



## ASSESSMENT OF INFECTION PREVENTION AND CONTROL PRACTICES AMONG HEALTHCARE WORKERS IN THE OPERATING ROOM

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### Abstract

**Background:** Hospital-acquired infections are considered one of the most serious problems in the world. The problem of infection prevention and control in hospitals becomes more serious, especially with the scarcity of resources and materials; also, the lack of supportive policies and direction can exaggerate the situation. The CDC recommended that educating healthcare workers regarding infection control measures is the highest priority to prevent and control nosocomial infections.

**Aim:** The study aimed to assess the healthcare workers' practices in the operating rooms in Al Noor Specialist Hospital in King Saudia Arabia (KSA).

**Research Design:** A cross-sectional descriptive survey design.

**Subject:** participants in the study included a convenience sample of healthcare workers (n=100) who worked in the OR at the time of data collection.

**Tool:** a self-administered questionnaire for the HCWs' knowledge, attitudes, training & education, and practices for the OR setting.

**Results:** The study results show that the majority of HCWs know about IPC practices and their role in reducing nosocomial infections. Also, the majority of HCWs have good attitudes towards IPC practices. These results are considered a good chance for improvement and development in this context.

**Recommendations:** Training courses and education sessions regarding IPC should be implemented for all HCWs to increase their awareness of this issue.

**Keywords:** Infection Prevention, Control Practices Medication, Hospital-acquired infections, Healthcare Workers and Operating Room.

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## Introduction

Globally, there is public concern about infection prevention and control practices among healthcare workers in healthcare systems <sup>(1)</sup>. Specifically, the ORs in any hospital are considered the most important departments for their important services which contribute to the reputation and marketing of the hospital's health services and give the hospital a competitive advantage against other hospitals <sup>(2)</sup>. Recent studies suggest that at least 20% of Healthcare-Associated Infection (HAIs) could be prevented through infection prevention and control strategies. Infection prevention and control (IPC) programs are both clinically effective and cost-effective, providing important cost savings in terms of fewer HAIs reduced length of hospital stay, less antimicrobial resistance, and decreased costs of treatment for infections <sup>(3,4)</sup>.

So, Infection prevention and control is a very important goal for all healthcare facilities <sup>(5)</sup>. It comes in the context of a quality improvement process that aims to provide safe and effective healthcare to patients to minimize morbidity and mortality during the provision of health procedures <sup>(6)</sup>. It is anticipated that all healthcare workers (HCWs) adhere to standards in their practices <sup>(7)</sup>. The standards must be part of the knowledge, attitude, and practice of all the health facilities to obtain the patient's safety and protection <sup>(8)</sup>. Infection control activities must be integrated into the routine activities of the hospital <sup>(9)</sup>. The ORs are a very important place that provides a large segment of health service, the ORs need to adhere to IPC protocols to guarantee the safety of the patients subjected to different types of surgeries <sup>(10)</sup>. There are a lot of infected cases that can be easily prevented by using the proper sterilization techniques according to the IPC guidelines and protocols <sup>(9, 10)</sup>.

Compliance with IPC protocols in ORs leads to high-quality health service and maintenance of the client's safety and health. In the ORs, there are different types of practices related to infection control and sterilization techniques which are considered as basic principles in ORs procedures <sup>(11, 12)</sup>. Everyone is doing his or her own thing; one of the biggest problems is inconsistent implementation of proven IPC measures. Adherence to IPC protocols in the ORs is considered the key element of the success of the surgical procedures and the safety of the patients <sup>(7, 13)</sup>.

Moreover, infection prevention and control refer to measures, practices, protocols, and procedures aimed at preventing and controlling infections and

transmission of infections in healthcare settings. Such infections may be pre-existing on admission or may be acquired in a health care facility (nosocomial) <sup>(14)</sup>. HAIs need to be properly managed to prevent the transmission of organisms amongst patients, HCWs, and visitors. HCWs and visitors may be sources of infections that may result in facility-based outbreaks <sup>(15)</sup>. IPC guidelines are aimed at providing a safe healthcare environment for patients and staff alike <sup>(16)</sup>.

