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ORIGINAL

Inculcating Hand Hygiene Practices Among Budding Dentists: A Multidisciplinary Requirement

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Abstract

Introduction: Hands are the major source of transmission of harmful germs in health care settings. Cross-transmission of microorganisms can be prevented by hand hygiene decreasing the incidence of Healthcare Associated Infections (HAI). Hand hygiene (HH) in dental practice is a crucial part of the infection control strategy. Dental participants are at a greater risk of transmission of germs and must comply with scientifically accepted and evidence-based principles of infection control. There is a requirement to explore the concept of hand hygiene among the dental participants. Aim of the study was to determine knowledge on internationally recommended hand hygiene practices among dental undergraduate students and to analyze impact of training on hand hygiene practices among dental undergraduate students. **Methods**: This interventional study was conducted in two phases. Phase 1 for evaluating Baseline knowledge, Phase 2 for awareness sessions on internationally recommended hand hygiene guidelines followed by observation on compliance to hand hygiene guidelines. The analysis was performed using descriptive statistics, ANOVA test and correlation analysis. **Results**: Overall knowledge on hand hygiene in phase I was 46.8%. Statistically significant difference (p=0.000) was in knowledge about hand hygiene among participants after training. DPMO (Defects Per Million Opportunities) was found to be 2.67 lakhs corresponding to six sigma level 2.12. **Conclusion**: Study identifies various causes of improper and inadequate Hand hygiene practices. Educational institutes need to strive to build work culture achieving sig sigma and internalization of Hand hygiene practices for a long lasting impact on the society. Organizations need to adopt multiple scientifically proven strategies like quality improvement tools, curricular amendment, infrastructure changes and leadership based motivation to achieve higher levels.

Keywords: hand hygiene, hand wash, dental infections, healthcare associated infections, training, curriculum, quality tools, Six Sigma, infection control, motivation, hospital, healthcare.

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Introduction

For centuries hand washing with soap and water has been considered a significant measure of personal hygiene. It was identified in the mid-1800s that transmission of hospital-acquired diseases occurred through the hands of health care workers. In 1847, Semmelweiss hypothesized that "cadaverous particles" were transmitted via hands of students and doctors from the autopsy room to the delivery room resulting in puerperal fever [1].

In 1995-1996, the Centre for Disease Control and Prevention (CDC); Healthcare Infection Control Practices Advisory Committee (HICPAC), USA recommended the use of either antimicrobial soap or a waterless antiseptic agent for cleansing hands after leaving the patient rooms [2,3]. In 2000, Pittet et al. reported remarkable improvement in hand hygiene compliance and reduction in Healthcare Associated Infections (HAI) [4]. The CDC/ HICPAC guidelines issued in 2002 defined alcohol-based handrubbing as the standard of care for hand hygiene practices in health-care settings. However, in many other countries, handwashing is still considered the standard of care and alcohol-based handrub is reserved for particular situations only (i.e. emergency, no sinks available) [5,6].

In year 2009, Hand hygiene originated as a global effort with the 'Save Lives: Clean Your Hands' campaign - an extension programme of WHO 'Clean Care is Safer Care' strategy for infection control [7-9]. World Health Organization (WHO) designed the 'My five moments of hand hygiene' – including two before care and three after care moments. These five moments of hand

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hygiene include washing and cleaning of hand :

1. Before touching a patient,
2. Before clean/aseptic procedures,
3. After body fluid exposure/risk,
4. After touching a patient and
5. After touching patient surroundings [10].

Hands are the major source of transmission of harmful germs in health care settings [11,12]. Hand Hygiene (HH) in dental practice is a crucial part of the infection control strategy [13]. Dentists are at a higher risk of getting infected themselves since the risk of cross infection is high due to characteristics of dental settings [14]. This enhances danger of exposure to pathogens [15]. Hand hygiene got highlighted as crucial COVID-19 preventive measure [11,12]. COVID-19 pandemic emerged as a major setback for unaware dental practitioners and generated an innate need to adopt safe practices for infection prevention.

