 20 |
| Total | 64.4 ± 12 | 58.5 ± 12 | 62.9 ± 7 | 68 ± 8 | 56 ± 13 |

lows: Medicine, 74.7%; Dentistry, 61.1%; Applied Medical Sciences, 76.5%; Nursing, 92.9%; and Pharmacy, 40%. The difference between Medicine and other colleges was not significant ($p = 0.756$).

Discussion

The primary objectives of this study were to assess knowledge and information sources on SPs and IC among Saudi-Arabian health

sciences students. The participants of this study demonstrated acceptable knowledge compared with the participants of the study conducted at King Faisal University (73.6% vs. 26.7%, respectively) [2]. In this study, the primary information source reported by students was formal curricular teaching, consistent with the findings of Tavolacci et al. [3] and Bello et al. [11]. However, this result contrasted with that of the study performed at King Faisal University, which reported self-directed learning and informal, bedside practice as the main information sources [2]. This may explain the difference in knowledge levels between this study and the study conducted at King Faisal University.

In this study, general concept of SPs, hand hygiene, and PPE were the most well-known domains, whereas disposal of and injuries from sharp objects and health-care providers' care were the least well-known. In the study performed at King Faisal University, hand hygiene and health-care providers' care were the most well-known domains, whereas management of sharp objects and PPE were the least well-known [2]. In contrast, Tavolacci et al. [3] reported that SPs and hand hygiene were the most well-known domains, whereas nosocomial infection knowledge was the least well-known. These findings show that knowledge of how to handle sharp objects requires improvement; therefore, the curriculum should be amended to increase its emphasis of these issues. Furthermore, IC should be introduced to health sciences students prior to their clinical phase. In this study, the highest proportion of individuals demonstrating sufficient knowledge was found among nursing students, consistent with the findings of Tavolacci et al. [3] and García-Zapata et al. [12].

Other than formal curriculum teaching, the elevated knowledge witnessed in this study may be attributable to the outbreak of Middle East respiratory syndrome coronavirus (MERS-COV) in 2015. The MERS-COV outbreak and closure of the main hospital in Riyadh necessitated the launch of a hospital-wide IC training program termed "Right Care Right Now" on September 27, 2015 at several facilities, including the KSAU-HS. Students were trained and their competency was assessed by IC practitioners prior to or during their clinical years at the postgraduate center of the KSAU-HS. Such interventions, theoretical knowledge, and practical learning may have increased all Saudi-Arabian health-care workers' knowledge of IC [13].

Conclusion

In this study, we revealed that knowledge of SPs and IC among Saudi-Arabian health sciences students is satisfactory, with no significant differences between sexes or between the College of Medicine and other colleges. Formal curricular teaching at the KSAU-HS is the main source of information on SPs and IC, and is effective at raising the level of knowledge on SPs and IC.

Limitations

A cross-sectional design using a questionnaire as the instrument of data collection restricts the observation of behavior, skills, and compliance of students during practice. Moreover, the number of respondents ($n = 129$) was below the sample size ($n = 207$).

Funding

No funding sources.

Competing interests

None declared.

Ethical approval

Ethics approval was granted by the ethical review board of the King Abdullah International Medical Research Center (KAIMRC), Riyadh KSA. The approval letter was issued on the February 27, 2017 (No. SP17/041/R).

Acknowledgments

The authors acknowledge that the questionnaire is adopted from the study of Dr Tarek Tawfik Amin and the authors of "Standard Precautions and Infection Control, Medical Students' Knowledge and Behavior at a Saudi University: The Need for Change" [2].

References

- [1] World Health Organization. Practical guidelines for infection control in health care facilities; 2004. http://www.wpro.who.int/publications/docs/practical_guidelines_infection_control.pdf. [Accessed].
- [2] Amin TT, Al Noaim KI, Bu Saad MA, Al Malhm TA, Al Mulhim AA, Al Awas MA. Standard precautions and infection control, medical students' knowledge and behavior at a Saudi university: the need for change. *Glob J Health Sci* 2013;5(4):114–25, <http://dx.doi.org/10.5539/gjhs.v5n4p114>.
- [3] Tavolacci M, Ladner J, Bailly L, Merle V, Pitrou I, Czernichow P. Prevention of nosocomial infection and standard precautions: knowledge and source of information among healthcare students. *Infect Control Hosp Epidemiol* 2008;29(7):642–7.
- [4] Petrit BI, Migena G, Indrit B. Knowledge and source of information among health care students on nosocomial infections. *Int J Hum Soc Sci Educ* 2014;1(7):46–51.
- [5] Al Kadi A, Salati SA. Hand hygiene practices among medical students. *Interdiscip Perspect Infect Dis* 2012;2012:1–6, <http://dx.doi.org/10.1155/2012/679129>.
- [6] Phillips G, Ker J. Champion students! Experience with a standardized infection control training package in medical students. *J Hosp Infect* 2006;62(4):518–9.
- [7] Mathur P. Hand hygiene: back to the basics of infection control. *Indian J Med Res* 2011;134(5):611, <http://dx.doi.org/10.4103/0971-5916.90985>.
- [8] Kelčíková S, Skodova Z, Straka S. Effectiveness of hand hygiene education in a basic nursing school curricula. *Public Health Nurs* 2012;29(2):152–9, <http://dx.doi.org/10.1111/j.1525-1446.2011.00985.x>.
- [9] Longtin Y, Sax H, Allegranzi B, Schneider F, Pittet D. Hand hygiene. *N Engl J Med* 2011;364(13):e24, <http://dx.doi.org/10.1056/nejmvcm0903599>.
- [10] Pittet D, Hugonnet S, Harbarth S, Mourouga P, Sauvan V, Touvneau S, et al. Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Lancet* 2000;356(9238):1307–12.
- [11] Bello AI, Asiedu EN, Adegoke BO, Quartey JN, Appiah-Kubi KO, Owusu-Ansah B. Nosocomial infections: knowledge and source of information among clinical health care students in Ghana. *Int J Gen Med* 2011;4:571, <http://dx.doi.org/10.2147/IJGM.S16720>.
- [12] García-Zapata MR, Silva e Souza AC, Guimarães JV, Tipple AF, Prado MA, García-Zapata MT. Standard precautions: knowledge and practice among nursing and medical students in a teaching hospital in Brazil. *Int J Infect Control* 2009;6(1), <http://dx.doi.org/10.3396/ijic.V6i1.005.10>.
- [13] Al Thaqafi A. Quality and patient safety newsletter; 2015. <http://ngha.med.sa/English/Professionals/QPSNewsletter/Volume.7.Issue.3.October.2015.pdf>. [Accessed].