Good infection control practices should be established to improve health outcomes and prevent negative outcomes such as morbidity, mortality, increased healthcare costs, and possible litigation <sup>(17)</sup>. IPC measures are a combination of interventions and activities, ranging from hand hygiene, aseptic technique, waste management, rational antibiotic use, cleaning and the use of chemical cleaning agents, pest and rodent control, food handling, linen handling and management, isolation, surveillance, risk management, the use of PPE, employee immunization programs and personnel hygiene <sup>(18-20)</sup>. Laxity in the application of any of these dimensions can result in significant negative public health consequences <sup>(18)</sup>.

Finally, infection control is a worldwide problem and a lot of efforts and studies made by governments and health organizations to tackle this problem to reach high-quality health services throughout the world. At the KSA level, more efforts are needed to be given to this issue by developing the work in our hospitals to match the IPC instructions and guidelines. So, this research aims to assess the healthcare workers' practices in the operating rooms and to determine the relationship between individual factors (knowledge, attitudes, training, and education) and infection prevention and control practices in the operating rooms.

## Subjects and Methods

**Research design:** A cross-sectional descriptive study was utilized to fulfill the aim of this study.

**Setting:** The study was conducted in the OR in .....hospital in the Kingdom of Saudi Arabia.

**Subjects Sample:** The study involved all HCWs working at the ORs in the selected hospital (surgeons, anesthesiologists, OR nurses, and anesthesia technicians) during the data collection period. The total number of HCWs at the ORs was 169 persons, 15 of them were drawn to the pilot study, and the rest (154) participated in the study for questionnaires.

**Data Collection Tool:** a validated self-administered questionnaire for the HCWs' knowledge, attitudes, training & education, and practices for the OR setting were used from October 2021 to December 2021.

The authors were permitted to use the questionnaire. The original language of these questions was English, and they were later translated into KSA-Arabic. To make sure the intended meaning was retained, linguistic validation was done. The validity of the face and content were examined by a jury of five experts in the field and necessary modifications were made. The information was pertinent to the main queries that needed to be addressed. The local language questions were designed to avoid prejudice and accurately reflect practices, attitudes, and knowledge.

**Reliability of the tools** was performed to confirm the consistency of the tool. Internal consistency is measured to identify the extent to which the items of the tools measure the same concept and correlate with each other. The internal consistency of the tool was assessed with Cronbach's alpha coefficient. Cronbach's alpha coefficient of 0.00 indicates no reliability and a coefficient 1.00 indicates perfect reliability. However, a reliability coefficient of 0.83 is acceptable. Cronbach's alpha for reliability testing was performed for the tool and the result was 0.89.

**Pilot study:** A pilot study was carried out before starting data collection for 10% of HCWs. In addition, the pilot study helped the researcher experience to estimate the needed time to fill out the data collection survey. Based on the results of

the pilot study, the survey did not need any modifications.

**Data collection procedure:** Permission to conduct the study was obtained from the director of the hospital and the head of the Surgical department. Permission was obtained to collect the data after the researchers explained the importance and purpose of the study.

**Statistical Analysis** The data obtained from the study tools were categorized, tabulated, and analyzed and data entry was performed using the SPSS software (Statistical Package for Social Sciences version (22.0)). Descriptive statistics were applied (e.g. mean, frequency, and percentage). Tests of significance were performed to test the study (i.e. t-test). A significant level value was considered when  $p < 0.05$ .

## Results

Table (1) shows that the majority of the respondents were surgeons who constitute 49.4%, 9.1% were anesthesiologists, 33.8% were nurses, 4.5 % were anesthesia technicians, and 3.2% for other occupations. Also, 31.2% of the respondents hold a two-year diploma, 18.2% hold a bachelor's degree, 29.2% hold a master's degree, 20.1% hold a Ph.D. degree, and 1.3% of the respondents have other degrees (a physician with board qualification). About 72.7% of the respondents were practitioners, 22.7% were heads of departments, and 4.5% were directors. Regarding experience, 51% of the participants have less than 10 years of experience, 34% have experience from 10 -20 years and 15% have more than 20 years of experience.

