CC BY

Knowledge, Practices Among Infection Control Practices Primary Healthcare Providers towards Healthcare Settings in Saudi Arabia 2024

Naeem Fayez Jameel Hawary[1], Osama Mohammad Allihybi[2], Ahmad Adnan Alharbi[3], Mohammed Abdulmohsen Al Luhaybi[4], Mohammed Abdulqader Janbi[4], Alaa Abdulmohsen Alrubaya[5], Hossam Hassan Saleem[6], Faisal Sultan Nasser Saidan[7], Muhsen Yahya Alneami[8], Fawaz Saeed Y Alghamdi[9], Fahad Manea Alshahrani[10], Esam Ali Aldomari[11], Nawaf Ahmed Hajaji[12]

[1]Specialist-Epidemiology, Al-Noor Specialist Hospital, Saudi Arabia.
[2]Specialist Health Education, Makkah Cluster Health Care Center Al-Awali, Saudi Arabia.
[3]Specialist Health Education, Makkah Cluster Health Care Center Al-Nawariyah, Saudi Arabia.
[4]Health Education specialist, Population Health Management (Executive Administration of Healthcare Excellence) Makkah health cluster, Saudi Arabia.
[5]health education, Public health specialist Riyadh, Saudi Arabia.
[6]Preventive Medicine Senior Registrar, AL Noor specialist Hospital, Saudi Arabia.
[7]Technician and Environment Al-Rain Hospital Annan Health Center, Saudi Arabia.
[8]PUBLIC HEALTH specialist, King Saud medical city, Saudi Arabia.
[9]Public Health specialist, KING SAUD MEDICAL CITY, Saudi Arabia.
[10]Technician-Public Health, Al Masif Primary Health Care Center, Saudi Arabia.
[11]Epidemiologist, Health Control Center in Bish Port, Saudi Arabia.
[12]Specialist Epidemiology, Disease Vector Control Center in Al-Darb, Saudi Arabia.

Abstract

Background: Nosocomial infections are infections acquired during the receipt of medical care that were neither present nor in the incubation stage at the time of admission. Standard precautions are intended to prevent patients from possible cross-infection and to safeguard professionals from dangers associated with exposure to bodily fluids, including blood, also known as a healthcare-associated infection (HAI), is an infection that develops in a patient during the receipt of healthcare treatment, which was neither present nor incubating at the time of admission. These infections can occur in various healthcare settings, including hospitals, long-term care facilities, outpatient clinics, and even after discharge. They may also affect healthcare personnel through occupational exposure the collection of knowledge regarding clinical infection control procedures is always expanding and changing. In order to avoid nosocomial infections, healthcare providers must have sufficient knowledge of and adhere to safe infection prevention practices.

This study aimed: To assess the knowledge, practices among Infection control Practices Primary Healthcare Providers towards Healthcare Settings in Saudi Arabia 2024**.**

Methods: A cross-sectional study was conducted among 171 HCPs who were selected by a simple random sampling technique. An interviewer-administered questionnaire was used to collect data. The study utilized multivariable logistic regression to determine the factors associated with knowledge and practice of infection prevention.

Result: A total of 171 study contributors were involved and the mean age of the study participants was 27.98 with SD ± 3.56 years. Of the total participants, (69.6%) of them were males and the majority (64.3%) were married. About (48.5%) study participants were Nurses regardless of their educational level. In terms of educational status, (59.6%) study participants were diploma and nearly one-third of respondents were currently working at the outpatient clinics.

Conclusion: Overall practices showed acceptable adherence in key areas such as glove use and hand hygiene, but unsafe behaviors related to waste disposal and needle handling remain common. Targeted educational interventions and regular training are needed to strengthen practices and reduce the risk of nosocomial infections in PHCCs in Saudi Arabia..

