Electronic Physician (ISSN: 2008-5842) http://www.ephysician.ir
April-June 2020, Volume: 12, Issue: 2, Pages: 7708-7714, DOI: http://dx.doi.org/10.19082/7708

Knowledge of and factors associated with stethoscope disinfection practice among physicians in Dammam, Saudi Arabia

Suha Alsaleh[1], Aidah Abdul-Aziz AlRammah[1], Syed Wajid[2], Rawan Alduhailan[3], Sufanah Kattan[3], Fawziah AlMana[4]

[1] MD, Department of Family Medicine, Imam Abdulrahman Bin-Faisal National Guard Health Affairs, Dammam, Saudi Arabia
[2] MPH, Department of Clinical Pharmacy, College of Pharmacy, King Saud University, Riyadh, Saudi Arabia
[3] MBBS, Department of Family Medicine, Imam Abdulrahman Bin-Faisal National Guard Health Affairs, Dammam, Saudi Arabia
[4] MBBS, Al-faisal University, College of Medicine, Riyadh, Saudi Arabia

Type of article: Original

Abstract

Background: The health care system employs various medical devices and procedures to treat patients and help them to recover. Infections can be associated with stethoscopes.

Objective: To determine the stethoscope disinfection compliance and factors associated with disinfection, amongst National Guard Health Affairs physicians in Dammam, Saudi Arabia.

Methods: A cross sectional study was performed at Imam Abdurrahman Al-Faisal Hospital over a period of 3 months from October to December 2018. We assessed compliance regarding stethoscope disinfection practice using self-administered validated structured questionnaires. Data were analyzed by IBM© SPSS© Statistics version 24. Chi-square test was performed to find the association between the variables; a p-value of ≤ 0.05 was considered statistically significant.

Results: The study results revealed that the majority of physicians, 89 (95.7%), agreed that stethoscopes often transmit infectious agents. Most of them, 88 (94.6%), agreed that stethoscopes needed to be disinfected. A relatively large majority, 86 (92.5%), of respondents stated they cleaned their stethoscopes using a suitable method. There was a significant difference among the respondents with regard to attending a course or symposium concerning stethoscope disinfection (p=0.001).

Conclusion: The study concluded that stethoscopes can be regarded as important source for the spread of healthcare-associated infections and need to be disinfected after every use. The results also revealed that most of the respondents did not attend courses or symposiums on disinfection practices. Providing seminars and symposium along with additional training and education activities making easy availability of disinfectants were effective methods to improve stethoscope disinfection compliance among health workers.

Keywords: Stethoscope hygiene; Compliance; Physicians; Dammam, Saudi Arabia

Abbreviations / Acronyms:
HCAI: Health care-associated Infection; **HCW:** Health Care Worker; **SH:** Stethoscope Hygiene

1. Introduction

Stethoscope hygiene (SH) is the simplest yet the fundamental measure for preventing the transfer of pathogenic bacteria and in infection control (1). Several studies have demonstrated that the importance of disinfection practices

Corresponding author:
Syed Wajid. Department of Clinical Pharmacy, College of Pharmacy, King Saud University, Riyadh, Saudi Arabia.
Tel: +966-503754169, E-mail: wali@ksu.edu.sa
Received: January 26, 2020, Accepted: February 20, 2020, Published: June 2020
iThenticate screening: February 19, 2020, Quality control: April 18, 2020
This article has been reviewed / commented by three experts
Ethics approval: King Abdullah International Medical Research Center (Ref: RD18/005/D)