**Table (1)** Sociodemographic characteristics of the participants (n=154)

	No	%
<b>Profession</b>		
Surgeon	76	49.4
Anesthesiologist	14	9.1
OR Nurse	52	33.8
Anesthesia technician	7	4.5
Other	5	3.2
<b>Education</b>		
Diploma	48	31.2
Bachelor	28	18.2
Master	45	29.2
PhD	31	20.1
Other	2	1.3
<b>Current position</b>		
Director	7	4.5
Head of department	35	22.7
Practitioner	112	72.7

	No	%
<b>Years of experience</b>		
Less than 10 years	79	51.0
10-20 years	52	34.0
More than 20 years	23	15.0

**Table (2)** shows respondents were asked about their knowledge of IPC concepts that 73.9% of the respondents believe that an initial test for hepatitis and HIV should be done on all patients admitted for surgery, 17.6% stated that this test should be done for major cases, and only 8.5% stated that the test doesn't need to be done. This result reflects the risk perception of the participants to infection. About 66.9% knew about the SP term and the rest

(33.1%) didn't know. Regarding the use of SPs, 77.9% stated that they are used for the care of all patients regardless of whether or not they are infected, 13% stated that they are applied to blood and all other body fluids, secretions, and excretions and 9.1% stated that they are used to reduce the risk of transmitting microorganisms from known or unknown sources of infection.

**Table (2)** Distribution of participants by knowledge about Standard Precautions (SPs)

	N	%
<b>Initial tests for hepatitis and HIV should be done.</b>		
All patients were admitted for surgery.	114	73.9
Major cases only.	27	17.6
Not necessary to be done.	13	8.5
<b>knowledge about the international SPs</b>		
Yes	103	66.9
No	51	33.1
<b>Standard precautions are designed for</b>		
The care of all patients	120	77.9
Blood and all other body fluids, secretions and excretions	20	13
Reduction of the risk of transmitting microorganisms	14	9.1

**Table (3)** shows the participants' knowledge about IPC practices. The overall mean of Knowledge equals 3.91 (78.12%). This means that the majority of HCWs know about IPC practices and their role in reducing nosocomial infections. About 89.35% of the respondents agreed with the statement that Infection prevention and control can reduce medical costs associated with HAIs. Also, 88.42% of the respondents stated that glove use for all

patients is a useful strategy for reducing the risk of SSI. About 86.10% of the respondents agreed and strongly agreed that keeping the door closed during surgical procedure minimizes microbial contamination and 75.95% of the respondents believed that performing hand hygiene in the recommended situations can reduce 52 patient mortality. And 50.85% of the respondents stated that PPE is not used in emergencies.

**Table (3)** Distribution of respondents by knowledge about IPC

Knowledge about infection prevention and control	Mean	%
Keeping the door closed during operation minimizes microbial Contamination.	4.31	86.10
PPE is not used in emergency	2.54	50.85
Glove use for all patients is a useful strategy for reducing the risk of SSI.	4.42	88.42
Performing hand hygiene in the recommended situations can reduce patients' mortality	3.80	75.95
IPC can reduce medical costs associated with HAIs.	4.47	89.35
<b>Total mean</b>	<b>3.91</b>	<b>78.12</b>

**Table (4)** shows the respondents' attitudes towards IPC, the mean of all statements is 4.32 (86.34%), This means that the majority of HCWs' attitudes about IPC practices and their role in reducing

nosocomial infections. About 88.96% of the respondents agreed with the statement that complying with IPC protocol is very essential for infection control. Also, 89.48% and 89.09%

respectively of the respondents stated that recurrent hand washing is essential to prevent HAIs and that PPE decreases infection. About 77.52% of the respondents agreed that the influence of IPC protocol on your practice is

positive and 83.55% of the respondents believed that ensuring the client's safety and preventing them from getting HAIs is HCWs responsibility. And 89.58% of the respondents stated that proper waste disposal decreases infection.