Keywords: Knowledge, practices, Infection control, Primary Healthcare, Providers Healthcare ,Saudi Arabia

Introduction

Infection, also known as a healthcare-associated infection (HAI), is an infection that develops in a patient during the receipt of healthcare treatment, which was neither present nor incubating at the time of admission. These infections can occur in various healthcare settings, including hospitals, long-term care facilities, outpatient clinics, and even after discharge. They may also affect healthcare personnel through occupational exposure.[1]
Primary health Care is essential health care made universally accessible to individuals and families in the community by means acceptable to them, through their full participation and at a cost that the community and country can afford. It forms an integral part both of the country's health system of which it is the nucleus and of the overall social and economic development of the community [2]

Infections affect approximately 5–10% of hospitalized patients in developed countries and up to 20% in developing nations. Common pathogens responsible for nosocomial infections include Staphylococcus aurous, Pseudomonas aeruginosa, Klebsiella pneumoniae, Escherichia coli, and Acinetobacter spp., among others.[3] Infections have a serious impact on the quality of patient health care outcomes, and increased morbidity, leading to unnecessary deaths and additional cost [4]

Healthcare-acquired infections (HAIs) are a common global challenge mainly in low and middle- income countries [5] An estimated 10% of hospitalized patients in developed countries and 25% in developing countries develop HAIs and subsequently results in adverse healthcare outcomes as increased hospital stay, economic burden, significant morbidity, and mortality. It is an unevenly distributed in developing countries, more than 90% of these infections occurred. [6]

The high burden of HCAIs is due to lack of standardized infection prevention program, which was neglected due to limited resources, poor sanitary conditions and hygiene practices

HCAIs are infections that were not present or incubating at the time of admission and are received by the patient during the process of care in a hospital or any other health care facility. Hepatitis B virus, Hepatitis C Virus, and HIV infection are commonest HAIs, mostly transmitted by healthcare workers who fail to practice infection prevention measures. Hence, Healthcare workers are front line of protecting themselves and clients from infection [7]

Infection prevention is a process of placing barrier between susceptible host and the microorganisms and a major component of safe and high-quality service delivery at the facility level [8] Hence, HAIs associated morbidity and mortality is preventable through infection prevention strategy like, proper hand hygiene [9]

Implementing standard precautions like safety injection, isolation precautions (contact, droplet, and airborne precautions), patient bathing, antibiotic stewardship, vaccinations, and environmental cleaning, disinfection, and sterilization, comprehensive unit based safety program and surveillance were the major steps of infection prevention [10]. Surveillance data in real time allows infection control practitioners to identify and understand important nosocomial infections and to detect epidemics or outbreaks [11]

Studies have shown that different factors such as availability of infection prevention guidelines, training on infection prevention and availability of personal protection equipment can promote safe infection prevention practices at the hospital level [12] However, the factors associated with knowledge and practice of infection prevention in the primary health care of Saudi Arabia has not previously been explored. Therefore, this study aimed to assess the level of knowledge and practices of healthcare providers (HCPs) towards infection prevention and its related factors in the health facilities at Saudi Arabia.

Methods

A cross-sectional study design was conducted from January to April in primary health care at Saudi Arabia. All HCPs (Laboratory, Nurse, Health officer, and Midwifery) have direct participation in patient care were eligible to be included in the study during data collection. The sample size was determined by using single population proportion formula by considering the proportion of practices on infection prevention method 87.5%, from the study conducted by Alemayehu et al., (2016) [13]using the assumptions: 95% confidence interval, 5% margin of error. The calculated sample size was 162 but after adding a 5% non-response rate, the final sample size became 171. A simple random sampling technique (table of random number) was used to select the representative subjects from all HCPs.

Knowledge (adequate/inadequate) and practice (safe/unsafe) in relation to infection prevention were the outcomes of interest. Socio-demographic traits, water availability, the existence of an infection prevention committee, the presence of infection prevention guidelines at a medical facility, and infection prevention training are examples of independent variables. Eleven questions were used to calculate knowledge about infection prevention. If an HCW's score was equal to or higher than the mean, their infection prevention knowledge was categorized as adequate. Respondents were categorized as having insufficient knowledge about infection prevention if their scores fell below the mean value of correct responses.

Data Collection :

The researchers collected the data through face to face interview using a structured and pre-tested questionnaire which was prepared in Arabic language. The tool was developed after reviewing related varieties of literature . Data collectors were trained and supervised during the data collection period. For each component, a reliability test was done. The reliability coefficient for practice and knowledge items had a Cronbach Alpha value of 0.85 and 0.75 respectively.