is not adequately recognized by health care workers (HCWs), and compliance with recommended guidelines is extremely low (2, 3). Earlier studies projected the average compliance rate with hygiene practice recommendations, at below 50%; although it differs between different hospital wards, among various professional categories of HCWs, and according to working conditions (2-4). Compliance with hygiene practices is the foremost challenge faced by infection control experts (2, 4). A previous study by Karaaslan A et al. in 2014, which aimed to evaluate compliance with disinfection practices among HCWs in the newborn who were in intensive care unit at a university hospital in turkey, reported that the compliance rate between health care workers was very poor; interestingly, the results also revealed that compliance was better among nurses than among physicians (1). Other previous studies similarly stated that compliance rate was better among nurses than doctors (5, 6). Another study by Herbert VG et al. in 2013, found that the rate of adherence to hygiene guidelines is inadequate among health care students and needs development (7). There are number of reports supporting the various barriers associated with poor compliance of stethoscope disinfection among health care workers, which include several kinds of allergies with the use of disinfecting agents, inaccessibility of hand hygiene supplies, protective clothing, amnesia, lack of knowledge of guidelines, lack of time, high workload and understaffing, and the lack of scientific information showing a definitive impact on improved disinfection practice in health care settings (2, 8-10). A number of studies from different countries found that continued education, circulation of information leaflets, workshops and seminars, were associated with good compliance rates, at best, transient improvement (2, 4). The stethoscope, a device also regarded as symbol of medicine, that is found among health care professionals globally, is highly likely to be infected by microorganisms, and if not disinfected, may transmit pathogens from one patient to another. Therefore, compliance with disinfection guidelines is considered significant in preventing health care-associated infections (HCAIs); failure to sufficiently disinfection practice results in transmission of nosocomial pathogens between patients and health care workers leads to serious complications (8, 11, 12). Therefore, the present study was carried out to assess the stethoscope Compliance and factors associated for compliance among physicians in Dammam, Saudi Arabia.

2. Material and Methods

2.1 Study design and participants

A cross-sectional study was carried out at National Guard Health Affairs in Dammam, Saudi Arabia over a period of one year from October 2018 to December 2018. We included consultants, specialists, registers, and trainees (residents and interns) in the study. Doctors with infrequent usage of stethoscopes, and doctors from the departments of dermatology, anesthesia, dentistry, ophthalmology, psychiatry, and radiology were not included in the study. The sample size was calculated using Raosoft calculator with 95% confidence level and a maximum error of 5%. The total population consisted of 120 physicians so that the required response rate would be 50% (recommended).

2.2. Pilot study, validity and reliability of the instrument

A pilot study was conducted at National Guard Health Affairs under supervision of the researcher and senior doctor, for evaluating responses of the subjects, measuring validity of the questionnaire, and to test the study questionnaire for collection of data. Face validity of the instrument was carried out by the senior who expert in this field. For the reliability of the questionnaire a pilot study was conducted suing 12 subjects. According to results of the pilot study, all minor changes in the questionnaire were made. Results of the pilot study were not included in the study. The Cronbach's alpha coefficient was 0.67 which indicated that the questionnaire could be used in this study.

2.3. Study questionnaire and data collection

The study questionnaire was developed through an extensive literature review (5, 8, 12) To determine physicians' compliance with stethoscope disinfection, we created 12 items for an anonymous validated questionnaire, comprising two sections (Table 1). Section one addressed the respondent's demographics and personal information such as gender, age, marital status, department, and designation. Section two focused on the respondent's compliance with stethoscope disinfection practices, with questions such as whether they attended a course or symposium on stethoscope disinfection; read an article on stethoscope disinfection; received instructions from supervisors regarding regular stethoscope disinfection; agree that a stethoscope can transmit infectious agents; and agree that a stethoscope need to be disinfected. Respondents had to provide binary answers to the above questions (Yes/No or I don't know). Fourteen Data collection was carried out by the chief investigator through personal interviews. The completed questionnaire was revised immediately after receiving it from the respondents. All questionnaires were collected between 2017 and 2018. Informed consent was obtained from the respondents through brief explanation about the study to the respondents before they attempted the questionnaires. Respondents were given adequate time to consider their participation.

Table 1. The questionnaire and checklist used for the current study

Variables	Attribute or measurement unit
Sex	Male / Female
Age	Years
Marital status	Single / Married / Divorced / Widowed
Working department	ER / Medical / Surgical / ICU (intensive care unit)
Total duration of use of stethoscope	Year
Job title	Consultant / Specialist / Registrar / Intern / Assistant consultant
Attended a course or symposium on stethoscope disinfection	Yes / No
Reading an article about stethoscope disinfection before	Yes / No
Supervisor instruction regarding regular stethoscope disinfection	Yes / No
IPC or QPS announcement for stethoscope disinfection	Yes / No
Can stethoscope transmit infectious agents	Yes / No / I don't know
Does it need to be disinfected	Yes / No / I don't know

2.4. Ethical considerations

Ethical approval was granted by the King Abdullah International Medical Research Center (KAIMRC), Kingdom of Saudi Arabia, ministry of National Guard –Health affairs –eastern region (RD18/005/D). All the participants were informed that the survey responses would be treated anonymously and confidentially.

