MedCrave
Step into the World of Research

Nursing & Care Open Access Journal

Research Article

Open Access

CrossMark

Instrument processing practice and associated factors among nurses working in Ethiopia: a cross-sectional study

Abstract

Introduction: Healthcare-associated infections (HAIs) prevention has been made over the past decade. However, HAIs increases patients' length of stay, higher inpatient costs, risk of morbidity, and mortality. The inappropriate instrument processing can cause harm to both health care workers and patients involved in the process. Therefore, this study was aimed to assess the instrument processing practice and associated factors among nurses working at Asella Referral and Teaching Hospital, Oromia Regional State, Ethiopia.

Methods: This study was done among 335 nurses working at Asella Referral and Teaching Hospital by using a cross-sectional survey. The study period was from December 20 to 29/2021. Data were collected by using the interview technique. Data were entered into EpiData version 4.2.0.0 and SPSS version 21 was used for statistical analysis.

Result: A total of 335 nurses were participated in the study and the response rate was 99.11%. The mean age of the nurse was 31.16 years (standard deviation=5.253). About 184(54.9%) of the nurses were aged below 31 years. The majority 182(54.3%) of the nurses were male. The level of good practice towards Instrument processing among nurses was 46% (n=154, 95%CI; 40.4,51.9). The multivariable logistic regression showed that educational level (AOR=1.59, 95%CI: 1.24, 8.45, p=0.044)), awareness towards instrument processing (AOR=3.523, 95%CI: 1.424,8.741); p=0.006) and good instrument processing knowledge (AOR=1.941, 95%CI: 1.132,3.327; p=0.016) were factors significantly associated with instrument processing practice.

Conclusions: The level of good instrument processing practice among nurses was low. Health educational programs and training on instrument processing are essential to enhance instrument processing practice among nurses.

Keywords: associated factors, decontamination, instrument processing, practice and sterilization

Volume 12 Issue 1 - 2026

Lidiya Tekle Gebreyohannes, Addisu Dabi Wake

Nursing Department, College of Health Sciences, Arsi University, Ethiopia

Correspondence: Lidiya Tekle Gebreyohannes, Nursing Department, College of Health Sciences, Arsi University, Ethiopia, Tel +0966014547

Received: March 02, 2026 | **Published:** March 17, 2026

Introduction

Instrument processing is an element of infection prevention strategy, which is a critical aspect of patient safety.[1] Instrumental processing is important to create an environment free of infection in the working place.[2] Infections are the foremost public health problems in health care facilities and this problem has a worldwide distribution.[3] Nurses have a role in infection control for patient safety. They should be familiar with practices to prevent the spread, existence infection and maintain suitable practices for all patients during the duration of their hospital stay.[4] When selecting probably hazardous chemicals to be used in the health care setting patient safety should be considered in addition to worker safety.[5]

Hospital cleaning is one element in controlling infection but it is neglected.[6] The inappropriate or incomplete instrument processing can cause harm to both health care workers and patients involved in the process.[1] Sterilization and disinfection in hospitals is a significant concern for both medical and community.[7] The protocols for reprocessing and sterilization exist for many commonly reused devices.[8] In all invasive procedures, there is contact between a medical device or surgical instrument and a mucous membrane of the patient or sterile tissue and there is a risk for infection during these procedures.[9]

Reusable medical devices are devices that are reused by health care providers to treat and diagnose multiple patients. Insufficient cleaning between patient uses can cause the retention of tissue, blood, and other biological debris (soil) in certain types of reusable medical devices.[10] HAIs are infections that the patient is exposed or gets when receiving treatment for surgical or medical conditions.[11] HAIs are considered a major risk to public health causing significant mortality, morbidity, and additional costs.[12]

HAIs have resulted problems and difficulty's in hospitals around the world.[13] HAIs are one of the main complications of modern medical therapy.[14] The effect of HAIs implies long-term disability, prolonged hospital stay, massive additional financial burden, increased resistance of microorganisms to antimicrobials, high costs for patients and their families, and increased mortality.[15] HAIs has resulted in momentous morbidity and mortality.[16] HAIs have an effect in higher inpatient costs, increases patients' length of stay and of mortality.[17] HAIs are a substantial public health concern as it contributes to augmented mortality, morbidity, and health care costs in both the United States and abroad.[18] HAIs are a major cause of mortality and morbidity in hospitalized patients.[19] HAIs occur commonly that causes harm to the patient and also high health care cost.[20] HAIs lead to increases in mortality, healthcare costs and morbidity. The case fatality rate depends on the type of infection which is from 2.3% to 14.4%.[14]