**Table (4)** Distribution of respondents by their attitudes towards IPC

Attitude towards IPC	Mean	%
Complying with IPC protocol is very essential for infection control.	4.45	88.96
Recurrent hand washing is essential to prevent HAIs	4.47	89.48
The PPE decreases the infection.	4.45	89.09
The influence of IPC protocol on your practice is positive.	3.88	77.52
ensuring the client's safety and preventing them from getting HAIs is HCW's responsibility.	4.18	83.55
Proper waste disposal decreases infection.	4.48	89.58
<b>Total mean</b>	<b>4.32</b>	<b>89.34</b>

**Table (5)** shows that the participants were asked if their hospital provides job or in-service training and education about IPC, 55.2% answered yes sometimes, 38.3% never, and 6.5% yes, regularly. Regarding the participants' attendance to any workshop or education session on IPC, 32.5% of the respondents answered yes, last year, 22.7% answered yes, more than two years, 14.3 % answered yes in the past two years, and 30.5% answered never. About 87.7% of the participants

said that the provided training improves their performance and this denotes the efficacy of the training and education process in this field. Also, 88.3% of the participants answered that they need to learn more about IPC. About 78.6% of the respondents said that their basic education curriculum incorporates training about the IPC protocols and guidelines and 44.2% noted that aware of the orientation of new personnel on IPC.

**Table (5)** Distribution of respondents by training and education variables

	No	%
<b>On-the-job training</b>		
Never	59	38.3
Yes sometimes	85	55.2
Yes regularly	10	6.5
<b>Participation in education session</b>		
Never	47	30.5
Yes, last year	50	32.5
Yes, in the past 2 years	22	14.3
Yes, more than 2 years	35	22.7
<b>Improvement in performance due to training</b>		
Yes	135	87.7
No	19	12.3
<b>Need for more training &amp; education</b>		
Yes	136	88.3
No	18	11.7
<b>The basic education curriculum incorporates training about IPC</b>		
Yes	121	78.6
No	33	21.4
<b>Orientation of new personnel on IPC</b>		
Yes	68	44.2
No	86	55.8

**Table (6)** shows the overall mean of the practice items is 3.59 (71.75) which indicates that the respondents agree with the items of this field. This is not satisfactory percent in such a field like IPC which must have more compliance especially if we are dealing with client safety. Also, the respondents' answers regarding their practices of infection prevention and control measures. For example, the first question was about the

adherence of HCWs to PPE during operation, the mean of answers is 4.42 (88.42%), the test value equals 22.81 and the p-value = 0.000. In the same table the answers to the question "Do you properly handle contaminated equipment to prevent cross infection?" the mean of answers is 4.32(86.49%), the test value equals 18.93 and the p-value = 0.000. The mean of the statement "You keep sterilization

during the surgery” equals 4.80 (96.05%), Value = 53.5, and P-value = 0.000.

**Table (6)** Distribution of respondents by their practices

	Practices	Mean	%	T-test	P value
1.	Do you use PPE in ORs?	4.42	88.42	22.81	0.000
2.	Do you properly handle contaminated equipment to prevent cross-infection?	4.32	86.49	18.93	0.000
3.	Keep sterilization during the surgery.	4.80	96.05	53.48	0.000
4.	You scrub your hands for 3-5 minutes when conducting an operation.	4.06	81.17	12.75	0.000
5.	You don't wash your hands when arriving at work.	2.61	52.24	-4.29	0.000
6.	When washing hands, you remove jewelry, watch and rings.	4.40	87.97	16.33	0.000
7.	You wash your hands after any contact with blood & body fluids.	4.86	97.12	56.80	0.000
8.	You don't wash hands before leaving OR	1.92	38.41	-11.88	0.000
9.	Wearing gloves when you come in contact with blood & body fluids.	4.71	94.12	31.60	0.000
10.	When you touch unsterile objects, you don't change your gloves?	1.83	36.67	-11.10	0.000
11.	Used needles, syringes, and knives are discarded into safety boxes.	4.88	97.66	64.80	0.000
12.	You don't cap the used needles before disposal	2.47	49.40	-4.79	0.000
13.	You break or bend the used needle before disposal.	2.11	42.25	-8.46	0.000
14.	You don't remove used needles from syringes before disposal.	2.55	50.93	-4.09	0.000
15.	HCP with symptoms of influenza is prevented from entering OR	3.74	74.77	7.43	0.000
	<b>All statements</b>	<b>3.59</b>	<b>71.75</b>	<b>20.13</b>	<b>0.000</b>

**Table (7)** shows a significant relationship between practices and knowledge about IPC measures with a p-value (Sig.) equal to 0.018. Also shows that the correlation coefficient between practices and attitudes equals .237 and the p-value (Sig.) equals

0.002 is statistically significant at  $\alpha = 0.05$ . Moreover, the correlation coefficient between practices and training and education equals .208 and the p-value (Sig.) equals 0.005 is statistically significant at  $\alpha = 0.05$ .

