Type of Manuscript: Survey

Awareness of Hand Hygiene among Dentists- A Questionnaire Survey

Deepika. R[1], Anitha Roy[2], A.K. Anjali[3]

[1]Research Associate, Dental Research Cell,[2]Associate Professor, Department of Pharmacology, [3]Senior lecturer, Department of Pathology, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India

Abstract

Dentistry is a service sector where the doctors are in close contact with the patients. Hand hygiene is very important in the dental practice as it can prevent infection to a great extent. The aim of the survey was to assess the importance of hand hygiene among dentists. A Questionnaire of 15 questions was prepared and circulated in the google forms, the responses were collected, compiled, and updated on the SPSS software for data analysis. Pie charts and bar graphs were used to evaluate and interpret the results. Chi-Square test was carried out to check statistical significance and p value <0.05 was considered as significant. The results obtained from the dentists who participated in the survey provide that the dentists were aware of hand hygiene protocol and the survey showed that hand hygiene is important to every dentist in their dental practice . 98.1% of the population agreed that maintenance of hand hygiene by the dentists prevents the spread of infections; 81.1% of the dentists participated were aware that 7 steps involved in the hand hygiene protocol ; 85% of the dentists were aware that, a minimum of 20 seconds are required for proper handwashing to maintain the hand hygiene, All the dentists participated in this survey agreed that hand hygiene has to be maintained definitely before the patient contact; 97.2% of dentists also suggested that hand hygiene maintenance is more necessary among the health care workers and 74.8% of the dentists agreed as hand hygiene is the most important criterion among their dental clinics. Thus, This survey could make awareness among the dentist regarding hand hygiene protocol.

Keywords *Hand hygiene; Dentist ;awareness ;Infection spread; Steps.*

Introduction

Hand washing is a technique of hand hygiene where different formulations are used to remove or reduce the no. of microorganisms. The Hand Sanitizer is such a formulation used for hand hygiene that reduces the pathogens and maintains the hand hygiene for the users.

Corresponding author
Anitha Roy,
Associate Professor, Dept .of Pharmacology
Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences,Saveetha University,
Chennai, Tamil Nadu, India
Email Id: anitharoy@saveetha.com
Phone no:+91 9840787458

The World Health Organisation suggests the techniques for hand hygiene that includes seven steps procedure or protocol [1]. Thus, this hand hygiene protects the clinicians, practitioners, and common people to prevent the spread of diseases due to contact and to control its transmission [2]. It is beneficial to make hand sanitizer using natural products other than chemicals. The hallmark of this study in the field of medicine is that hand hygiene is the major criterion in controlling the infectious spread, especially in the medical and dental procedures. The hand hygiene provides health care against the infections and acts as a protective measure against the disease caused due to the contact [3]. During dental procedures, the contact with the dentist from the infected patients, especially with their saliva, can cause infections to other patients and the dentist. Hence, it is mandatory to follow hand hygiene protocols to avoid community spread infections. Hand

sanitizers can also be considered as drugs since they prevent infections. The different formulations [4] used for hand hygiene include lotions, surgical hand sanitizers, alcohol-based scrubs, etc. All these can reduce infection [5]. Hand hygiene is the main practice provided to reduce the risk of the spread of infections from human - to - human[6].

Naik S in his study stated that only a small portion of dentists was aware of CDC rules and guidelines, hence rules and significance of CDC are to be improved among the dentists [7]. Darawad M.W in his study proposed that only half of the dentist population is aware of the effects of hand hygiene provided by hand sanitizer. Thus he stated that a survey on hand hygiene has to be enhanced to create awareness among people.[8].

The lacunae of this study include the sample size which was taken within a limited geographical area. The other factors also include that there is no restriction of age mentioned and the dentist was alone concentrated to fill this survey, where other medical and non-medical professionals could have also been included to create awareness among people [9]. The challenges faced also include the unaffordability of different classes of people to buy sanitizers and other formulations. In some cases, the hand sanitizer and other chemical formulations can also cause adverse effects such as itching, irritation, inflammation, etc.The study aim of the study was to assess the awareness on hand hygiene and to highlight the important effects of hand hygiene among dental professionals.

Materials and Method

A total number of 106 dentists participated in this study. The sampling method used in this study was random survey sampling. To minimize sampling bias certain measures were taken which includes framing straight forward questions which sounds simple and the questions were kept short and clear. A self-structured survey questionnaire was prepared which consists of 15 Questions. These questions were self framed and the validity checking of these questions was made by three internal experts in the university. The questionnaire included the steps involved and the importance given by the dentist on hand hygiene protocol. The dependent variables included the Awareness, hand hygiene, and the independent variables include the wash techniques, steps, and formulations.Google forms were used to circulate the questions and the responses were collected, the data analysis was carried out using SPSS software. Chi square test was used for statistical analysis and p value < than 0.05 was considered as significant.