Need for Study

Several studies have reported lower knowledge, attitude and observance of hand hygiene by the undergraduate students [16-20] and lower compliance among healthcare workers [21]. Some of them addressed hand hygiene practice on college campuses primarily as observation cross sectional studies [22]. Neither of study was conducted to assess the impact of in-house training on hand hygiene practices. This study aims to determine the level of knowledge regarding internationally recommended hand hygiene practices among dental undergraduate students and to analyze the impact of training on their hand hygiene practices.

Material and methods

Study design

This study was conducted at a leading private dental college in northern India. This interventional study was conducted in two phases.

Phase 1: Baseline knowledge evaluation.

Phase 2: Awareness sessions on internationally recommended hand hygiene guidelines followed by observation on compliance guidelines.

Study Population

Study population comprised of 1st, 2nd, 3rd, 4th yr students and interns. List of all students and interns was obtained from the college. They were approached during their free time and explained about the nature and content of the study. They were informed that participation in study was voluntary and confidentially of responses was assured. A written consent was obtained from each participant before filling questionnaire.

Inclusion/Exclusion Criteria

Those willing to participate and provide consent were included. Those who were not willing to participate and provide consent were not included.

Out of 351 eligible participants, 308 participated in study (few were absent or did not submit distributed questionnaire). Incomplete questionnaires (n =19) were excluded from analysis and final analysis was done on 289 respondents.

Ethical statement /IEC approval

Ethical approval for the conduct of study was obtained from institutional ethical committee with ref no. DC/2019.

Study procedure and interventions

Phase 1: Baseline knowledge evaluation was conducted between December 2018 and April 2019. During this phase knowledge on internationally recommended hand hygiene guidelines among dental undergraduate students was assessed. Self-assessment based multiple choice questionnaire (12 questions) was prepared after due consultation with senior professors and subject experts.

Phase 2: Awareness sessions were conducted for participants (students and interns) on WHO hand hygiene guidelines. Guidelines on hand wash steps as per WHO were displayed at various prominent places. This phase was conducted at one of the eight departments selected by choice for having higher risk of HAI.

Interns during their rotational clinical posting were observed for compliance to WHO hand Hygiene requirements between July 2019 and February 2020 against the predefined criterion of HH being performed for each of the 5 moments. Everyday half an hour was randomly selected to observe hand hygiene being performed as per guideline. Term 'Opportunity' was defined as each of the 5 moments when participant was supposed to perform hand hygiene. Participants were observed for hands wash/hand rub being performed for all the applicable 5 moments of hand hygiene. A predefined checklist was prepared in tabulated format. Every time hand hygiene was performed (when applicable), '1' unit score was assigned for such moment and each time candidate missed to perform hand hygiene '0' score was assigned against that moment. Sum of scores of all observations was taken as numerator and count of all observations was taken a denominator.

Percentage compliance was calculated as below.

$$\textbf{Percentage compliance}_{\text{(Hand hygiene)}} = \frac{\text{Sum of scores}}{\text{Count of scores}} \times 100$$

Reliability and validity

Reliability and validity of the study questionnaire was assessed. Cronbach's alpha **(alfa coefficient)** was calculated as a measure of internal consistency. It was found to be 0.830.

Statistical analysis

The information obtained from the questionnaires was fed in spread sheet and analyzed using SPSS 20 (IBM, NY, USA). Each correct response was assigned 1 point and incorrect response was assigned 0 point. The analysis was performed using descriptive statistics, correlation between variables were tested using Pearson's correlation and ANOVA test followed by post hoc test was used for multiple comparisons among various groups. The p-value of 0.05 was considered to be statistically significant.

Results

Study groups comprised of all the students (1st, 2nd, 3rd, 4th year students) and interns. Out of 351 participants 289 participated in study with a response rate of 82%. Participants included 1st year students 26% (n=75), 2nd year students 22% (n=64), 3rd year students 11% (n=30), 4th year 1 students 9% (n=56) and interns 22% (n=64) as per proportions shown in Figure 1. Gender wise distribution included 89% (n=256) female participants and 11% (n=33) male participants (Figure 2).