**Table (7)** Relationship between knowledge, attitude and training & education and practice.

	Pearson Correlation Coefficient	P-Value (Sig.)
<b>Knowledge</b>	0.170	0.018*
<b>Attitudes</b>	0.237	0.002*
<b>Training &amp; Education</b>	0.208	0.005*

## Discussion

The knowledge, skills, and attitudes of the HCWs are very important to achieve the proper practice of IPC at ORs. Knowledge includes the facts that the participants need to know to perform their jobs<sup>(21)</sup>. Lack of knowledge of guidelines for IPC combined with an unawareness of preventive indications during daily patient care and the potential risks of transmission of microorganisms to patients constitute barriers to IPC compliance<sup>(21, 22)</sup>. Lack of knowledge about the appropriateness, efficacy, and use of IPC measures determines poor compliance<sup>(23, 24)</sup>.

To overcome these barriers, education, and training are the cornerstones of improvement in IPC practices<sup>(25)</sup>. HCWs should be aware of the fact that knowledge is power. However, lack of knowledge of IPC measures has been repeatedly shown after education and training<sup>(26)</sup>. HCWs' awareness should include issues related to hand hygiene, wearing personal protective equipment (PPE), immunization for the prevention of communicable diseases, modes of infection

transmission, assessment of patients for infection, medical instrument decontamination, healthcare waste handling, and needle stick and sharp safety policy<sup>(27)</sup>. Even more importantly, HCWs should be compliant with these IPC precautions, methods, and strategies to ensure HAI reduction in healthcare settings<sup>(28)</sup>.

This study was carried out to assess the healthcare workers' practices in the operating rooms and to determine the relationship between individual factors (knowledge, attitudes, training, and education) and infection prevention and control practices in the operating rooms. According to the current study, the majority of the respondents believe that an initial test for hepatitis and HIV should be done on all patients admitted for surgery, the minority of the respondents stated that this test should be done for major cases, and the test doesn't need to be done. This result reflects the risk perception of the participants to infection. More than two-thirds of respondents know about the SP term and the rest didn't know. This result is

consistent with studies conducted by Abu Zaid, (2010) <sup>(29)</sup> showed that more than half of the respondents were familiar with the concept of SP. Awad, (2009) <sup>(30)</sup> revealed that the majority of HCWs are knowledgeable about SP. Also, the study of El-Dalow, (2011) <sup>(31)</sup> showed that more than half of the respondents know about SPs. Moreover, this study is matched with a study conducted by Motamed, (2002) <sup>(32)</sup> which showed that a large percent of the total population was familiar with SPs. Another study reported a high knowledge of SPs of the respondents who claimed knowledge about universal precautions (Hesse et al, 2006) <sup>(33)</sup>.

The present study shows a significant relationship between practices and knowledge about IPC measures. This result is consistent with a study by Motamed, et al (2006) <sup>(32)</sup> which revealed a significant relationship between the respondents' knowledge and practices toward universal precautions. Another study was conducted by El-Shamma, (2010) <sup>(34)</sup> at the endoscopy units to assess the knowledge of the health team about infection control measures as well as their level of practice in the application of infection control measures. The researcher found that the factor affecting infection control measures in the endoscopy department regarding the endoscopy health team's level of knowledge and practice is the lack of knowledge in addition to insufficient level of performance during and post-procedure as disinfection of endoscope, hand washing, and cleaning of environment post-procedure, and few written Arabic protocols for universal precautions. The current finding revealed that the correlation coefficient is statistically significant between practices and attitudes. This result is consistent with a study conducted by Singh et al, (2011) <sup>(35)</sup> which revealed that a significant linear correlation was seen between attitude and practice scores. The level of knowledge and practice of infection control measures was poor among dental students. The attitude towards infection control measures was positive, but greater compliance was needed. They recommended rigorous training on infection control measures before graduation and mandatory hepatitis B immunization of students before exposure to clinical practice.