Results and Discussion

A total of 106 dentists of different age groups have participated in this survey out of which 50 were male and 56 were female. (Figure 1a) represents the response to the question regarding the hand hygiene program wherein 57.55% attended the training program and 42.5% of the dentists did not attend the training. The World Health Organisation suggests that hand hygiene is the most powerful preventive measure over infections. Also, the study suggests that people who have attended the hand hygiene programs have created a greater impact on hand hygiene over them [10]. The hand hygiene programs were not developed and organized in rural areas which restricts the people and dentists to educate themselves with the effect of hand hygiene [11]. Thus it is important to attend the hand hygiene program. (Figure 1b) depicts the prevention in the spread of infection by hand hygiene for which “yes it is prevented’’ is suggested by 99.06% of dentists and “no it doesn’t” is suggested by 0.94% of dentists. Infections are prevented by following the proper protocol of hand hygiene steps, especially by the health care workers, as their hands are the vehicle of transmission [12].

Some formulations of hand sanitizer also produce adverse effects to skin making worse, thus the effectiveness has to be checked before usage [13]. (Figure 1c) indicates the opinion of dentists on Hand nails hinder the hand hygiene protocol -Yes it hinders is suggested by 69.81% of dentists; no it doesn’t is suggested by 27.36% and maybe by 2.83% of dentists. The nails serve as a bacterial burden where the microorganisms commonly reside, thus the nails make it difficult to clean and to maintain proper hand hygiene.[14]. Nails can be cleaned using alcohol-based rubs but long nails hinder the hand hygiene protocol [15]. (Figure 1d) represents the steps involved in wash techniques as per WHO includes the result as, 3.77% of the dentist suggested as 5 step technique and 6 steps are given by 7.55% of dentists and 7 step technique were given by 81.13% and finally 7.55% of dentists suggested

as 8 step technique. The World Health Organisation suggested the hand hygiene protocol of 7 steps were the most effective steps, conventionally involved to prevent the transmission [16]. Interventions in the steps of the hand hygiene were made for better protection but the effectiveness is involved in 7 step management [17]. (Figure 1e) portrays the awareness of the necessity of hand wash technique among the health care workers, "yes" necessary was suggested by 97.17% of dentists and ``no, not necessary'' is given by 2.83% dentists. Interventions are proved to improve the hand hygiene practices among the practicing nurses and healthcare providers who are more in need and are in direct contact with patients[18]. Thus another study provides information that only a few had a clear knowledge of hand hygiene protocol and established the techniques regularly. Hence to avoid cross-infection, education, and information to them are required [19]. (Figure 2a) provides information on hand hygiene products that are detrimental to the skin in which 42.45% of dentists suggest as "yes" it is detrimental and 48.11%. dentists suggest "no" not detrimental and 9.43% as "maybe".

The hygiene products also include the sanitizers that in some cases suggest having adverse effects like allergies due to the formulations [13]. In most cases, the alcohol-based sanitizer provides utmost reduction from microorganisms and efficacy against pandemic disease as COVID-19 [20] . (Figure 2b) represents the duration of handwashing with soap and water which was suggested as 10 seconds by 0.94% of dentists; 20 seconds by 84.91% of dentists and 30 seconds by 14.15% of dentists. The efficacy is extended and appropriate, accurate washing for at least 15-20 seconds is recommended for the reduction of contamination [21]. But 15 seconds were also proved as non-inferior with faster to kill microorganism effectiveness [22]. (Figure 2c) depicts the necessity of hand hygiene before patient contact -"yes" is suggested by the whole 100% of dentists. In a study, hand hygiene has been improved among the Healthcare workers before patient contact which leads to a result of the reduction in the transmission of infection and diseases provided to be effective against Covid-19 [23]. Hand hygiene health is the main route in the transmission of diseases to patients. Thus hand hygiene before patient contact has to be maintained to prevent contamination [24] .

(Figure 2d) depicts the importance of hand hygiene at the dental office as 74.5% of dentists have answered as "most important", 24.5% of dentists have answered as "moderately important" and 1% have answered to be "less important". Hand hygiene maintenance enhances and provides a better environment in the dental clinics which are included under infection control management. The disposal of the PPE and hand hygiene plays an important role in this [25] . (Figure 2e) depicts the response to the question, CDC hand hygiene guidelines, adversely affecting the skin of hands for which "yes" is suggested by 31.13% of dentists and "No" it does not affect is suggested by 63.21% and maybe is given by 5.66% of dentists. The result of this survey shows that dental professionals were moderately aware of the Hand hygiene protocol. In which most of them were well educated on the importance of dental hand hygiene and implemented at their clinics.