Worldwide, hundreds of millions of patients are affected by HAI Based on data from a number of countries.[4] Estimating the burden of HAIs compared to other communicable diseases remains

Submit Manuscript | http://medcraveonline.com

©2026 Gebreyohannes et al. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and build upon your work non-commercially.

challenging.[21] HAIs caused by pathogens which led to higher hospital costs and a noteworthy enlarged length of stay as compared to those caused by their susceptible counterparts.[22] In hospitals, disinfection and sterilization are the main concern because nosocomial infections affect 1 out of 10 admitted patients,[24] but evidence shows that at least 20% of all nosocomial infections are preventable.[24] Infections caused by multidrug-resistant organisms are a worldwide threat and common in hospitals.[25]

Healthcare workers use several measures to prevent infections including complying with standard sterile techniques, and caring for medical equipment's.[26] Infection control programme could benefit the patients and their careers and also will deliver significant health care resources for alternative use.[27] Study's shows that about 55% of cases of ventilator-associated pneumonia, 65% to 70% of cases of catheter-associated bloodstream infections and surgical site infections may be preventable.[28] Restoring hygienic standards in hospitals is helpful method in controlling HAIs, which would be cost-effective.[6]

Globally, there is still a problem with the controlling of infections and prevention of HAIs.[29] In order to protect patients from HAIs related problems, the allocation of adequate scientific research, financial resources, and a strong commitment from all healthcare providers are necessary.[16] Having poor practice and poor level of awareness of infection control creates a significant risk of HAIs for patients and staff.[30] The study done in Ethiopia showed that only 36% of the healthcare workers had good HAI prevention practice .[31] However, there is lack of studies that have addressed instrument processing practice and associated factors among nurses working in the study setting, including worldwide. Therefore, this study was intended to assess the instrument processing practice and associated factors among nurses working at Asella Referral and Teaching Hospital, Oromia Regional State, Ethiopia.

Methods

Study area, period and design

A cross-sectional survey was conducted at Asella Referral and Teaching Hospitals, Asella town, Oromia Regional State, Ethiopia from December 20 to 29/2021. The hospital is located at 175 km from Addis Ababa. The hospital has a teaching and clinical service purpose.

Source and study population

The source population for this study were all nurses working at Asella Teaching and Referral Hospital and the study population were all nurses working at Asella Teaching and Referral hospital and who fulfilled the inclusion criteria.

Eligibility criteria

All nurses working at all clinical departments and who were willing to participate in the study were the inclusion criteria. Whereas, nurses who were on study leave and annual leave were excluded from this study.

Sample size determination, sampling technique and procedure

By using a complete survey or census, all nurses working at Asella Teaching and Referral hospital were considered. All nurses who fulfilled the inclusion criteria at a time of data collection period were included into this study. Primarily, the eligibility criteria the nurses were checked using a staff registration record. All nurses available at data collection period and who fulfilled the inclusion criteria and volunteers to take part into the study were included in to this survey. Finally, sample size for this study was 335.

Study variables

Dependent variables: Instrument processing practice.

Independent variables: Sociodemographic factors: Gender, age, level of education, marital status, and average monthly income. Whereas, working experience, ever had infection prevention training, awareness on instrument processing methods, availability of posters on instrument processing, availability of guideline on instrument processing, vaccination against hepatitis B, and department currently serving were as Institutional and personal related factors**.**

Operational definitions

Good instrument processing knowledge: If nurses scored the mean and above the mean value on knowledge questions related to instrument processing.

Poor instrument processing knowledge: If nurses scored below the mean value on the knowledge questions related to instrument processing.

Positive instrument processing attitude: If nurses scored mean and above the mean value for the attitude questions related to instrument processing.

Negative instrument processing attitude: If nurses scored below the mean value on the attitude questions related to instrument processing.

Good instrument processing practice: If nurses scored the mean and above the mean value on practice questions related to instrument processing.