The present study illustrates that there is a significant relationship between practices and training and education. This result is consistent with the IPC guidelines of WHO, which clarifies that staff working in the sterilizing service department and are responsible for the

reprocessing of instruments and equipment must have undergone formal training in how to clean, disinfect and sterilize instruments and equipment. The level of training must be appropriate for the level of responsibility that the staff member is expected to undertake (WHO, 2004) <sup>(36)</sup>. Another study conducted by Suchitra and Lakshmi (2007) <sup>(37)</sup> revealed that education has a positive impact on the retention of knowledge, attitudes, and practices.

### Conclusion

It can be concluded from the current research that: there is a relationship between knowledge, attitude, training & education, and practices of IPC at the ORs, which is consistent with the reviewed literature. The study results show that the majority of HCWs know about IPC practices and their role in reducing nosocomial infections. Also, the majority of HCWs have good attitudes towards IPC practices. These results are considered a good chance for improvement and development in this context.

**Recommendations:** will be recommended to:

1. Training courses and education sessions regarding IPC should be implemented for all HCWs to increase their awareness of this issue.
2. The HCWs have to comply with SPs to protect themselves and others; they must end the culture of ignoring infection control guidelines.
3. The MOH should activate its role as it is considered the main HCP. Also, it must activate the IPCC, to do its task of disseminating the protocols.
4. The IPC protocols must be developed and updated to meet all aspects of health care especially the procedures at the ORs.
5. The role of management in supervising, monitoring, and evaluating the practices of IPC, must be strengthened.
6. At the ORs level a high-quality practitioner has to be designated to practice the role of in-service training and education.

**Recommendations** for further research studies: A study to investigate factors that affect HCWs' compliance with SPs.

### References:

1. Alhumaid S, Al Mutair A, Al Alawi Z, Alsuliman M, Ahmed GY, Rabaan AA, Al-Tawfiq JA, Al-Omari A. Knowledge of infection prevention and control among