When comparing the awareness of hand hygiene to prevent the spread of infection with gender, it was shown that females had a higher level of awareness about the hand hygiene when compared to males (p=0.342), which was statistically not significant (figure 3). When comparing the knowledge about the steps involved in the hand hygiene protocol with gender , it was shown that females had a better knowledge about the steps involved in the hand hygiene protocol compared to the males (p = 0.119), which was statistically not significant (figure 4). When comparing the awareness of the necessity of hand hygiene among dental assistants with gender , it was shown that females had a higher level of awareness that hand hygiene was necessary for dental assistants compared to the males involved in this survey (p=0.493), which was statistically not significant (figure 5). When comparing the knowledge about the duration taken for hand wash technique with gender, it was shown that females had a higher level of knowledge when compared to the males involved in this survey (p=0.635) which is statistically not significant (figure 6)

Scientists are exploring plants for screening active phytochemicals and many plants like *Caralluma fimbriata*[26,27], *Acacia catech*u.[28–30] were evaluated and reported with antidiabetic, anticancer, and antimicrobial properties [31,26,27]. Many invivo studies have been conducted for hepatoprotective effects [32,33]. Green synthesis of nanoparticles such as silver [34,35], zinc[37], and

selenium[36] was reported to have fewer side effects compared to other methods of nanoparticle synthesis. These drugs have fewer side effects and help in better treatment for many diseases [38,39,40]. It provides many properties for betterment. These phytochemicals, extracts, and nanoparticles may be incorporated for the preparation of eco-friendly hand sanitizers for better maintenance of hand hygiene among dentists.

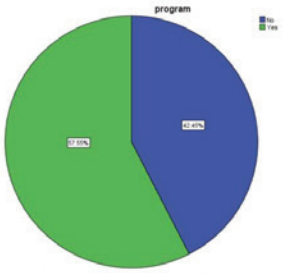

Figure 1(a) : Pie chart representing the percentage distribution of dentists attended the hand hygiene program before. 57.55% responded as 'yes' (green) attended and 42.45% responded 'No'(blue).

Figure 1(b) : Pie chart representing the prevention in the spread of infection by hand hygiene, 99.06% responded as 'yes' (green) of the study population and 0.94% responded 'No' (blue).

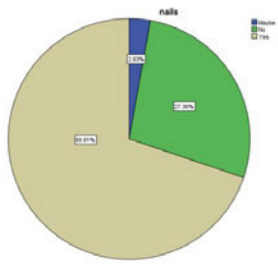

Figure 1(c): Pie chart represents the hindrance of nails in hand hygiene protocol. 69.81% of the dentists responded as 'yes' (buff), 27.36% responded as 'no' (green) and maybe (blue) by 2.83% of dentists.

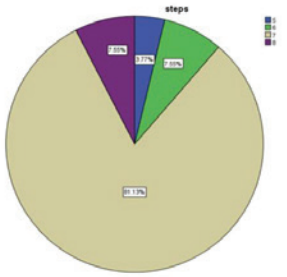

Figure 1(d) : Pie chart represents the steps involved in the hand hygiene protocol, 81.13% responded as 7 steps(buff), 7.55% as 6 steps (green), 7.55% of 8 steps (purple) and 3.77% responded as 5 steps (blue).

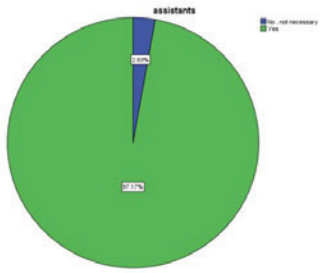

Figure 1(e): Pie chart represents the necessity of hand hygiene among health care workers, 97.17% of the dentists participating responded as 'Yes, it's necessary' (green) and 2.83% responded as 'No' (blue).

Figure 1

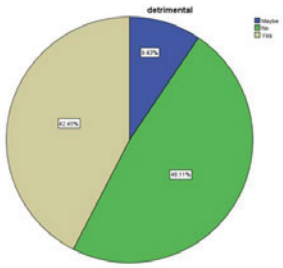

Figure 2(a) : Pie chart represents that hand hygiene products are detrimental to the skin, 42.45% responded as 'Yes' (buff), 48.11% responded as 'No' (green) and 9.43% responded as 'maybe' (blue).

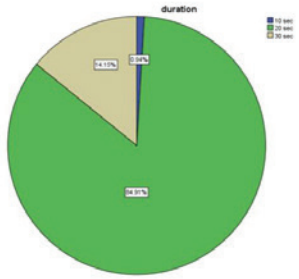

Figure 2(b) : Pie chart represents the duration for hand washing, 0.94% responded as 10 seconds (blue), 84.91% responded as 20 seconds (green) and 14.15% of dentists responded as 30 seconds (buff).