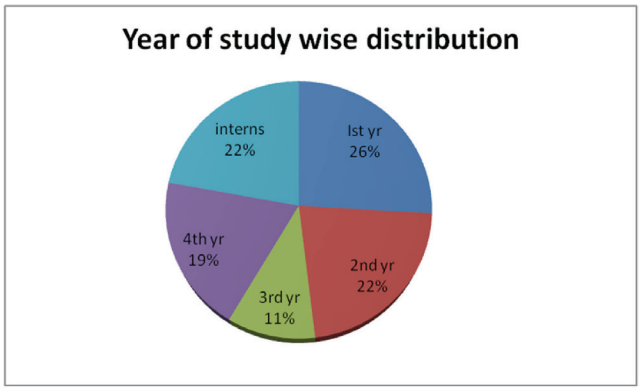


Figure 1: Year of study wise distribution

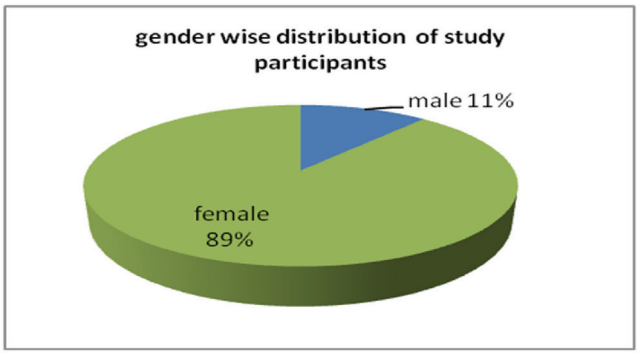


Figure 2: Gender wise distribution of study participants

WHO guidelines recommend that minimum contact time for hand rub is 20 sec and maximum is 30 sec time [5]. In our study only (62/289) 21.4% participants responded correctly as 20 sec. Knowledge regarding proper technique proposed by WHO for hand wash was found in (201/289) 70% participants. There was significant variation p=0.024 and p=0.000 among study participants regarding knowledge of correct time and right technique for hand wash.

About (167/289) 57.7% participants responded that hands should be dry before care, (107/289) 37% responded that hands can be dried with a towel after using hand rub and (13/289) 4.5% responded that hands should be dripped with alcohol. Only 17% preferred to use gloves depending on the case and 83% participants preferred to use gloves during each patient examination shown in Table1.

Regarding awareness of five moments of hand hygiene, (220/289) 76% was observed for moments like hand hygiene before touching a patient and (246/289) 85%. Immediately after a risk of body fluid exposure After exposure to immediate surroundings of a patient, (127/289) 43%. Immediately before a clear/ aseptic procedure, (190/289) 65%. After touching a patient (107/289) 37% (Figure 3).

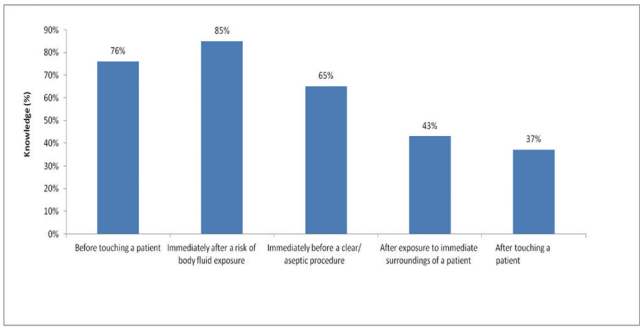


Figure 3: Awareness of five moments of hand hygiene

Awareness/knowledge about hand washing with soap and water versus hand rubbing with an alcohol-based hand rub was tested. Only (34/289) 11.7% participants correctly responded that hand rubbing is more rapid than hand washing, whereas, (27/289) 9.3% responded that hand rubbing cause more skin dryness than hand washing and , (62/289) 21.4% responded that hand rubbing is more effective against protection from germs than hand washing and (177/289) 61.2% responded that hand washing and hand rubbing are recommended to be performed in sequence shown in figure 4. In phase I overall knowledge among participants was 46.8%.