- healthcare workers and factors influencing compliance: a systematic review. *Antimicrob Resist Infect Control*. 2021 Jun 3;10(1):86. doi: 10.1186/s13756-021-00957-0. PMID: 34082822; PMCID: PMC8173512.
- Bali RK. Operating Room Protocols and Infection Control. *Oral and Maxillofacial Surgery for the Clinician*. 2020 Jun 24:173–94. doi: 10.1007/978-981-15-1346-6\_9. PMCID: PMC7882240.
  - Haque M, Sartelli M, McKimm, J, Abu Bakar M. Health care-associated infections—An overview. *Infect. Drug. Resist.* 2018, *11*, 2321-33.
  - Sartelli M, Pagani L, Iannazzo S, Moro ML, Viale P, Pan A, Ansaloni L, Coccolini F, D’Errico MM, Agreiter I, et al. A proposal for a comprehensive approach to infections across the surgical pathway. *World. J. Emerg. Surg.* 2020, *15*, 13.
  - Manchanda V, Suman U & Singh N. Implementing Infection Prevention and Control Programs When Resources Are Limited. *Curr Treat Options Infect Dis* **10**, 28–39 (2018). <https://doi.org/10.1007/s40506-018-0142-3>
  - Melnyk B M, Buck, J. & Gallagher-Ford, L. Transforming quality improvement into evidence-based quality improvement: A key solution to improve healthcare outcomes. *Worldviews on Evidence-Based Nursing*, 2015, **12**(5), 251–252.
  - Weldetinsae A, Alemu ZA, Tefaye K, Gizaw M, Alemahyehu E, Tayachew A, Derso S, Abate M, Getachew M, Abera D, Mebrhata A, Kefale H, Habebe S, Assefa T, Mekonnen A, Tollera G, Tessema M. Adherence to infection prevention and control measures and risk of exposure among health-care workers: A cross-sectional study from the early period of COVID-19 pandemic in Addis Ababa, Ethiopia. *Health Sci Rep*. 2023 Jun 23;6(6):e1365. doi: 10.1002/hsr2.1365. PMID: 37359411; PMCID: PMC10288972.
  - Yazie TD, Sharew GB, Abebe W. Knowledge, attitude, and practice of healthcare professionals regarding infection prevention at Gondar University referral hospital, northwest Ethiopia: a cross-sectional study. *BMC Res Notes*. 2019 Sep 9;12(1):563. doi: 10.1186/s13104-019-4605-5. PMID: 31500659; PMCID: PMC6734428.
  - Marschang S, Bernardo G. Prevention and control of healthcare-associated infection in Europe: a review of patients’ perspectives and existing differences. *J Hosp Infect*. 2015;89(4):357–62.
  - Bali RK. Operating Room Protocols and Infection Control. *Oral and Maxillofacial Surgery for the Clinician*. 2020 Jun 24:173–94. doi: 10.1007/978-981-15-1346-6\_9. PMCID: PMC7882240.
  - Mohamad N, Pahrol MA, Shaharudin R, Md Yazin NKR, Osman Y, Toha HR, Mustapa N, Mohamed Z, Mohammad A, Ismail R. Compliance to Infection Prevention and Control Practices Among Healthcare Workers During COVID-19 Pandemic in Malaysia. *Front Public Health*. 2022 Jul 18;10:878396. doi: 10.3389/fpubh.2022.878396. PMID: 35923958; PMCID: PMC9340217.
  - Mohapatra S. Sterilization and Disinfection. *Essentials of Neuroanesthesia*. 2017:929–44. doi: 10.1016/B978-0-12-805299-0.00059-2. Epub 2017 Mar 31. PMCID: PMC7158362.
  - Iliyasu G, Dayyab FM, Habib ZG, Tihamiyu AB, Abubakar S, Mijinyawa MS, et al. Knowledge and practices of infection control among healthcare workers in a Tertiary Referral Center in North-Western Nigeria. *Ann Afr Med*. 2016;15(1):34.
  - Edmond MB, Wenzel RP. Infection Prevention in the Health Care Setting. *Mandell, Douglas, and Bennett’s Principles and Practice of Infectious Diseases*. 2015:3286–3293.e1. doi: 10.1016/B978-1-4557-4801-3.00300-3. Epub 2014 Oct 31. PMCID: PMC7151977.
  - Costa AL, Privitera GP, Tulli G, Toccafondi G. Infection Prevention and Control. In: Donaldson, L., Ricciardi, W., Sheridan, S., Tartaglia, R. (eds) *Textbook of Patient Safety and Clinical Risk Management*. Springer, Cham. 2021. [https://doi.org/10.1007/978-3-030-59403-9\\_9](https://doi.org/10.1007/978-3-030-59403-9_9)
  - Harun MGD, Anwar MMU, Sumon SA, Hassan MZ, Haque T, Mah-E-Muneer S, Rahman A, Abdullah SAHM, Islam MS, Styczynski AR, Kaydos-Daniels SC. Infection prevention and control in tertiary care hospitals of Bangladesh: results from WHO infection prevention and control assessment framework (IPCAF). *Antimicrob Resist Infect Control*. 2022 Oct 6;11(1):125. doi: 10.1186/s13756-022-01161-4. PMID: 36203207; PMCID: PMC9535892.
  - Storr J, Twyman A, Zingg W. *et al.* Core components for effective infection prevention and control programmes: new WHO evidence-based recommendations. *Antimicrob Resist Infect*