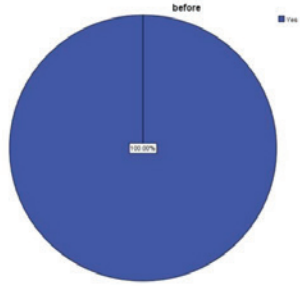

Figure 2(c) : Pie chart represents the necessity of maintenance of hand hygiene before patients contact, all the participants responded as 'yes' 100% (blue).

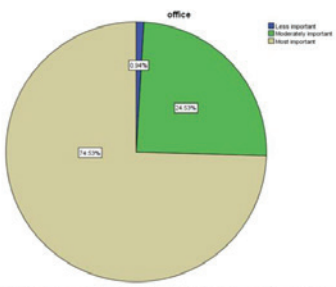

Figure 2(d) : Pie chart represents the maintenance of hand hygiene at dental offices, 74.8% responded as most important (buff) , 24.3% answered as moderately important (green) and 1% of dentists responded as less important (blue).

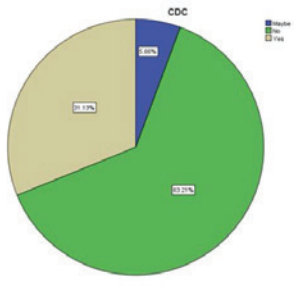

Figure 2(e) : Pie chart represents the CDC guidelines adversely affect the skin, 31.13% responded as 'yes' (buff), 63.21% responded as 'no' (green) and 5.66% of dentists responded as 'maybe'(blue).

Figure 2

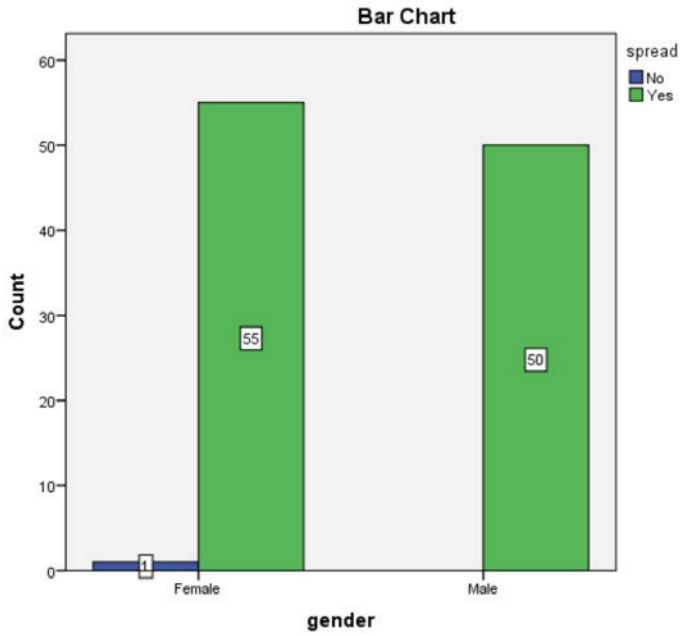

Figure 3: Bar graph depicting the association between gender and the awareness of hand hygiene to prevent the spread of infection; where blue denotes No and green denotes yes. X-axis represents the gender and Y-axis represents the number of respondents.Chi square test showing p = 0.342 (p > 0.05 indicating statistically not significant). So there is no significant association between gender and awareness on hand hygiene prevents the spread of infection.

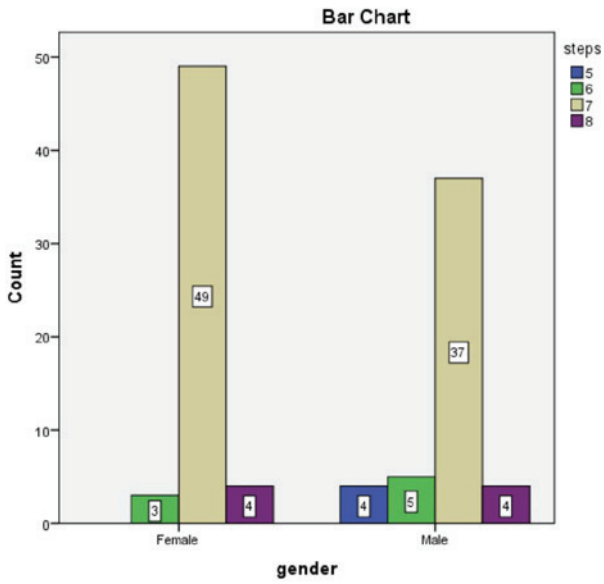

Figure 4: Bar chart depicting the association between gender and the steps involved in the hand hygiene protocol where blue denotes 5 steps , green denotes 6 steps , yellow denotes 7 steps and purple denotes 8 steps. X-axis represents the gender and Y-axis represents the number of respondents. Chi square test showed p = 0.119 (p >0.05 indicating statistically not significant). So there is no significant association between gender and the steps involved in the hand hygiene protocol.