Half of the study participants, (149/289) 51% had received formal training in hand hygiene in the past. Statistically significant

Table 1: Knowledge of hand hygiene among participants (n=289)

1.	**What is the minimal time needed for alcohol- based hand rub to kill most germs on your hands?**	**%**
a.	3 s	3.8%
b.	10 s	47%
c.	1 min	27%
d.	20 s	21.4%
2.	Knowledge regarding proper technique proposed by WHO for hand wash	
a.	yes	70%
b.	no	30%
3.	Which of following statements are true?	
a.	hands should be dry before care,	57.7%
b.	hands can be dried with a towel after using hand rub	37%
c.	hands should be dripped with alcohol	4.5%
4.	How do you prefer to touch/examine the patient?	
a.	Depends on the Case	17%
b.	Gloves	83%

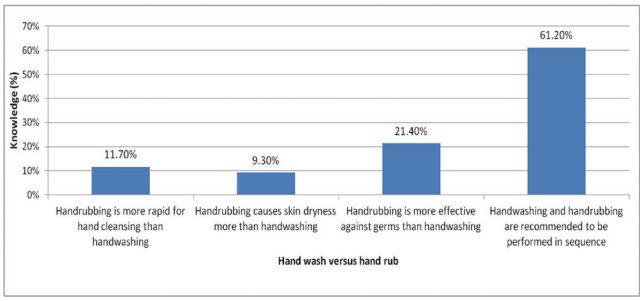


Figure 4: knowledge of hand was versus hand rub among study participants

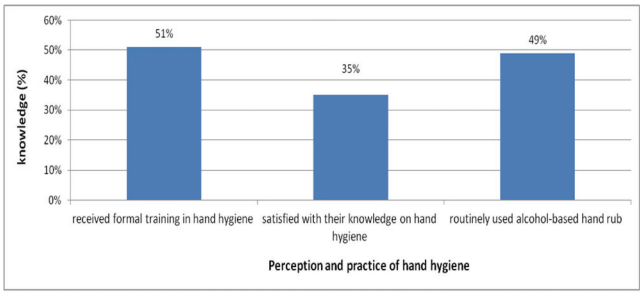


Figure 5: Practice of hand hygiene among study participants

correlation 0.000 (Pearson's). 492** was found between formal training and knowledge levels at 0.01 level of confidence. However smaller proportion of participants, (102/289) 35% were satisfied with their knowledge on hand hygiene. Half of study (144/289) 49% participants expressed that they routinely used alcohol based hand rub in their clinical rotations and during patient care (Figure 5).

Statistically significant difference (p=0.000) was found in overall knowledge among participants and year of education (Table 1).

Multiple comparison analysis of overall knowledge of various parameters showed a statistically significant difference (p value < 0.005) among students in different years of study (Table 2).

Overall knowledge on hand hygiene in phase 1 was 46.8%. Phase 2 was planned to provide training followed by observations feeding in spread sheet and analysis. Table 3 shows percentage compliance on monthly basis displayed as line graph (Fig.5) providing pictorial representation of gap and monthly variation. It is to be noted that

Table1: Analysis of variance (ANOVA) of knowledge among participants and year of education

Variable	Sum of Squares	df	Mean Square	F	P value
Between Groups	124.342	4	31.086	11.401	0.000
Within Groups	774.371	284	2.727		
Total	898.713	288			

Table 2: Multiple comparisons of knowledge among participants depending on year of dental education, using analysis of variance (ANOVA)