2.5. Data analyses

Descriptive statics involving frequency distribution percentages were figured for all variables. IBM© Statistical package for social sciences (SPSS©) Statistics version 24 (IBM© Corp., Armonk, NY, USA) was used for Analysis. Chi-square test was used to find the significant difference among the variables with a p-value of < 0.05 was considered to be statistically significant.

3. Results

Overall Ninety-three physicians completely responded to the study. The mean age was 38.02±9.6 years. Slightly more than half of them 56 (60.2%) were male and 37 (39.8%) were female; a one third of them 73 (78.8%) were married, and 17 (18.3%) were single. Among the respondents, 27 (29.0%) were residents, 23 (24.7%) were specialists, 19 (20.4%) were registrars, 21 (22.6%) were consultants, and 2 (2.1) were interns. Of the respondents, 57 (67.3%) practiced in medical departments, 15 (16.1%) in surgical departments, 11 (11.8%) in the emergency room, and 8 (8.6%) in the ICU. The mean stethoscope use (in years) among the surveyed respondents was 13.71±7.63 (Mean ± SD) (Table 2).

Study results found that most of the respondents 89 (95.7%) reported that they were unaware of stethoscope disinfection, or had never attended a course or symposium concerning it, and only 4 (4.3%) reported that they had attended such an event. Most respondents 81 (87.1%) had never read articles about stethoscope disinfection, and 82 (88.2%) reported that they were never provided with information concerning appropriate and regular stethoscope disinfection practices by peers, colleagues, or supervisors. Of the respondents, 71 (76.3%) reported that they had not received any announcements from Infection Prevention and Control (IPC) or Quality and Patient Safety (QPS). Virtually all of the respondents, 89 (95.7%), agreed that stethoscopes transmitted infectious agents and most, 88 (94.6%), agreed that it needed to be disinfected (Table 3).

Table 3 shows that there is a significant difference among the respondents' departments and attending a course or symposium concerning stethoscope disinfection ($p=0.001$). Additionally, there was no significant difference among departments and stethoscope transmit infectious agents ($p=0.649$), stethoscope need to be disinfected ($p=0.869$). Findings also reported statistical significant difference among the Specialty stethoscope need to be disinfected ($p=0.422$) (Tables 4, 5). In addition, there was a significant difference among the age groups ($p=0.419$), genders ($p=0.439$) about the reading article of stethoscope disinfection before (Table 6).

Table 2. Demographic information of the participants (n = 93)

Characteristics of participants		Number	%
Sex	Male	56	60.2
	Female	37	39.8
Age (year)	24	1	1.1
	25–35	39	41.9
	36–46	19	20.4
	≥47	24	25.8
Marital status	Married	3	8.8
	Single	17	18.3
	Divorced	1	1.1
	Widow	1	1.1
Working department	ER	11	11.8
	Medical	57	61.3
	Surgical	15	16.1
	ICU	8	8.6
Total duration of using stethoscope (year)		13.71±7.63	

Table 3. Compliance concerning stethoscope disinfection

Variables		n (%)
Attended a course or symposium on stethoscope disinfection	Yes	4 (4.3)
	No	89 (95.7)
Reading an article about stethoscope disinfection before	Yes	12 (12.9)
	No	81 (87.1)
Supervisor instruction regarding regular stethoscope disinfection	Yes	11 (11.8)
	No	82 (88.2)
IPC or QPS announcement for stethoscope disinfection	Yes	19 (20.4)
	No	71 (76.3)
Can stethoscope transmit infectious agents	Yes	89 (95.7)
	No	2 (2.2)
	I don't know	2 (2.2)
Does it need to be disinfected	Yes	88 (94.6)
	No	1 (1.1)
	I don't know	3 (3.2)

Table 4. Correlation between working departments and certain model variables

Variables		Department				
		ER	Medical	Surgical	ICU	p-value
Can a stethoscope transmit infectious agents?	Yes	10 (11.5)	54 (59.3)	15 (16.5)	8 (8.8)	0.649
	No	---	2 (2.2)	--	--	
	I don't know	1 (1.1)	1 (1.1)	---	---	
Does it need to be disinfected?	Yes	11 (12.1)	53 (58.2)	15 (16.5)	8 (8.8)	0.869
	No	-----	1 (1.1)	-	-	
	I don't know	---	3 (3.3)	-	-	
Having attended a course or symposium about stethoscope disinfection before	Yes	-	---	3 (3.3)	--	0.001
	No	11 (12.5)	57 (64.8)	12 (13.6)	8 (8.8)	
Reading article about stethoscope disinfection before	Yes	1 (1.1)	6 (6.6)	3 (3.3)	1 (1.1)	0.775
	No	10 (11.0)	51 (56)	12 (13.2)	7 (7.7)	