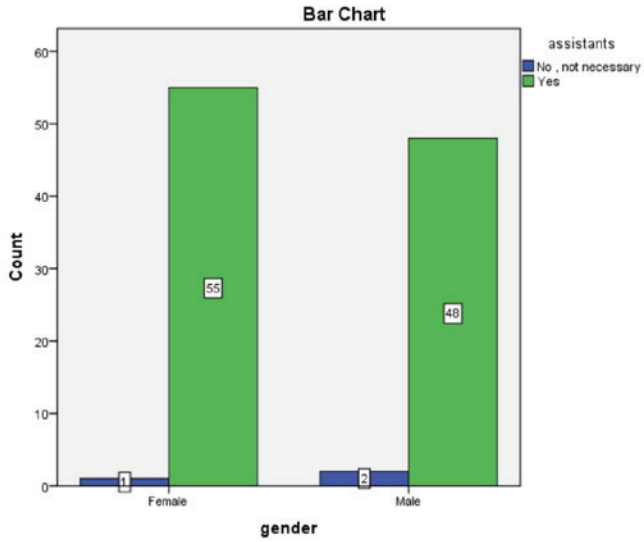

Figure 5: Bar chart depicting the association between gender and the awareness on necessity of hand hygiene among dental assistants where blue denotes No, not necessary and green denotes Yes necessary. X-axis represents the gender and Y-axis represents the number of respondents. Chi square test showing p = 0.493 , so (p > 0.05 indicating statistically not significant). So there is no significant association between gender and the awareness of the necessity of hand hygiene among dental assistants

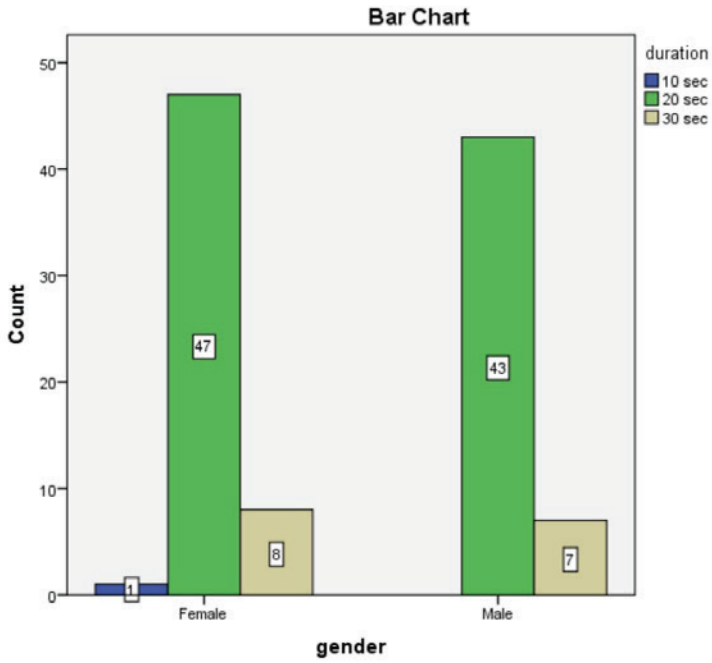

Figure 6: Bar chart depicting the association between gender and the awareness of duration taken for hand wash technique where blue denotes 10 seconds, green denotes 20 seconds, yellow denotes 30 seconds. X-axis represents the gender and Y-axis represents the number of respondents. Chi square test showing p = 0.635 (p >0.05 indicating statistically not significant). So there is no significant association between gender and the awareness of duration taken for hand wash technique

Annexure -I

S.no	Questions	Options
1.	Age	above 25
2.	Gender	Male/Female
3.	Have you attended a hand hygiene program before?	yes/ no
4.	Is contact the main route of transmission of potentially harmful germs to patients?	yes/no
5.	Do you think hand hygiene prevents the spread of infections to patients?	yes/No
6.	Do you believe that there is an association between hand hygiene and infection control?	yes/No
7.	Do hand nails hinder hand hygiene protocol?	yes/no/maybe
8.	How many steps of hand wash techniques are involved as per WHO	5/6/7/8
9.	Is it necessary to teach dental assistants on the Hand Wash technique?	yes/no
10.	Do you think hand hygiene products are detrimental to the skin?	yes/ no/ Maybe
11.	What is the duration of handwashing with soap and water?	20 secs/30 sec/10sec
12.	If you follow CDC hand hygiene guidelines, does it affect our skin?	yes/no/maybe
13.	Does hand rubbing & washing are performed in sequence?	yes/No
14.	Is it necessary to maintain hand hygiene before patient contact?	yes/ No/ Maybe
15.	How important is hand hygiene at your dental office?	Most important/ moderately important/ less important / not important at all

Conclusion

Hand hygiene is mandatory to prevent communicable diseases, especially in dental practice as the dentists are in close contact with patients. This survey could bring awareness about the need for hand hygiene to the readers as well as to dentists.