Data analyzed

The data were examined for completeness and consistency during data collection on a daily base by the supervisor. Data were analyzed by SPSS version 28. Before analysis, data were cleaned and checked for outliers and missing's. Logistic regression was done and variables with a *P*-value of less than 0.2 at bivariable logistic regression model were entered into the multivariable logistic regression model. In all cases, *p*-values of less than 0.05 were considered as statistically significant.

Result

Table (1) shows a total of 171 study contributors were involved and the mean age of the study participants was 27.98 with SD ± 3.56 years. Of the total participants, (69.6%) of them were males and the majority (64.3%) were married. About (48.5%) study participants were Nurses regardless of their educational level. In terms of

educational status, (59.6%) study participants were diploma and nearly one-third of respondents were currently working at the outpatient clinics.

Table (1): Socio-demographic characteristic of HCPs

Variables	Category	Frequency	Percentage (%)
Age	18–27	84	49.1
	28–37	82	48.0
	38–47	5	2.9
Sex	Male	119	69.6
	Female	52	30.4
Marital status	Married	110	64.3
	Single	61	35.7
Profession	Nurse	68	39.8
	Midwifery	33	19.3
	Health Officer	26	15.1
	Laboratory technologist/technician	29	17.0
	Pharmacist/pharmacy-technician	15	8.8
Educational status	Degree and above	69	40.3
	Diploma	102	59.7
Work experience in health facility	Less than 5 years	114	66.7
	> = 5 years	57	33.3
Currently working unit	Outpatient department	51	29.8
	Emergency and Triage	22	12.9
	Maternity unit	33	19.3
	Inpatient clinic	13	7.5
	Laboratory	29	17.0
	Pharmacy	15	8.8
	Under-five clinic	8	4.7

Table (2) shows more than two-thirds of health facilities had infection prevention committee and around 73% of health facilities had infection prevention guidelines. About (19.3%) study participants didn't take any training on infection prevention and universal precaution.

Table 2 Characteristic of HCPs

Characteristics	Category	Frequency	Percentage (%)
Type of health facility	Rural Health center	98	57.3
	Urban health center	73	42.7
Members of infection prevention committee	Yes	119	69.5
	No	52	30.5
Access infection prevention guideline	Yes	124	72.5
	No	47	27.5
Infection prevention training	Yes	58	33.9
	No	113	66.1
Availability of continuous water supply	Yes	88	51.5
	No	83	48.5

Table (3) shows 70.8% of participants had adequate knowledge about infection prevention. (9.4%) were believed that gloves cannot provide complete protection against acquiring infection. (95.3%) of the study participants responded that washing hands with soap or an alcohol-based antiseptic decreases the risk of transmission of hospital acquired pathogens.

Table (3): Knowledge questions for HCPs in health facilities

Knowledge Variables	Category	Frequency	Percentage (%)
Have you heard about infection prevention principle?	Yes	171	100
	No	0	0
Do you think that gloves cannot provide complete protection against acquiring/transmitting infection?	Yes	155	90.6
	No	16	9.4

Knowledge Variables	Category	Frequency	Percentage (%)
Do you think that healthcare-associated pathogens can be found on normal and intact patient skin?	Yes	163	95.3
	No	18	4.7
Do you think that washing your hands with soap or alcohol-based antiseptic decreases the risk of transmission of hospital acquired infection?	Yes	163	95.3
	No	8	4.7
Do you think that use of an alcohol-based antiseptic for hand hygiene is as effective as soap and water if hands are not visibly dirty?	Yes	168	98.2
	No	3	1.8
Do you think that gloves reduce the contamination of the hand but do not prevent it completely?	Yes	137	80.1
	No	34	19.9
Do you think that no need to wash hands before doing procedures that do not involve bodily fluids?	Yes	33	19.3
	No	138	80.7
Do you think that no need to wear the same pair of gloves for multiple patients as long as there is no visible contamination?	Yes	130	76.0
	No	41	24
Do you think TB is carried in airborne particles that are generated from patients with active pulmonary TB?	Yes	169	98.8
	No	2	1.2
Do you know to what level safety boxes should be filled before closing and sealing?	Full	16	9.4
	¾ full	155	90.6
Do you know specific waste disposal buckets according to the level of their contamination?	Yes	167	97.7
	No	4	2.3

Table (4) shows practice of HCPs on infection prevention, 55% of HCPs had safe infection prevention practice. From all participants, 68.4% wash their hands before patient care and 77.2% used soap to wash their hands. Around 50.3% of healthcare providers have used all personal protective equipment's and 90.6% participant changes chlorine solution every 24 h.