Table 5. Association between working position and certain variables

Variables		Specialty					
		Consultant	Specialist	Registrar	Resident	Intern	p-value
Can stethoscope transmit infectious agents?	Yes	21 (22.6)	23 (24.7)	18 (19.4)	24 (25.8)	2 (2.2)	0.699
	No	--	---	--	2 (2.2)	--	
	I don't know	---	---	1 (1.1)	1 (1.1)	---	
Does it need to be disinfected?	Yes	21 (22.6)	23 (24.7)	19 (20.4)	23 (24.7)	2 (2.2)	0.422
	No	--	---	--	1 (1.1)	-	
	I don't know	--	--	--	3 (3.2)	--	
Having attended a course or symposium about stethoscope disinfection before	Yes	1 (1.1)	2 (2.2)	-	1 (1.1)	-	0.835
	No	20 (21.5)	21 (22.6)	19 (20.4)	26 (28)	2 (2.2)	
Reading article about stethoscope disinfection before	Yes	4 (4.3)	3 (3.2)	3 (3.2)	2 (2.2)	--	0.847
	No	17 (18.3)	20 (21.5)	16 (17.2)	25 (26.9)	2 (2.2)	

Table 6. Association between age group and gender and certain variables

Variables		Age group					Gender		
		24	25-35	36-46	≥ 47	p-value	Male	Female	p-value
Can stethoscope transmit infectious agents?	Yes	1 (1.2)	38 (45.8)	18 (21.7)	24 (28.9)	0.734	54 (58.1)	35 (37.6)	0.913
	No	--	--	--	----		1 (1.1)	1 (1.1)	
	I don't know	--	1 (1.2)	1 (1.2)	----		1 (1.1)	1 (1.1)	
Does it need to be disinfected?	Yes	1 (1.2)	37 (44.6)	18 (21.7)	24 (28.9)	0.877	53 (57)	36 (38.7)	0.694
	No	---	1 (1.2)	--	--		1 (1.1)	--	
	I don't know	---	1 (1.2)	1 (1.2)	---		2 (2.2)	1 (1.1)	
Attending course or symposium about stethoscope disinfection before	Yes	-	2 (2.4)	---	1 (1.2)	0.795	3 (3.2)	1 (1.1)	0.537
	No	1 (1.2)	37 (44.6)	19 (22.9)	23 (27.7)		53 (57)	36 (38.7)	
Reading article about stethoscope disinfection before	Yes	-	4 (4.8)	1 (1.2)	5 (6)	0.419	6 (6.5)	6 (6.5)	0.439
	No	1 (1.2)	35 (42.2)	18 (21.7)	19 (22.9)		50 (53.8)	31 (33.3)	

4. Discussion

To the best of our knowledge this is the first study to assess stethoscope disinfection compliance and knowledge about stethoscope disinfection among healthcare providers in Dammam. The results show that most health care workers believe that stethoscopes can transmit infectious pathogens. A majority of them also believe that stethoscopes need to be disinfected. The current findings suggested health care workers found to have good knowledge about importance of disinfecting the stethoscopes. These results were similar to the findings of previous studies by other investigators (12-14). For example, Ghumman et al. (12) evaluated healthcare workers Stethoscope Cleaning behavior, findings reported that almost all subjects believed that stethoscopes can be involved in pathogen transmission. Similar results were found in our study; however, Ghumman et al. reported that only 29% of participants reported cleaning their stethoscopes after every use (12). These finding is inconsistent with our findings where majority of the subjects reported after every use of Stethoscope need to be disinfected. This kind of variation in the results might be due to availability of the disinfectant at the practice site and awareness about importance of disinfection of Stethoscope among HCPs.

According to previous literature published in developed countries reported, patients have at least one HCAI that extends their hospital stay, and increases the substantial economic burden on the healthcare system as well as the patient (13, 14). For instances the estimation of the cost associated with HCAI were $9.8 billion, among the estimated cost, most of it was related to SSIs (13). These findings clearly demanding the healthcare societies to fallow a structured guideline for the prevention of HCAI and SSIs infection various facilities of health care. Among all the respondents in our study minority of the participants attended a course or symposium on stethoscope disinfection, while a previous study by Herbert VG et al. reported that majority (74%) of the subjects had received

professional introduction to hygiene guidelines beyond their subject of Hygiene and Microbiology. Our study results were lower in comparison with previous results published in this regard. The reasons for variation in the findings might be due to the job constraint and interest of the participants. In contrast, earlier studies also suggested that most medical students were dissatisfied with hospital hygiene training and considered it useful to receive more information infection prevention (15, 16).