Acknowledgement : The authors would like to thank the participants of this survey for spending their valuable time.

Conflict of Interest: Authors declare no potential conflict of interest.

Source of Funding: Self

Ethical Clearance: Not Required

References

1. Girou E, Chai SHT, Oppein F, Legrand P, Ducellier D, Cizeau F, et al. Misuse of gloves: the foundation for poor compliance with hand hygiene and potential for microbial transmission? J Hosp Infect [Internet]. 2004 Jun;57(2):162–9. Available from: http://dx.doi.org/10.1016/j.jhin.2004.03.010
2. World Health Organization. WHO Guidelines on Hand Hygiene in Health Care: First Global Patient Safety Challenge : Clean Care is Safer Care [Internet]. World Health Organization; 2009. 262 p. Available from: https://books.google.com/books/about/WHO_Guidelines_on_Hand_Hygiene_in_Health.html?hl=&id=qtGTQAAACAAJ
3. Erasmus V, Daha TJ, Brug H, Richardus JH, Behrendt MD, Vos MC, et al. Systematic review of studies on compliance with hand hygiene guidelines in hospital care. Infect Control Hosp Epidemiol [Internet]. 2010 Mar;31(3):283–94. Available from: http://dx.doi.org/10.1086/650451
4. Littau CA, Thompson KM. Investigation of the Effects of Consumer Market Lotions vs. Professional Grade Lotions in Combination with Alcohol Hand Antiseptics: A Comparative Study of Skin Health Effects and Glove Barrier Integrity [Internet]. Vol. 35, American Journal of Infection Control. 2007. p. E146. Available from: http://dx.doi.org/10.1016/j.ajic.2007.04.138
5. Fluent MT. Hand hygiene in the dental setting: reducing the risk of infection. Compend Contin Educ Dent [Internet]. 2013 Sep;34(8):624–7. Available from: https://www.ncbi.nlm.nih.gov/pubmed/24564616
6. Myers R, Larson E, Cheng B, Schwartz A, Da Silva K, Kunzel C. Hand hygiene among general practice dentists: a survey of knowledge, attitudes and practices. J Am Dent Assoc [Internet]. 2008 Jul;139(7):948–57. Available from: http://dx.doi.org/10.14219/jada.archive.2008.0282
7. Naik S, Khanagar S, Kumar A, Vadavadagi S, Neelakantappa HM, Ramachandra S. Knowledge, attitude, and practice of hand hygiene among dentists practicing in Bangalore city - A cross-sectional survey. J Int Soc Prev Community Dent [Internet]. 2014 Sep;4(3):159–63. Available from: http://dx.doi.org/10.4103/2231-0762.142013
8. Darawad MW, Al-Hussami M, Almhairat II, Al-Sutari M. Investigating Jordanian nurses' handwashing beliefs, attitudes, and compliance. Am J Infect Control [Internet]. 2012 Sep;40(7):643–7. Available from: http://dx.doi.org/10.1016/j.ajic.2011.08.018
9. Patarakul K, Tan-Khum A, Kanha S, Padungpean D, Jaichaiyapum O-O. Cross-sectional survey of hand-hygiene compliance and attitudes of health care workers and visitors in the intensive care units at King Chulalongkorn Memorial Hospital. J Med Assoc Thai [Internet]. 2005 Sep;88 Suppl 4:S287–93. Available from: https://www.ncbi.nlm.nih.gov/pubmed/16623043
10. Farhoudi F, Sanaei Dashti A, Hoshangi Davani M, Ghalebi N, Sajadi G, Taghizadeh R. Impact of WHO Hand Hygiene Improvement Program Implementation: A Quasi-Experimental Trial. Biomed Res Int [Internet]. 2016 Nov 23;2016:7026169. Available from: http://dx.doi.org/10.1155/2016/7026169
11. Dey NC, Parvez M, Islam MR, Mistry SK, Levine DI. Effectiveness of a community-based water, sanitation, and hygiene (WASH) intervention in reduction of diarrhoea among under-five children: Evidence from a repeated cross-sectional study (2007-2015) in rural Bangladesh. Int J Hyg Environ Health [Internet]. 2019 Sep;222(8):1098–108. Available from: http://dx.doi.org/10.1016/j.ijheh.2019.08.006
12. Allegranzi B, Pittet D. Role of hand hygiene in healthcare-associated infection prevention [Internet]. Vol. 73, Journal of Hospital Infection. 2009. p. 305–15. Available from: http://dx.doi.org/10.1016/j.jhin.2009.04.019
13. Jing JLJ, Pei Yi T, Bose RJC, McCarthy JR, Tharmalingam N, Madheswaran T. Hand Sanitizers: A Review on Formulation Aspects, Adverse Effects, and Regulations. Int J Environ Res Public Health [Internet]. 2020 May 11;17(9). Available from: http://dx.doi.org/10.3390/ijerph17093326
14. Hewlett AL, Hohenberger H, Murphy CN, Helget L, Hausmann H, Lyden E, et al. Evaluation of the bacterial burden of gel nails, standard nail

polish, and natural nails on the hands of health care workers. Am J Infect Control [Internet]. 2018 Dec;46(12):1356–9. Available from: http://dx.doi.org/10.1016/j.ajic.2018.05.022