Poor instrument processing practice: If nurses scored below the mean value on the practice questions related to instrument processing.[32]

Data collection tool, procedures, and quality assurance

Data were collected by using a semi structured face-to-face interviewer-based questionnaire. The questionnaire was prepared in English from relevant literature reviewed.[32] Sociodemographic characteristics, institutional and personal related factors and instrument processing practice were parts of the used questionnaires. Pretest was done and the reliability of the questionnaire was checked by using reliability analysis. Training was provided on the data collection tools and procedures for data collectors for one day. Supervision was carried out at the time of data collection period.

Data processing and analysis

EpiData version 4.2.0.0 was used for data entry. The data were exported to SPSS window version 21. The descriptive statistics, and frequency distribution were used to present the descriptive results. Bivariate logistic regression was used to analyze the association between outcome and potential predictor variables. Then independent variables with p-value less than 0.25 in bivariable logistic regression were considered as a candidate for multivariable logistic regression analysis. During this, to display the strength of the association, crude odds ratio (COR) and adjusted odds ratio (AOR) with 95% confidence interval (CI) was calculated. Model fitness was checked by Hosmer-Lemeshow's goodness-of-fit test. The result was p-value =0.237, which is p-value >0.05. Finally, p value<0.05 was considered as statistically significant for independent variables in the multivariable logistic regression analysis. The results of this study were presented by text, tables, and pie chart.

Copyright: ©2026 Gebreyohannes et al.

Result

Sciodemographic characteristics of nurses

A total of 335 nurses were participated in the study, providing a response rate of 99.11%. The mean age of the nurse was 31.16 years (standard deviation ±5.253). About 184(54.9%) of the nurses were aged below 31 years. Whereas, the rest of percents of nurses were aged ≥31 years. The majority 182(54.3%) of the nurses were male. 309(92.2%) of the nurses were qualified for BSc degree and above. About 150(44.8%) of the nurses were orthodox followers, 73(21.8%) of the nurses were protestant followers, 112(33.4%) of the nurses were muslin followers. The majority 212(63.3%) of the nurses were married and the rest of them were single. 211(63.0%) of the nurses had average monthly income of ≥7000 ETB and the rest had average monthly income of < 7000. 243(72.5%) of the nurses were Oromo by ethnic background, and 92(27.5%) of the nurses were Amhara by ethnic background.

Institutional and personal related factors

The majority 284(84.8%) of the nurses were served for less than 10 years. About 228(68.1%) of nurses ever had infection prevention training. The majority 294(87.8%) of nurses responded as they had awareness about instrument processing methods. 201(60.0%) of the nurses responded as there were postures on instrumental processing. 184(54.9%) of the nurses responded as there were guideline on instrumental processing. 226(67.5%) of the nurses were vaccinated against hepatitis B. 64(19.1%) of the nurses were serving the department of surgical ward, 40(11.9%) the nurses were serving the department of gynecology and obstetrics ward, 46(13.7%) the nurses were serving the department of emergency, 24(7.2%) the nurses were serving the department of medical ward and 123(36.7%) the nurses were serving the department of antiretroviral therapy, expanded programme on immunization, tuberculosis and outpatient department and the rest of the nurses were serving the department of pediatric ward.

Practice item score toward instrument processing

About 297(88.7%) of the nurses always perform proper instrument processing as per the recommendations. A total of 304 (90.7%) of Nurses always performed decontamination before cleaning and 302(90.1%) of nurse reported they always placed contaminated items for 10 minutes. About 294(87.8%) of the respondents immediately immerse surgical instruments in decontaminant solution after use. About a half 171 (51.0%) nurses wear all the necessary personal protective equipment like mask, eyewear, apron and heavy-duty utility gloves while performing instrument processing. The majority 304(90.7%) of nurses always thoroughly clean items before sterilization. About 198(59.1%) of the respondents use chemical indicators to monitor time, temperature, and pressure for steam sterilization and time and temperature for dry heat sterilization in every sterilization procedure (Table 1).