Our results also showed that a very small number of the respondents read articles on stethoscope disinfection; however, a majority (88%) of the doctors reported that they did not receive any instructions related to stethoscope disinfection from their supervisor. These findings suggest that poor availability of an intervention program and the lack of instructions from their peers on stethoscope disinfection in health care facilities may be major reasons for the health care providers at Imam Abdurrahman Al-Faisal Hospital to have very low levels of compliance towards hygiene practice. However, previous studies reported that disinfection campaigns, with special emphasis on hand disinfection that resulted in sustained improvement in compliance with disinfection compliance, resulted in a substantial decrease in the number of hospital acquired infections (15-17). Additionally, literature also suggested that, advertisements on hygiene practices through the use of color posters; emphasizing the significance of hand cleansing, particularly hand disinfection; and HH performance feedback, would progressively result in improved compliance;18 although some studies reported that the availability of bedside, antiseptic hand-rubs increased compliance levels among health care workers (17,18).

Earlier literature suggested that disinfecting the stethoscope membranes by using innovative solution such as applications of ultraviolet (UV) light-emitting diodes (LEDs), shows effective in controlling and improving the compliance of disinfection practice in health care settings (19, 20). We recommend that identifying the reasons for non-compliance with disinfection practices among health care workers is required. In addition, we suggest providing information to health care workers regarding compliance to disinfection practice, through communication seminars and symposium as well as everyday reminders about compliance to disinfection along with feedback from the health care workers and from the organizational and involvement of institutional leaders are needed.

5. Conclusions

Our findings concluded that Importance of stethoscope disinfection practice in health care settings after every use and revealed the potential of transmission of microorganisms and pathogens. The results of the present study also revealed that most of the respondents did not attend courses or symposiums on disinfection practices. Providing seminars and symposium along with additional training and education activities making easy availability of disinfectants were effective methods to improve stethoscope disinfection compliance among health workers. Subsequently, our results may help convince health care providers about the importance of proper and timely disinfection. Also, further studies are needed to better understand how stethoscopes can be efficiently and safely disinfected.

Acknowledgments:

Authors express their sincere gratitude to the Imam Abdurrahman Al-Faisal Hospital, Dammam Saudi Arabia for allowing to carry out the study. Our special thanks to all the HCWs who participated in this study and cooperated during data collection. It was a pleasure to be associated with them through this work. We are thankful to all the health care professionals for participating in the study.

Financial support and sponsorship:

The authors received no financial support.

Conflict of Interest:

There is no conflict of interest to be declared.

Authors' contributions:

All authors contributed to this project and article equally. All authors read and approved the final manuscript.

References:

1) Karaaslan A, KepenekliKadayifci E, AtıcıS, Sili U, Soysal A, Çulha G, Pekru Y, Bakır M. Complianceof healthcare workers with hand hygiene practices in neonatal and pediatric intensive care units: overt

observation. Interdiscip Perspect Infect Dis. 2014;2014:306478. DOI: 10.1155/2014/306478 PMid: 25525428 PMCid: PMC4262750