Table (4): Infection prevention practice questions for HCPs in health facilities

Variables	Category	Frequency(N)	Percentage(%)
How often you wash your hands with proper detergent after contact with patient?	Always	68	39.8
	Sometimes	87	50.9
	Never	16	9.3
Do you use antiseptic hand rub to clean hands?	Yes	160	93.6
	No	11	6.4
How often do you use all personal protective equipment's as per standard to prevent infection?	Always	86	50.3
	Some times	85	49.7
When do you change chlorine solutions that used for instrumental processing?	Every 24 h	155	90.6
	After 2 days	16	9.4
How often do you use glove when you perform procedures that need wearing glove?	Always	142	83.0
	Some times	29	17.0
Have you ever exposed to blood or other body fluids of patients through contact or unprotected skin?	Yes	122	71.3
	No	49	28.7
What measure did you take if you are exposed to blood or fluids, needle stick injury?	Only taking Post exposure prophylaxis	19	11.1
	Only clean by alcohol	68	39.8
	Only washing with water	2	1.2
	Taking Post exposure prophylaxis and clean byalcohol	32	18.7
	Taking post exposure prophylaxis and washingwith water	7	4.1
	Clean by alcohol and washing with water	14	8.2
	All action taken	29	17.0
Did you practice high-level disinfection where sterilization is not applicable?	Yes	124	72.5
	No	47	27.5
What is your facility sterilization technique?	Boiling	19	11.1
	steam sterilization	152	88.9

Table (5) shows all variables with a *P*-value of less than 0.2 at bivariate logistic regression model were included in the multivariable analysis. Thus age, sex, educational status, profession, work experience, presence of infection prevention guideline, getting of infection prevention training, availability of continuous water supply, type of health center and currently working unit were evaluated as possible factors associated with knowledge of infection prevention. But, we removed two variables; type of health center and member of infection prevention committee to avoid multicollinearity (detected through chi-square test).

In multivariable analysis presence of IP guidelines, IP training, work experience and currently working unit were significantly associated with knowledge of infection prevention ($P < 0.05$). The odds of having adequate knowledge of infection prevention among health care providers who have IP guidelines in their health institutions were 3.7 times higher (AOR: 3.65, 95% CI;1.26, 10.54) than those who have not IP guideline. The odds of having adequate knowledge towards infection prevention were higher in health worker who has trained about infection prevention (AOR = 2.19: 95% CI; 1.01, 4.75) than those who were not trained. (**Table 5**)

Similarly, participants who had more than 5 years' work experience had higher odds of having adequate infection prevention knowledge (AOR = 1.52: 95%CI; 1.13–4.51). Healthcare providers who were currently working in maternity and laboratory unit had higher odds of having ad- equate knowledge about IP ((AOR = 1.67:95%CI; 1.38– 5.23), (AOR = 2.56:95%CI; 1.26–4.13)) respectively. (**Table 5**)

Table (5): Bivariate and multivariate logistic regression of factors associated with knowledge of health care providers towardsinfection prevention

Characteristics		Knowledge status		COR (95%CI)	AOR (95%CI)
		Adequate	Inadequate		
Sex	Male	80(67.2)	39(32.8)	0.55(0.25–1.18)	1.03(0.34–3.09)
	Female	41(78.8)	11(21.2)	1	1
Educational status	Diploma	65(63.7)	37(37.3)	1	1
	Degree	53(80.3)	13(19.7)	2.47(1.17–5.20)	1.05(0.32–3.44)
Work experience	< 5 Years	75(65.7)	39(34.3)	1	1
	> = 5 years	46(80.7)	11(19.3)	0.46(0.21–0.98)	1.52(1.13–4.51) *
IP Guideline	Yes	100(80.6)	24(19.4)	5.16(2.49–10.68)	3.65(1.26–10.54) *
	No	21(44.7)	26(55.3)	1	1
IP Training	Yes	32(42.1)	26(24.8)	17.64(6.87–45.33)	2.19(1.01–4.75)*
	No	44(57.9)	79(75.2)	1	1
Currently working unit	Outpatient department	30(32.2)	21(26.9)	1	
	Emergency and Triage	6(6.5)	16(20.5)	1.25(0.53–2.04)	0.25(0.13–1.54)
	Maternity unit	23(24.7)	10(12.8)	1.31(1.08–3.38)	1.67(1.38–5.23)*
	Inpatient clinic	8(8.6)	5(6.4)	0.78(0.25–2.81)	1.38(0.48–2.51)
	Laboratory	15(16.1)	14(17.9)	1.46(1.13–3.43)	2.56(1.26–4.13)*
	Pharmacy	6(6.5)	9(11.5)	0.84(0.39–3.03)	0.54(0.17–1.57)
	Under-five clinic	5(5.4)	3(3.8)	0.91(0.32–1.84)	0.87(0.57–3.47)