Table 1 Practice item score towards instrument processing among nurses working at Asella referral and teaching hospital, Asella, Ethiopia, 2021. [n=335]

Variables	Category	Frequency	Percent
Do you always perform proper instrument processing as per the recommendations?	No	38	11.3
	Yes	297	88.7
Do you always perform decontamination before cleaning?	No	31	9.3
	Yes	304	90.7
Do you always place contaminated items in decontaminate solution for 10 minutes?	No	33	9.9
	Yes	302	90.1
Do you immediately immerse surgical instruments in decontaminant solution after use?	No	41	12.2
	Yes	294	87.8
Do you always wear all the necessary Personal Protective Equipment (like mask, eyewear, apron and heavy-duty utility gloves) during instrument processing?	No	164	49
	Yes	171	51
Do you always disinfect stethoscopes?	No	214	63.9
	Yes	121	36.1
Do you always thoroughly clean items before sterilization?	No	31	9.3
	Yes	304	90.7
When you prepare 0.5% decontaminate chlorine solution do you take one-part concentrated solution and add to nine parts of water?	No	29	8.7
	Yes	306	91.3
Do you always perform High Level Disinfection after applying proper decontamination, and thorough cleaning?	No	52	15.5
	Yes	283	84.5
Do you always monitor the correct temperature, pressure and time combination for sterilization cycle?	No	65	19.4
	Yes	270	80.6
Do you perform weekly biological test for dry heat or steam sterilizer? Or is there a system that perform biological test for sterilizers that you usually used?	No	167	49.9
	Yes	168	50.1
Do you use chemical indicators to monitor time, temperature, and pressure for steam sterilization and time and temperature for dry heat sterilization in every sterilization procedure?	No	137	40.9
	Yes	198	59.1

Nurses' level of instrument processing practice

In this study, the nurses' level of good instrument processing practice was 46% (n=154, 95%CI; 40.4,51.9) (Figure 1).

Copyright: ©2026 Gebreyohannes et al.

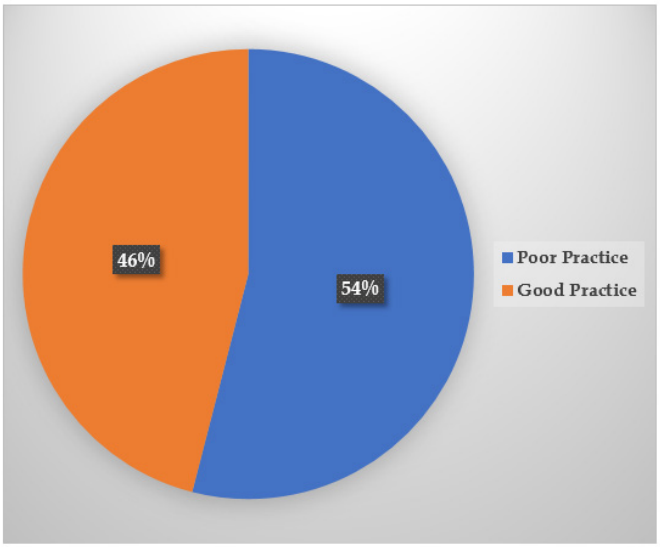

Figure 1 Nurses level of instrument processing practice at Asella teaching and referral hospital, Asella, Oromia regional state, Ethiopia, 2021, [n=335].

Factors associated with instrument processing practice

Age, gender, religion, marital status, educational level, average monthly income, working experience, ever trained on infection prevention, having awareness about instrument processing, availability of posters on instrument processing, availability of guideline on instrument processing, being vaccinated against hepatitis B, department currently serving, instrument processing knowledge and instrument processing attitude were checked for their association with instrument processing practice. In bivariable logistic regression, age, average monthly income, working experience were factors that had a p-value>0.25 and they were omitted from the final model, multivariable logistic regression. However, in multivariable logistic regression, having awareness about instrument processing, educational level and instrument processing knowledge were factors significantly associated with instrument processing practice. The odds of having good instrument processing practice among nurses who were qualified for diploma 1.59 times (AOR=1.59, 95%CI: 1.240, 8.450, p=0.044) more likely when compared with nurses who were qualified for BSc degree and above.

Likewise, the likelihood of having good instrument processing practice among nurses who had awareness towards instrument processing was 3.523 times (AOR=3.523, 95%CI: 1.424,8.741); p=0.006) more likely than their contraries.

Furthermore, the likelihood of having good instrument processing practice among nurses who had good instrument processing knowledge was 1.941 times (AOR=1.941, 95%CI: 1.132,3.327; p=0.016) more likely than nurses who had poor instrument processing knowledge (Table 2).