2) Al Saleh S, Al Rammah AA, Syed W, Al Duhailan R, Kattan S, Al-Mana F. Stethoscope hygiene and barriers among physicians – A cross-sectional study from National Guard Health Affairs in Dammam, Saudi Arabia. J Patient Saf Infect Control 2019; 7:53-8. DOI: 10.4103/jpsic.jpsic_19_19
3) Jumaa PA. Hand hygiene: simple and complex. International Journal of Infectious Diseases. 2005 Jan 1;9(1):3-14. DOI: 10.1016/j.ijid.2004.05.005 PMid: 15603990
4) Larson E. Skin hygiene and infection prevention: more of the same or different approaches? Clin Infect Dis 1999;29:1287-1294. DOI: 10.1086/313468 PMid: 10524977
5) Mazi W, Senok AC, Al-Kahldy S, Abdullah D. Implementation of the world health organization hand hygiene improvement strategy in critical care units. Antimicrobial Resistance and Infection Control. 2013;2, article 15 doi: 10.1186/2047-2994-2-15. PMid: 23673017 PMCid: PMC3673893
6) Scheithauer S, Oude-Aost J, Heimann K, Haefner H, Schwanz T, Waitschies B, Kampf G., Orlikowsky T., Lemmen S. W.Hand hygiene in pediatric and neonatal intensive care unit patients: daily opportunities and indication- andprofession-specificanalyses of compliance. The American Journal of Infection Control. 2011;39(9):732-7. DOI: 10.1016/j.ajic.2010.12.020 PMid: 21704425
7) Herbert VG, Schlumm P, Kessler HH, Frings A. Knowledge of and Adherence to Hygiene Guidelines among Medical Students in Austria. Interdiscip Perspect Infect Dis. 2013;2013:802930. DOI: 10.1155/2013/802930 PMid: 23690765 PMCid: PMC3649164
8) Bhatta DR, Gokhale S, Ansari MT, Tiwari HK, Gaur A, Mathuria JM, et al. Stethoscopes: a possible mode for transmission of nosocomial pathogens. Journal of Clinical and Diagnostic Research. 2011 November (Suppl-1), Vol- 5(6): 1173-6.
9) Jain A, Shah H, Jain A, Sharma M. Disinfection of stethoscopes: gap between knowledge and practice in an Indian tertiary care hospital. Annals of Tropical Medicine and Public Health. 2013 Mar 1;6(2):236. DOI: 10.4103/1755-6783.116503
10) Zuniga A, Manalich J, Cortes R. Stethoscope or staphyloscope?: Potential vector in nosocomial infections. Revista chilena de infectologia: organo oficial de la Sociedad Chilena de Infectologia. 2016 Feb;33(1):19-25. DOI: 10.4067/S0716-10182016000100003 PMid: 26965873
11) Rutala WA, Weber DJ. The Healthcare Infection Control Practices Advisory Committee (HICPAC). 2008. Guideline for disinfection and sterilization in healthcare facilities. 2008. Available from: https://www.cdc.gov/infectioncontrol/guidelines/disinfection/
12) Ghumman GW, Ahmad N, Iftikhar S. Stethoscope Cleaning During Patient Care. Rhode Island Medical Journal. 2018 May 1;101(5):18-20.
13) Zimlichman E, Henderson D, Tamir O, Franz C, Song P, Yamin CK, et al. Health care–associated infections: a meta-analysis of costs and financial impact on the US health care system. JAMA internal medicine. 2013 Dec 9; 173(22):2039-46. DOI: 10.1001/jamainternmed.2013.9763 PMid: 23999949
14) Kennedy EH, Greene MT, Saint S. Estimating hospital costs of catheter-associated urinary tract infection. Journal of hospital medicine. 2013 Sep; 8(9):519-22. DOI: 10.1002/jhm.2079 PMid: 24038833 PMCid: PMC3786530
15) Melenhorst WB, Poos HP, Meessen NE. Medical students need more education on hygiene behavior. American Journal of Infection Control. 2009;37(10):868-9. DOI: 10.1016/j.ajic.2009.05.010 PMid: 20004814
16) Duroy E, Le Coutour X. Hospital hygiene and medical students. Médecine et Maladies Infectieuses. 2010;40:530–536. DOI: 10.1016/j.medmal.2010.02.010 PMid: 20447787
17) Pittet D, Hugonnet S, Harbarth S et al. Effectiveness of a hospital-wide program aimed at improving compliance with hand hygiene. Lancet 2000; 356: 1307-12. DOI: 10.1016/S0140-6736(00)02814-2
18) Novoa AM, Pi-Sunyer T, Sala M, Molins E, Castells X. Evaluation of hand hygiene adherence in a tertiary hospital. American journal of infection control. 2007 Dec 1;35(10):676-83. DOI: 10.1016/j.ajic.2007.03.007 PMid: 18063133
19) Messina G, Burgassi S, Messina D, Montagnani V, Cevenini G. A new UV-LED device for automatic disinfection of stethoscope membranes. American journal of infection control. 2015 Oct 1;43(10):e61-6. DOI: 10.1016/j.ajic.2015.06.019 PMid: 26254501
20) Messina G, Fattorini M, Nante N, Rosadini D, Serafini A, Tani M, Cevenini G. Time Effectiveness of Ultraviolet C Light (UVC) Emitted by Light Emitting Diodes (LEDs) in Reducing Stethoscope Contamination. Int J Environ Res Public Health. 2016 Sep 23;13(10). DOI: 10.3390/ijerph13100940 PMid: 27669273 PMCid: PMC5086679