IP infection prevention, *COR* crude odds ratio, *AOR* adjusted odds ratio; * = significantly associated at $P < 0.05$

Table (6) shows age, sex, educational status, profession, work experience, presence of infection prevention guideline, getting of infection prevention training, availability of continuous water supply, type of health center and currently working unit were evaluated as possible factors associated with safe infection prevention practices. But, getting infection prevention training and the availability of continuous water supply in the health facility were significantly associated ($P < 0.05$) with safe infection prevention practices in the multivariable analysis.

Healthcare providers who have trained on infection prevention were 2.2 times (AOR: 2.19, 95% CI; 1.01–4.75) more likely to have good practice than those who were not trained. The odds of safe infection prevention practices were 52% lower among healthcare providers who work in health facility which have not continuous water sup- ply (AOR = 0.48:95% CI;0.214–0.832)) than their counterparts (**Table 6**).

Table (6): Bivariable and multivariable logistic regression of factors associated with infection prevention practice of HCPs

Characteristics		Infection prevention practice status		COR 95% CI	AOR 95% CI
		Safe	Unsafe		
Sex	Male	80(67.2)	39(32.8)	0.55(0.26–1.19)	1.21(0.52–2.80)
	Female	41(78.8)	11(21.2)	1	1
Educational status	Degree	53(80.3)	13(19.7)	2.47(1.17–5.20)	0.78(0.32–1.91)
	Diploma	65(63.7)	37(37.3)	1	1
Work experience	< 5 Years	75(65.7)	39(34.3)	0.46(0.21–0.99)	0.89(0.42–1.913)

Characteristics		Infection prevention practice status		COR 95% CI	AOR 95% CI
		Safe	Unsafe		
	> = 5 years	46(80.7)	11(19.3)	1	1
Presence IP guideline	Yes	100(80.6)	24(19.4)	5.16(2.49–10.68)	0.95(0.83–4.55)
	No	21(44.7)	26(55.3)	1	1
Infection prevention training	Yes	114(82.6)	24(17.4)	17.64(6.87–45.33)	2.19(1.13–4.75) *
	No	7(21.2)	26(78.8)	1	1
Availability of continuous water supply	Yes	74(52.1)	14(48.3)	1	1
	No	68(47.9)	15(51.7)	0.86(0.34–0.95)	0.48(0.21–0.83) *
Currently working unit	Outpatient department	39(36.1)	12(22.6)	1	1
	Emergency and Triage	9(8.3)	13(24.5)	0.21(0.13–1.24)	0.25(0.13–1.54)
	Maternity unit	18(16.7)	5(9.4)	1.11(0.79–1.21)	1.67(0.89–3.61)
	Inpatient clinic	7(6.5)	6(11.3)	0.28(0.15–1.63)	0.68(0.34–1.97)
	Laboratory	22(20.4)	7(13.2)	0.97(0.53–2.76)	3.24(1.68–6.27) *
	Pharmacy	7(6.5)	8(15.1)	0.84(0.39–3.03)	0.54(0.17–1.57)
	Under-five clinic	6(5.6)	2(3.8)	0.47(0.21–1.35)	0.79(0.36–2.17)
*= significantly associated at *P*-value < 0.05					