15. Wałaszek MZ, Kołpa M, Różańska A, Jagiencarz-Starzec B, Wolak Z, Wójkowska-Mach J. Nail microbial colonization following hand disinfection: a qualitative pilot study. J Hosp Infect [Internet]. 2018 Oct;100(2):207–10. Available from: http://dx.doi.org/10.1016/j.jhin.2018.06.023
16. Tschudin-Sutter S, Sepulcri D, Dangel M, Ulrich A, Frei R, Widmer AF. Simplifying the World Health Organization Protocol: 3 Steps Versus 6 Steps for Performance of Hand Hygiene in a Cluster-randomized Trial [Internet]. Vol. 69, Clinical Infectious Diseases. 2019. p. 614–20. Available from: http://dx.doi.org/10.1093/cid/ciy948
17. Tyagi M, Hanson C, Schellenberg J, Chamarty S, Singh S. Hand hygiene in hospitals: an observational study in hospitals from two southern states of India. BMC Public Health [Internet]. 2018 Nov 27;18(1):1299. Available from: http://dx.doi.org/10.1186/s12889-018-6219-6
18. Doronina O, Jones D, Martello M, Biron A, Lavoie-Tremblay M. A Systematic Review on the Effectiveness of Interventions to Improve Hand Hygiene Compliance of Nurses in the Hospital Setting. J Nurs Scholarsh [Internet]. 2017 Mar;49(2):143–52. Available from: http://dx.doi.org/10.1111/jnu.12274
19. Ahmed J, Malik F, Memon ZA, Bin Arif T, Ali A, Nasim S, et al. Compliance and Knowledge of Healthcare Workers Regarding Hand Hygiene and Use of Disinfectants: A Study Based in Karachi. Cureus [Internet]. 2020 Feb 18;12(2):e7036. Available from: http://dx.doi.org/10.7759/cureus.7036
20. Schrank CL, Minbiole KPC, Wuest WM. Are Quaternary Ammonium Compounds, the Workhorse Disinfectants, Effective against Severe Acute Respiratory Syndrome-Coronavirus-2? ACS Infect Dis [Internet]. 2020 May 15; Available from: http://dx.doi.org/10.1021/acsinfecdis.0c00265
21. Graham M. Frequency and duration of handwashing in an intensive care unit [Internet]. Vol. 18, American Journal of Infection Control. 1990. p. 77–81. Available from: http://dx.doi.org/10.1016/0196-6553(90)90085-7
22. Pires D, Soule H, Bellissimo-Rodrigues F, de Kraker MEA, Pittet D. Antibacterial efficacy of handrubbing for 15 versus 30 seconds: EN 1500-based randomized experimental study with different loads of Staphylococcus aureus and Escherichia coli. Clin Microbiol Infect [Internet]. 2019 Jul;25(7):851–6. Available from: http://dx.doi.org/10.1016/j.cmi.2018.10.012
23. Saitoh A, Sato K, Magara Y, Osaki K, Narita K, Shioiri K, et al. Improving Hand Hygiene Adherence in Healthcare Workers Before Patient Contact: A Multimodal Intervention in Four Tertiary Care Hospitals in Japan. J Hosp Med [Internet]. 2020 May;15(5):262–7. Available from: http://dx.doi.org/10.12788/jhm.3446
24. Pittet D, Allegranzi B, Sax H, Dharan S, Pessoa-Silva CL, Donaldson L, et al. Evidence-based model for hand transmission during patient care and the role of improved practices. Lancet Infect Dis [Internet]. 2006 Oct;6(10):641–52. Available from: http://dx.doi.org/10.1016/S1473-3099(06)70600-4
25. Sebastiani FR, Dym H, Kirpalani T. Infection Control in the Dental Office [Internet]. Vol. 61, Dental Clinics of North America. 2017. p. 435–57. Available from: http://dx.doi.org/10.1016/j.cden.2016.12.008
26. Ashwini S, Ezhilarasan D, Anitha R. Cytotoxic Effect of Caralluma fimbriata Against Human Colon Cancer Cells [Internet]. Vol. 9, Pharmacognosy Journal. 2017. p. 204–7. Available from: http://dx.doi.org/10.5530/pj.2017.2.34
27. Perumalsamy H, Sankarapandian K, Veerappan K, Natarajan S, Kandaswamy N, Thangavelu L, et al. In silico and in vitro analysis of coumarin derivative induced anticancer effects by undergoing intrinsic pathway mediated apoptosis in human stomach cancer. Phytomedicine [Internet]. 2018 Jul 15;46:119–30. Available from: http://dx.doi.org/10.1016/j.phymed.2018.04.021
28. Lakshmi T, Krishnan V, Rajendran R, Madhusudhanan N. Azadirachta indica : A herbal panacea in dentistry - An update [Internet]. Vol. 9, Pharmacognosy Reviews. 2015. p. 41. Available from: http://dx.doi.org/10.4103/0973-7847.156337