Table 2 Bivariable and multivariable logistic regression analysis of factors associated with instrument processing practice among nurses working at Asella referral and teaching hospital, Asella, Oromia regional state, Ethiopia, 2021. [n=335]

Variables	Category	Practice		COR (95%CI)	AOR (95%CI	p-value
		Good	Poor			
Age	<31 years	82(44.6%)	102(55.4%)	1		
	≥31 years	72(47.7%)	79(52.3%)	1.13(0.736,1.746)	**NA**	
Gender	Male	90(49.5%)	92(50.5%)	1.36(0.882,2.098)	1.40(0.882, 2.230)	0.153
	Female	64(41.8%)	89(58.2%)	1	1	
Marital status	Married	48(39.0%)	75(61.0%)	1	1	
	Single	106(50.0%)	106(50.0%)	1.56(0.995,2.454)	1.36(0.841,2.197)	0.210
Educational level	Diploma	15(57.7%)	11(42.3%)	1.67(0.742,3.748)	**1.59(1.240, 8.450)**	**0.044**
	BSc degree and above	139(45.0%)	170(55.0%)	1	1	0.255
Average monthly income	<7000 ETB	61(49.2%)	63(50.8%)	1		
	≥7000 ETB	93(44.1%)	118(55.9%)	0.81(0.522,1.270)	**NA**	
Working experience	<10Years	129(45.4%)	155(54.6%)	1		
	≥10 Years	25(49.0%)	26(51.0%)	1.16(0.636,2.098)	**NA**	
Ever had infection prevention training	Yes	109(49.1%)	113(50.9%)	1.48(0.921,2.308)	1.16(0.689,1.957)	0.575
	No	45(39.8%)	68(60.2%)	1	1	
Awareness about infection prevention process	Yes	147(95.5%)	147(81.2%)	4.86(2.086,11.310)	**3.52(1.424,8.714)**	**0.006**
	No	7(4.5%)	34(18.8%)	1		
Availability of posters on instrument processing	Yes	100(49.8%)	101(50.2%)	1.47(0.943,2.283)	1.01(0.580,1.773)	0.962
	No	54(40.3%)	80(59.7%)	1	1	
Availability of guideline on instrument processing	Yes	96(52.2%)	88(47.8%)	1.75(1.130,2.709)	1.42(0.791,2.553)	0.240
	No	58(38.4%)	93(61.6%)	1	1	
Vaccination against hepatitis B	Yes	111(49.1%)	115(50.9%)	1.48(0.931,2.357)	0.99(0.568,1.709)	0.958
	No	43(39.4%)	66(60.6%)	1	1	

Table 2 Continued.....

Department currently serving	Emergency	18(39.1%)	28(60.9%)	1	1	
	Gynecologic and Obstetrics ward	19(47.5%)	21(52.5%)	1.41(0.597,3.318)	1.22(0.489,3.048)	0.669
	Surgical ward	37(57.8%)	27(42.2%)	2.13(0.985,4.615)	1.73(0.766,3.885)	0.188
	Medical ward	8(33.3%)	16(66.7%)	0.78(0.276,2.189)	0.58(0.195,1.751)	0.337
	ART, EPI, TB, and OPD	54(43.9%)	69(56.1%)	1.22(0.610,2.429)	1.12(0.541,2.315)	0.761
	Pediatric ward	18(47.4%)	20(52.6%)	1.40(0.587,3.340)	1.19(0.474,3.012)	0.707
Knowledge towards instrument processing	Poor	43(33.6%)	85(66.4%)	1	1	
	Good	111(53.6%)	96(46.4%)	2.29(1.447,3.611)	**1.94(1.132,3.327)**	**0.016**
Attitude towards instrument processing	Negative	49(39.7%)	70(60.3%)	1	**1**	
	Positive	108(49.3%)	111(50.7%)	1.48(0.938,2.338)	1.05(0.620,1.778)	0.857

Discussion

Despite the consideration of infection prevention protocols, HAI is alarmingly rising globally. This is due to that poor instruments processing would lead to HAIs. Appropriate instruments processing is crucial to prevent HAIs. Nurses are the frontline for all patient care at hospital. Therefore, understanding the instrument processing practice and their associated factors among nurses are essentials to provide the insight to the concerned bodies to prevent HAIs. This study was conducted on the instrument processing practice and associated factors among nurses working at Asella Referral and Teaching Hospital, Ethiopia.

In this study, the nurses' level of good instrument processing practice was 46% (n=154, 95%CI; 40.4,51.9). This finding was lower than the study conducted in Addis Ababa, Ethiopia (67.1%).[32] The possible justification could be that the difference in the study population, while the study of Addis Ababa, Ethiopia was done among healthcare workers.