Discussion

Decreasing healthcare-associated infections requires adequate knowledge of infection prevention. According to the study's findings, around one-third of the medical professionals employed by basic healthcare units had sufficient understanding of infection prevention. This finding is supported by preceding studies [28-30] done in Saudi Arabia. The current study showed that only 55% of HCPs had safe infection prevention practices. This finding was in line with a study done by[14]., [15] but lower when compared with studies done The discrepancy might be due to a difference in the study setting and composition of HCPs [16] Remarkably, in the current study, about 90% of health care providers believed that gloves can't provide complete protection against acquiring infection. This finding is higher than previous studies done [17] This study revealed that HCPs who had more than five years of work experience were 1.5 times more likely to have adequate knowledge than their counterparts. This is in line with findings from [18] This might be due to the fact that as the number of years of practice increases, HCPs are exposed to infection prevention information and became more experienced through working with senior staff.

According to WHO recommendation, all primary healthcare facilities should develop their own standard operating procedures based on national infection prevention and control guidelines [19] Developing and implementation of infection prevention guidelines is one of the core components of infection prevention and control programs at all healthcare facilities [20] In this study, similar to previous studies [21,22] revealed that the presence of infection prevention guidelines in health institutions also increases the odds of having adequate knowledge about infection prevention . This might be attributed to the fact that HCPs who have infection prevention guidelines were more likely to get updated information, which improves their knowledge of infection prevention .[23]

Healthcare providers who are currently working in maternity and laboratory unit had higher odds of having adequate knowledge about IP. This might be due to the availability of infection prevention standard operating procedures in the laboratory unit which might improve their knowledge. Besides, this could be due to the difference in infection prevention training among units. HCPs who had ever attended any form of training program on infection prevention were more likely to practice than those who didn't take training on infection prevention. This is supported by a study done [24]

This implies more than two- third of healthcare providers need training for infection prevention. Similarly, healthcare providers who had infection prevention guidelines were more likely to have safe infection prevention practice than those who had no infection prevention guidelines. The finding highlights the necessity of infection prevention guideline in the improvement of healthcare providers' practice.[25]

Conclusion

According to the study's findings, 45% of healthcare providers engaged in dangerous infection prevention practices, and a sizable percentage of HCPs lacked sufficient knowledge of infection prevention. Work experience, obtaining infection prevention training, and the existence of infection prevention guidelines have all been strongly linked to knowledge of infection prevention. As a result, HCPs should receive sufficient pre-service and on-the-job training to enhance their understanding of infection prevention. Additionally, infection prevention guidelines should be used to enhance infection prevention practice and knowledge.