29. Ezhilarasan D, Lakshmi T, Vijayaragavan R, Bhullar S, Rajendran R. Acacia catechu ethanolic bark extract induces apoptosis in human oral squamous carcinoma cells [Internet]. Vol. 8, Journal of Advanced Pharmaceutical Technology & Research. 2017. p. 143. Available from: http://dx.doi.org/10.4103/japtr.japtr_73_17

30. Ezhilarasan D, Lakshmi T, Nagaich U, Vijayaragavan R. Acacia catechu ethanolic seed extract triggers apoptosis of SCC-25 cells [Internet]. Vol. 13, Pharmacognosy Magazine. 2017. p. 405. Available from: http://dx.doi.org/10.4103/pm.pm_458_16

31. Anitha R, Ashwini S. Antihyperglycemic activity of Caralluma fimbriata: An In vitro approach [Internet]. Vol. 13, Pharmacognosy Magazine. 2017. p. 499. Available from: http://dx.doi.org/10.4103/pm.pm_59_17

32. Mehta M, Deeksha, Tewari D, Gupta G, Awasthi R, Singh H, et al. Oligonucleotide therapy: An emerging focus area for drug delivery in chronic inflammatory respiratory diseases [Internet]. Vol. 308, Chemico-Biological Interactions. 2019. p. 206–15. Available from: http://dx.doi.org/10.1016/j.cbi.2019.05.028

33. Gheena S, Ezhilarasan D. Syringic acid triggers reactive oxygen species–mediated cytotoxicity in HepG2 cells [Internet]. Vol. 38, Human & Experimental Toxicology. 2019. p. 694–702. Available from: http://dx.doi.org/10.1177/0960327119839173

34. Karthiga P, Rajeshkumar S, Annadurai G. Mechanism of Larvicidal Activity of Antimicrobial Silver Nanoparticles Synthesized Using Garcinia mangostana Bark Extract [Internet]. Vol. 29, Journal of Cluster Science. 2018. p. 1233–41. Available from: http://dx.doi.org/10.1007/s10876-018-1441-z

35. Rajeshkumar S, Agarwal H, Venkat Kumar S, Lakshmi T. Brassica oleracea Mediated Synthesis of Zinc Oxide Nanoparticles and its Antibacterial Activity against Pathogenic Bacteria [Internet]. Vol. 30, Asian Journal of Chemistry. 2018. p. 2711–5. Available from: http://dx.doi.org/10.14233/ajchem.2018.21562

36. Menon S, Ks SD, R S, S R, S VK. Selenium nanoparticles: A potent chemotherapeutic agent and an elucidation of its mechanism. Colloids Surf B Biointerfaces [Internet]. 2018 Oct 1;170:280–92. Available from: http://dx.doi.org/10.1016/j.colsurfb.2018.06.006

37. Rajeshkumar S, Kumar SV, Ramaiah A, Agarwal H, Lakshmi T, Roopan SM. Biosynthesis of zinc oxide nanoparticles usingMangifera indica leaves and evaluation of their antioxidant and cytotoxic properties in lung cancer (A549) cells. Enzyme Microb Technol [Internet]. 2018 Oct;117:91–5. Available from: http://dx.doi.org/10.1016/j.enzmictec.2018.06.009

38. Sharma P, Mehta M, Dhanjal DS, Kaur S, Gupta G, Singh H, et al. Emerging trends in the novel drug delivery approaches for the treatment of lung cancer [Internet]. Vol. 309, Chemico-Biological Interactions. 2019. p. 108720. Available from: http://dx.doi.org/10.1016/j.cbi.2019.06.033

39. Ezhilarasan D. Oxidative stress is bane in chronic liver diseases: Clinical and experimental perspective [Internet]. Vol. 19, Arab Journal of Gastroenterology. 2018. p. 56–64. Available from: http://dx.doi.org/10.1016/j.ajg.2018.03.002

40. Ezhilarasan D, Sokal E, Najimi M. Hepatic fibrosis: It is time to go with hepatic stellate cell-specific therapeutic targets [Internet]. Vol. 17, Hepatobiliary & Pancreatic Diseases International. 2018. p. 192–7. Available from: http://dx.doi.org/10.1016/j.hbpd.2018.04.003