- Control* **6**, 6 (2017).  
<https://doi.org/10.1186/s13756-016-0149-9>
18. Centers for Disease Control and Prevention (CDC). National Center for Emerging and Zoonotic Infectious Diseases. 2016. Guide to Infection Prevention for Outpatient Settings: Minimum Expectations for Safe Care. <https://www.cdc.gov/infectioncontrol/pdf/outpatient/guide.pdf>.
  19. CDC. National Institute for Occupational Safety and Health (NIOSH). 2015. Veterinary Safety and Health. Hazard Prevention and Infection Control. <https://www.cdc.gov/niosh/topics/veterinary/hazard.html>.
  20. CDC. NIOSH. 2016. Workplace Safety & Health: Hierarchy of Controls. <https://www.cdc.gov/niosh/topics/hierarchy/default.html>.
  21. Geberemariam BS, Donka GM, Wordofa B. Assessment of knowledge and practices of healthcare workers towards infection prevention and associated factors in healthcare facilities of West Arsi District, Southeast Ethiopia: a facility-based cross-sectional study. *Arch Public Health*. 2018;**76**(1):1–11. doi: 10.1186/s13690-018-0314-0.
  22. Albano L, Matuozzo A, Marinelli P, Di Giuseppe G. Knowledge, attitudes and behaviour of hospital health-care workers regarding influenza A/H1N1: a cross sectional survey. *BMC Infect Dis*. 2014;**14**(1):1–7. doi: 10.1186/1471-2334-14-208.
  23. Aloush SM, Al-Sayaghi K, Tubaihat A, Dolansky M, Abdelkader FA, Suliman M, et al. Compliance of Middle Eastern hospitals with the central line associated bloodstream infection prevention guidelines. *Appl Nurs Res*. 2018;**43**:56–60. doi: 10.1016/j.apnr.2018.06.018.
  24. Smiddy MP, O'Connell R, Creedon SA. Systematic qualitative literature review of health care workers' compliance with hand hygiene guidelines. *Am J Infect Control*. 2015;**43**(3):269–274. doi: 10.1016/j.ajic.2014.11.007.
  25. Safdar N, Abad C. Educational interventions for the prevention of healthcare-associated infection: a systematic review. *Crit Care Med*. 2008;**36**(3):933–940. doi: 10.1097/CCM.0B013E318165FAF3.
  26. Ward DJ. The role of education in the prevention and control of infection: a review of the literature. *Nurse Educ Today*. 2011;**31**(1):9–17. doi: 10.1016/j.nedt.2010.03.007.
  27. Atack L, Luke R. Impact of an online course on infection control and prevention competencies. *J Adv Nurs*. 2008;**63**(2):175–180. doi: 10.1111/j.1365-2648.2008.04660.x.
  28. Haile TG, Engeda EH, Abdo AA. Compliance with standard precautions and associated factors among healthcare workers in Gondar University Comprehensive Specialized Hospital, Northwest Ethiopia. *J Environ Public Health*. 2017.
  29. Abu Zaid, T. Compliance of dental healthcare providers with the infection prevention and control practices at UNRWA health centers Gaza governorates: master thesis. Al-Quds University Palestine. (Unpublished master thesis). 2010.
  30. Awad, N. Adherence to infection prevention and control protocols in the neonatal intensive care units in the Ministry of Health hospitals in Gaza governorates: master thesis. Al-Quds University Palestine. (Unpublished master thesis). 2009.
  31. El-Dalaw, S. Compliance with the infection prevention and control protocol at the governmental pediatric hospitals- Gaza governorates: master thesis Al-Quds University Palestine. (Unpublished master thesis). 2011.
  32. Motamed N, BabaMahmoodi F, Khalilian A, Peykanheirati M & Nozari M. Knowledge and practices of health care workers and medical students towards 98 universal precautions in hospitals in Mazandaran Province. *Eastern Mediterranean Health Journal*, 2006; 12 (5): 653-61.
  33. Hesse A, Adu-Aryee NA, Entsua-Mensah K & Wu L. Knowledge, Attitude and Practice Universal Basic Precautions by Medical Personnel in a Teaching Hospital. *Ghana Med J*. 2006; 40(2), 61-4.
  34. El Shamaa E. Developing a control action plan for infection prevention at the endoscopy unit. *International Journal of Academic Research*, 2010; 2(4), 218-26.
  35. Singh A, Purohit M, Bhambal A, Saxena S & Gupta A. Knowledge, attitudes, and practice regarding infection control measures among dental students in Central India. *Journal of Dental Education*. 2011; 75, (3), 421-27
  36. WHO. (2004). Practical guidelines for infection control in health care facilities. Regional Office for Western Pacific, Manila Regional Office for South-East Asia, New

Delhi: SEARO Regional Publication No. 41WPRO Regional Publication.

37. Suchitra JB, & Lakshmi DN. Impact of education on knowledge, attitudes, and practices among various categories of health care workers on nosocomial infections. *Indian J Med Microbiol.* 2007; 25, 181-87