References

1. Colet P.C., Cruz J.P., Cacho G., Al-Qubeilat H., Soriano S.S., Cruz C.P. Perceived infection prevention climate and its predictors among nurses in Saudi Arabia. J. Nurs. Scholarsh. 2018;50:134–142. doi: 10.1111/jnu.12360.
2. Assiri A.M., Choudhry A.J., Alsaleh S.S., Alanazi K.H., Alsaleh S.S. Evaluation of infection prevention and control programmes (IPC), and assessment tools for IPC-programmes at MOH-health facilities in Saudi Arabia. Open J. Nurs. 2014;4:46633. doi: 10.4236/ojn.2014.47051.
3. Gulilat K, GT. Assessent of knowledge, attitude and practice of health care workers on infection prevention in health institution Bahir Dar city administration. Sci J Public Health. 2014;2(5):384–93.
4. Biniyam S, Azeb G, Desta H, GT. Infection prevention practices and associated factors among healthcare workers in governmental healthcare facilities in Addis Ababa, Ethiopia. Ethiop J Health Sci. 2018;28(2):177–86.
5. Taffurelli C, Sollami A, Camera C, Federa F, Grandi A, Marino M, et al. Healthcare associated infection: good practices, knowledge and the locus of control in heatlhcare professionals. Acta bio-medica : Atenei Parmensis. 2017;88(3s):31–6.
6. Desta M, Ayenew T, Sitotaw N, Tegegne N, Dires M, Getie M. Knowledge, practice and associated factors of infection prevention among healthcare workers in Debre Markos referral hospital, Northwest Ethiopia. BMC Health Serv Res. 2018;18(1):465.
7. Geberemariyam 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;76:69.
8. Yakob E, Lamaro T, AH. Knowledge, attitude and practice towards infection control measures among Mizan-Aman general hospital workers, south West Ethiopia. Commun Med Health Educ. 2015; 5:5–9.
9. Woldegioris T, Bantie G, Getachew H. Nurses' knowledge and practice regarding prevention of surgical site infection in Bahir Dar, Northwest Ethiopia. Surg Infect. 2019;20(1):71–7.
10. Sahiledengle B, et al. Infection prevention practices and associated factors among healthcare Workers in Governmental Healthcare Facilities in Addis Ababa. Ethiop J Health Sci. 2018;28(2):2–8.
11. World Health Organization. Guidelines on core components of infection prevention and control programs at the national and acute health care facility level. Geneva: WHO; 2016.
12. World Health Organization. [Guidelines on Core Components of Infection Prevention and Control Programmes at the National and Acute Health Care Facility Level]. World Health Organization. Country Office for Thailand; 2020.
13. Alemayehu R, Ahmed K, OS. Assessment of knowledge and practice on infection prevention among health Care Workers at Dessie Referral Hospital, Amhara region, south Wollo zone, north East Ethiopia. J Commun Med Health Educ. 2016;6:4–8
14. Temesgen C, Demissie M. Knowledge and practice of tuberculosis infection control among health professionals in Northwest Ethiopia; 2011. BMC Health Serv Res. 2014;14:593.
15. Anwar M, Majeed A, Saleem RM, Manzoor F, Sharif S. Assessment of infection control practices in teaching hospitals of Quetta. J Pakistan Med Assoc. 2016;66(8):947–51.
16. Arinze-Onyia SU, Ndu AC, Aguwa EN, Modebe I, Nwamoh UN. Knowledge and practice of standard precautions by health-Care Workers in a Tertiary Health Institution in Enugu, Nigeria. Niger J Clin Pract. 2018;21(2):149–55.
17. Rosenthal VD, Udwadia FE, Kumar S, Poojary A, Sankar R, Orellano PW ea. Clinical impact and cost-effectiveness of split-septum and single-use prefilled flushing device vs 3-way stopcock on central line-associated bloodstream infection rates in India: a randomized clinical trial conducted by the international nosocomial infection control consortium (INICC). Am J Infect Control 2015;43:1040–1045 10.1016/j.ajic.2015.05.042.
18. Rosenthal VD, Guzman SMO, C CJ. The attributable cost, length of hospital stay, and mortality of central line-associated bloodstream infection in intensive care departments in Argentina: a prospective, matched analysis. Am J Infect Control. 2003;31:475–480. doi: 10.1016/j.ajic.2003.03.002.
19. Kamunge EW. Exploring knowledge, attitudes and practices of registered nurses regarding the spread of nosocomial infections. Seton Hall University (ETDs). 2013:1865.
20. Tietjen Let. Infection prevention guideline for health care facilities with limited resource. JHPHIEGO 2011.
21. Priya NL, Krishnan KU, Jayalakshmi G, Vasanthi S. An analysis of multimodal occupational exposure leading to blood borne infections among health care workers. Indian J Pathol Microbiol. 2015;58(1):66–68. doi: 10.4103/0377-4929.151191.
22. Saito H, Inoue K, Ditai J, Wanume B, Abeso J, Weeks A. Alcohol-based hand rub and incidence of healthcare associated infections in a rural regional referral and teaching hospital in Uganda Antimicrobial Resistance and Infection Control 2017;6(Suppl 3):O26.
23. Boyce JM, Pittet D. Guideline for hand hygiene in health-care settings: recommendations of the healthcare infection control practices advisory committee and the HICPAC/SHEA/APIC/IDSA hand hygiene task force. Infect Control Hosp Epidemiol. 2002;23(12 Suppl):S3–40. doi: 10.1086/503164.
24. WHO. WHOGuidelines on Hand Hygiene in Health Care: a Summary [Internet]. WHO; 2009. Available: www.who.int/patientsafety/en/. 2009.
25. Husin SA, Lee YF, Rashid NAA, Azizan A, Fajariah P, Bakhtiar NF, et al. Effect of the world health organization multimodal hand hygiene improvement strategies on healthcare associated infections prevalence in 14 tertiary

hospitals in Malaysia. Antimicrob Resist Infect Control. 2017;6(Suppl 3):86.