This finding was consistent with the study conducted in Trinidad and Tobago (44%).[33] However, the study of Trinidad and Tobago was conducted the assessment of practice towards infection prevention. Besides, it was done among healthcare workers. This finding was consistent when compared with the study done in Saudi Arabia (50.5%).[34] However, the study of Saudi Arabia was conducted the assessment of practice towards infection control policy and procedures, and also difference in study population, while the study of Saudi Arabia was done among primary care professionals.

Regarding the factors associated with instrument processing practice, the odds of having good instrument processing practice among nurses who were qualified for diploma 1.59 times (AOR=1.59, 95%CI: 1.240, 8.450, p=0.044) more likely when compared with nurses who were qualified for BSc degree and above. Likewise, the likelihood of having good instrument processing practice among nurses who had awareness towards instrument processing was 3.523 times (AOR=3.523, 95%CI: 1.424,8.741); p=0.006) more likely than their contraries. Furthermore, the likelihood of having good instrument processing practice among nurses who had good instrument processing knowledge was 1.941 times (AOR=1.941, 95%CI: 1.132,3.327; p=0.016) more likely than nurses who had poor instrument processing knowledge**.** This finding was supported by the study conducted in Addis Ababa, Ethiopia.[32]

Limitations of this study

One of the limitations of this study was the study design used, which was cross-sectional. A cross-sectional design does permit to determine the cause-and-effect relationship. The other limitation was that there were limitations of the studies that had addressed this topic globally. Therefore, this study would assist in lessening such encounters for future researchers who will do a study on this topic.

Conclusion

This study showed that the level of good instrument processing practice among nurses working at Asella referral and teaching hospital was below half. The multivariable logistic regression analysis showed that educational level, awareness about instrument processing and instrument processing knowledge were factors significantly associated with instrument processing practice.

This finding would encourage the responsible bodies such as government, healthcare providers, local and national policy makers and implementers and researchers. It would provide them the insight towards these critical issues. This is because of instrument processing practice plays a great role in preventing the HAIs. HAIs are leading to the numerous morbidity and mortality globally. Therefore, health educational programs and structured training addressing instrument processing are needed to take place to enhance the instrument processing practice.

Ethics approval and consent to participate

Ethical clearance was received from Arsi University, College of Health Sciences, department of nursing. The official letter was submitted to Asella Referral and Teaching Hospital. Permission was obtained from the concerned body. The necessary information about the study was explained to all nurses recruited to the study before data collection. Moreover, the nurses were assured about the confidentiality of the information they provide us for this study. Finally, we have received the written informed consent from the nurses who were participated in this study.

Acknowledgment

None.

Conflicts of interest

The authors declare that there is no conflicts of interest.

Funding

None.

References

1. Cuny E, Collins FM. Instrument processing, work flow and sterility assurance. 2010.
2. *Infection prevention guidelines for healthcare facilities in Ethiopia*. Heal Ethiopia Dise Pre Con. 2004.