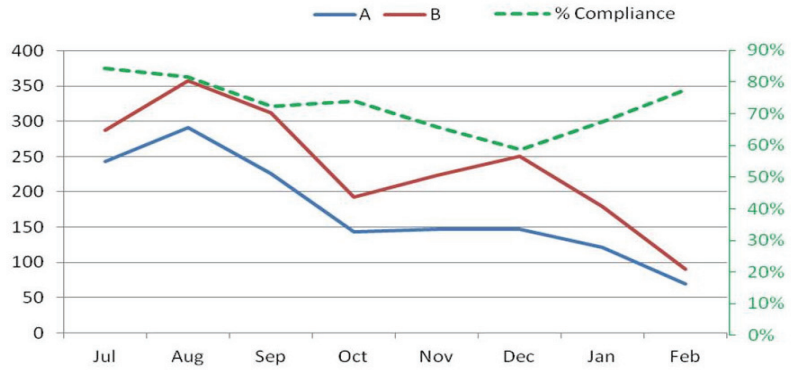
Multiple Comparisons					
Dependent Variable: overall					
	(I) year	**(J) year**	**Mean Difference (I-J)**	**Std. Error**	**P value**
Tukey HSD	First	Second	-0.066	0.281	0.999
		Third	0.067	0.357	1.0
		Fourth	-0.568	0.292	0.295
		Interns	-1.644*	0.281	0.0
	Second	First	0.066	0.281	0.999
		Third	0.132	0.365	0.996
		Fourth	-0.502	0.302	0.459
		Interns	-1.578*	0.292	0.0
	Third	First	-0.067	0.357	1.0
		Second	-0.132	0.365	0.996
		Fourth	-0.635	0.374	0.437
		Interns	-1.710*	0.365	0.0
	Fourth	First	0.568	0.292	0.295
		Second	0.502	0.302	0.459
		Third	0.635	0.374	0.437
		Interns	-1.076*	0.302	0.004
	Interns	First	1.644*	0.281	0.0
		Second	1.578*	0.292	0.0
		Third	1.710*	0.365	0.0
		Fourth	1.076*	0.302	0.004

*p value ≤ 0.005

Table 3: Percentage compliance with respect to hand hygiene based on 5 moments of hand hygiene as defined by WHO.

Month/year	HH actually performed #	HH opportunities *	Percentage compliance
Jul-19	243	288	84%
Aug-19	291	357	82%
Sep-19	226	312	72%
Oct-19	143	193	74%
Nov-19	147	223	66%
Dec-19	147	251	59%
Jan-20	121	179	68%
Feb-20	70	90	78%
Total	**1388**	**1893**	**73%**

* Based on WHO defines 5 moments of WHO
# based on applicable 5 moments



A= Total: HH actually performed, B= Total: HH opportunities

Figure 5: line graph showing percentage improvement in hand hygiene knowledge

the set of participants changed every month as per the participant's rotation schedule.

Defects per Million Opportunities 'DPMO' (or nonconformities per million opportunities) is a measure of performance. In terms of hand-washing non-compliance, it is defined as:

DPMO= No of times HH being not performed *1000000/Total of opportunities for HH.

In the current study DPMO was found to be 2.67 lakhs corresponding to six sigma level 2.12.

Discussion

In our study 51% participants received formal training in hand wash in contrast to 85.4% by Kamble VS et al [23] and 79% by Sreejith Nair et al [17] but higher than findings (26.3% and 43%) by Glad Mahesh et al [24] and Modi PD et al [11]. These findings showed institutional variation to compliance. Overall knowledge on hand hygiene in phase 1 was 46.8%. Similar findings on knowledge (40%) were observed in other study conducted in Raichur, India [17] but in contrast to 12.2% of study carried in Bombay, India [11].

Regarding Five moments of hand hygiene higher awareness i.e. 76% was found with respect to moment (before touching a patient) similar to the findings (70.9 %) by Kamble VS et al [23] but less than findings (91.6%) by Sreejith Nair et al. [17] higher awareness (60%) was found for hand hygiene actions which prevent transmission of germs immediately before a clean/aseptic procedure than 20% of Kamble et al [25] and 80.3% by Sreejith Nair et al [17]. Awareness for hand hygiene actions which prevent transmission of germs after risk of body fluid exposure was 55% in present study participants in comparison to 69.1% of study by Kamble [42] and 22.9% by Mohesh [24]. In present study 45% responded correctly for knowledge of hand hygiene actions which prevent transmission of germs after the exposure to immediate surroundings of a patient in contrast to findings (58.1%) of a study carried in India [23].

Hand hygiene can be achieved by hand washing and hand rub, in our study 50% participants preferred alcohol-based hand rub, similar to the findings (58.1%) of another study [23] carried in Gulbarga, India and in contrast to findings (9%) of study [26] carried in west Bengal, India. In our study 21% participants responded that hand rubbing is more effective than hand washing as compared to findings (50.9% and 69.6%) [23-24] of studies in India. In one study by Kamble VS et al [23] 50.9% participants responded that Hand rubbing is less effective than washing and 21.8% responded that both hand washing and hand rubbing should not be performed in a sequence which are similar to present study findings i.e. 51% and 17%. in one study [24]. In present study 61% participants responded correctly that minimal time needed for alcohol-based hand rub to kill germs on hands is 20s and these are in contrast to results i.e. 38.1%, 38.3% of two studies [23,24]. In a study carried among dental participants in western India [27]

more than 76.8% participants used soap and water for maintenance of hand hygiene in contrast to 50% in present study. During patient care use of gloves protects hand from direct acquisition of pathogens [7].

Training during graduation and internship needs to be adequate for sensitization among students [28,29]. Organizations need to define a training team and empower trainers with information material so that they can educate students and staff through induction program regularly [30]. Education is most crucial interventional tool and faculty plays an imperative role educating and revamping unskilled to skilled professionals. Theoretical knowledge is achieved at the time of graduation is partly practiced clinically [31]. Lower knowledge can be attributed to the inadequacy in curriculum inadequate facilities, lack of training [31].

Hand hygiene compliance in phase 2 was analyzed. Episodic/single training and educational efforts lagged to achieve 100% compliance. Noncompliance observed could be attributed to organizational culture, lesser awareness on scientifically proven hand hygiene guidelines, insensitivity to HAI, inability to recognize hand hygiene opportunities, insensitivity to burden of HAI on patients [16-20].

Six sigma value of 2.12 showed gross deviation from expected compliance. RCA was attempted by brainstorming session. At the place of study, July to September are the summer months, winter starts from October and subsides by the month of March. Non-compliance was discussed with candidates and college authorities to explore the possible causes. At the time of study, only hand wash facility was provided by college and available for candidates. Alcohol rub was optional for them at their own expense. Decrease in compliance during colder months could be attributed to hand rub being not freely available and cold water for hand wash become a limiting factor.

In March 2020, COVID-19 pandemic changed the scenario and hand hygiene was identified the most important infection control measure. Layman to a professional and from child to elderly everyone started performing HH. Handrub started appearing in hospitals and homes in abundance. Situation forced authorities to make alcohol rub frequently available. It is pertinent to note that such rigorous Hand Hygiene practices adopted (identified regulation) were probably in response to threat of spread of infection from patient/third party to self. The alternative to improve the compliance is building of organization culture and to enhance the motivational levels of the employees. Motivation of healthcare providers plays an important role in adoption of new practices and needs to be focused upon by organizational leaders.[32] On probable explanation of adoption of HH practices during COVID times was threat to self and family rather than with the intent to prevent cross transmission from one patient to another.

Conclusion

Training during early stages of education is crucial to inculcate scientific practices into building habits. Hand hygiene practices need to be entrenched in the system and organizational culture. Such practices need to be included and focused upon by institutional infection control committee toward achievement of patient safety goals. The question that remains to be explored is how to make care provider equally responsive and compliant on HH practices for prevention of HAI to patients and achieving higher six sigma. Such compliance would thus require a multifaceted approach.

Organizations need to adopt scientifically proven quality tools for systematic focus with focus on following:

Infrastructure/ facility component: Access hand wash facilities, liberal hand rub material, ambient hand wash water temperature during extreme weather.

Information, Education and Communication: Posters as education material for students, faculty, hospital staff, Placard based reminder, create awareness among patients by education material such as videos, posters, patient's awareness activities.

Reinforcement: regular reinforcement sessions, audits and recognition for compliers. *Quality Control:* developing QC department, active monitoring of HAI, use of quality tools, root cause analysis, issues of advisory to respective practices.

Management focus: to build and support organizational culture which adopts and promotes HH practices to reduce HAI. Educational institutes additionally must strive to build work culture achieving higher sig sigma level and thus making student internalize the HH practices for a long-lasting impact on the budding professional and consequently on society.

To conclude organizations, need to adopt multiple scientifically proven strategies like quality improvement tools, curricular amendment, infrastructure changes and leadership-based motivation to achieve higher levels.

Scope and Limitations of the study

As the study was conducted in one dental institute results may not be generalizable to other dental education institutes.

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Conflict of Interest:	Author declare no COI
Ethics:	There is no ethical violation as it is based on voluntary anonymous interviews
Funding:	No external funding
Guarantor:	Dr. Sonu Gupta will act as guarantor of this article.

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