3. National infection prevention guidelines for healthcare facilities in Ethiopia. *Fed Mini Heal Ethiopia*. 2005.
4. World Health Organization. *Prevention of hospital-acquired infections. A practical guide 2nd edition*. 2002.
5. Abdallah SA, Al-Shatti L, Al-Awadi B, et al. Disinfectants use awareness among college of nursing students and nurses in some healthcare settings, Kuwait. *Middle-East J Sci Res*. 2012;12(7):964–969.
6. Dancer SJ. Mopping up hospital infection. *J Hosp Infect*. 1999;43(2):85–100.
7. Sukhlecha AG, Vaya S, Parmar GG, et al. Knowledge, attitude, and practice regarding sterilization among health-care staff in a tertiary hospital of western India. *Int J Med Sci Public Health*. 2015;4(10):1377–1382.
8. Shuman EK, Chenoweth CE. Reuse of medical devices: implications for infection control. *Infect Dis Clin North Am*. 2012;26(1):165–172.
9. Rutala WA, Weber DJ. Disinfection and sterilization in health care facilities: what clinicians need to know. *Clin Infect Dis*. 2004;39(5):702–709.
10. *Reprocessing of reusable medical devices*. FDA. 2023.
11. *Healthcare-associated infections*. American Nurses Association. 2021.
12. Arif S, Sadeeqa S, Saleem Z, et al. The burden of healthcare-associated infections among pediatrics: a repeated point prevalence survey from Pakistan. *Hosp Pract*. 2021;49(1):34–40.
13. Sarani H, Balouchi A, Masinaeinezhad N, et al. Knowledge, attitude and practice of nurses about standard precautions for hospital-acquired infection in teaching hospitals affiliated to Zabol University of medical sciences (2014). *Glob J Health Sci*. 2015;8(3):193–198.
14. Al-Tawfiq JA, Tambyah PA. Healthcare associated infections (HAI) perspectives. *J Infect Public Health*. 2014;7(4):339–344.
15. *The burden of health care-associated infection.* World Health Organization. 2009.
16. Calfee DP. Crisis in hospital-acquired, healthcare-associated infections. *Annu Rev Med*. 2012;63(1):359–371.
17. Glance LG, Stone PW, Mukamel DB, et al. Increases in mortality, length of stay, and cost associated with hospital-acquired infections in trauma patients. *Arch Surg*. 2011;146(7):794–801.
18. Llata E, Gaynes RP, Fridkin S. Measuring the scope and magnitude of hospital-associated infection in the United States: the value of prevalence surveys. *Clin Infect Dis*. 2009;48(10):1434–1440.
19. Souza ES, Belei RA, Carrilho CMD de M, et al. Mortality and risks related to healthcare-associated infection. *Texto Cont - Enferm*. 2015;24(1):220–228.
20. Lewis SS, Moehring RW, Chen LF, et al. Assessing the relative burden of hospital-acquired infections in a network of community hospitals. *Infect Control Hosp Epidemiol*. 2013;34(11):1229–1230.
21. Cassini A, Plachouras D, Eckmanns T, et al. Burden of six healthcare-associated infections on European population health: estimating incidence--based disability-adjusted life years through a population prevalence-based modelling study. *PLOS Med*. 2016;13(10):e1002150.
22. Mauldin PD, Salgado CD, Hansen IS, et al. Attributable hospital cost and length of stay associated with health care-associated infections caused by antibiotic-resistant gram-negative bacteria. *Antimicrob Agents Chemother*. 2010;54(1):109–115.
23. Revelas A. Healthcare – associated infections: a public health problem. *Niger Med J*. 2012;53(2):59–64.
24. Harbarth S, Sax H, Gastmeier P. The preventable proportion of nosocomial infections: an overview of published reports. *J Hosp Infect*. 2003;54(4):258–266.
25. Barrasa-Villar JI, Aibar-Remón C, Prieto-Andrés P, et al. Impact on morbidity, mortality, and length of stay of hospital-acquired infections by resistant microorganisms. *Clin Infect Dis*. 2017;65(4):644–652.
26. Infections in hospital – reduce the risk. 2023.
27. Plowman R. The socioeconomic burden of hospital acquired infection. *Euro surveill*. 2000;5(4):49–50.
28. Umscheid CA, Mitchell MD, Doshi JA, et al. Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs. *Infect Control Hosp Epidemiol*. 2011;32(2):101–114.
29. Jackson C, Lowton K, Griffiths P. Infection prevention as "a show": a qualitative study of nurses' infection prevention behaviors. *Int J Nurs Stud*. 2014;51(3):400–408.
30. Ferguson JK. Preventing healthcare-associated infection: risks, healthcare systems and behavior: preventing healthcare-associated infection. *Intern Med J*. 2009;39(9):574–581.
31. Bayleyegn B, Mehari A, Damtie D, et al. Knowledge, attitude and practice on hospital-acquired infection prevention and associated factors among healthcare workers at university of Gondar comprehensive specialized hospital, northwest Ethiopia. *Infect Drug Resist*. 2021;14:259–266.
32. Geberemariyam BS. Instrument processing knowledge and practice amongst healthcare workers in Addis Ababa, Ethiopia. *Int J Infect Control*. 2018;14(2).
33. Unakal CG, Nathaniel A, Keagan B, et al. Assessment of knowledge, attitudes, and practices towards infection prevention among healthcare workers in Trinidad and Tobago. *Int J Community Med Public Health*. 2017;4(7):2240–2247.
34. Al-Ahmari AM, Alkhaldi YM, Al-Asmari BA. Knowledge, attitude and practice about infection control among primary care professionals in Abha City, kingdom of Saudi Arabia. *J Fam Med Prim Care*. 2021;10(2):662–668.