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Knowledge and practice of dental healthcare providers about disinfection of light curing units

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ABSTRACT

Aims: A light curing unit (LCU) is a heat-intolerant instrument. This study aimed to assess the knowledge and practice of dental healthcare providers about the disinfection of LCUs.

Methods: This cross-sectional study included 350 consented dental clinicians and clinical dental students from Dakshina Kannada district of Karnataka, India, for the questionnaire part of the study. Bacterial load and debris on the LCU tips were studied in 27 LCUs from different clinics and we studied the relationship between debris and bacterial load.

Results: The survey included 334 healthcare providers. Only 51.8% agreed that LCUs should be disinfected after every patient. A significant proportion of the participants (62.3%) had no information about the type of disinfectant used in the clinic. Microorganism cultures were positive in approximately 80% of the 27 LCUs evaluated. Most of the LCU tips (67%) had visible debris. The numbers of colony-forming units (CFU)/cm^2 on blood agar and mitis salivarius agar were 57.94±92.28 and 28.56±40.63, respectively. Culture positivity was significantly lower on LCU with visibly clean tips ($p<0.001$) (0.33±7.83 CFUs/cm^2 on blood agar and 0.78±1.39 CFUs/cm^2 on mitis salivarius agar).

Conclusions: This study showed insufficient knowledge and practice in reprocessing heat-sensitive semi-critical items among dental healthcare workers.

Introduction

The novel Coronavirus disease-2019 (COVID-19) outbreak, which started in 2019, has caused a public health emergency at a global level. The transmission of the 2019 Severe acute respiratory syndrome-Coronavirus-2 (SARS-CoV-2) mainly occurs through inhalation, ingestion, or mucosal contact with infected respiratory droplets, either through direct or indirect contact. The origin of droplets can be nasopharyngeal or oropharyngeal, frequently associated with saliva (1,2). Salivary secretion is a potential source for the transmission of SARS-CoV-2 because live viruses have been detected in the saliva specimens of patients with SARS-CoV-2 infection (3). The virus is thought to enter the saliva via the exchange of liquid droplets between the lower and upper respiratory tract, via crevicular fluid to blood, or through major and minor salivary glands (2).

Dental practice perpetually carries the risk of coronavirus transmission due to the following reasons; (i) frequent exposure to saliva and blood; (ii) very close proximity between patient and dental personnel during clinical procedures; and (iii) many dental procedures produce droplets and aerosols (2). Other than COVID-19, well-known diseases that can be potentially transmitted in a dental care facility are various viral infections (herpes, hepatitis, human immunodeficiency virus) and bacterial infections (tuberculosis, pseudomonas infections) (4). The prevention of cross-infection in the dental clinic is mandatory for patient care in dentistry. Hence, dentists and working staff should be aware of these infections, the route of transmission, and infection control protocols to be followed (5).

The instruments and devices used in dentistry can be categorized as critical (instruments that penetrate the soft tissue), semi-critical (non-sharp items that enter the oral cavity), or non-critical (items that have contact with intact skin) based on the risk of transmitting infections during their use and the required level of sterilization or disinfection (6). Semi-critical items contact with the mucous membrane but do not penetrate bone or soft tissues like mouth mirrors, impression trays, dental handpieces, and air-water syringe tips. These items are frequently contaminated by blood. Thus, they should be disposable or, if reused, sterilized. If sterilization is not feasible (e.g., heat-sensitive instruments), the use of a high-level disinfectant (HLD) is recommended (6).

A light curing unit (LCU) is used in dental practice to cure resin-based composites (7). It is a semi-critical item as it is introduced into the mouth and can get contaminated with saliva (8). Several methods of controlling infections on the tips of LCUs are available, including disinfectant wipes, autoclavable guides, pre-sterilized single-use plastic sheaths, and transparent disposable barriers to cover the LCU tip (9). Heat-sensitive LCU tips must be cold sterilized because they are semi-critical items and a potential source of nosocomial infections.

The COVID-19 pandemic has reminded dentists and other healthcare professionals to protect against the spread of infectious diseases diligently (2). Our ambition in this study was to increase awareness of the disinfection process of commonly used equipment in dental practice since proper disinfection techniques can reduce nosocomial infections. This study aimed to assess the knowledge and practice of dental healthcare providers about the disinfection of LCUs. Microbial loads on the LCU tips were also sought.

Methods

Study design and population

We conducted this cross-sectional study in 2015 in two parts. The first part consisted of a survey using a self-administered questionnaire. The second part consisted of culture studies on LCU tips.

Consented dental students with clinical exposure and dental clinicians from dentistry teaching hospitals and other dental clinics in Dakshina Kannada district of Karnataka, India, were included in the survey via convenience sampling. Finally, 350 participants working with an LCU were enrolled, including senior dental undergraduates, dental postgraduates, dental faculty, and private dental practitioners. Incomplete questionnaires were excluded from the analysis.

Institutional Ethical Committee approved the study protocol (protocol no: MCODS/I98/2013, date: 07.12.2013; and amended the protocol on 09.07.2020).

Questionnaire

A questionnaire was designed to evaluate the knowledge and practice of the participants about the disinfection of LCUs. The questionnaire consisted of 7 close-ended questions related to infection control while using an LCU (Figure 1). Incomplete questionnaires were excluded from the analyses.

Isolation of bacteria

We selected 27 LCUs from different clinics. Table 1 shows the type of LCUs. Swab cultures were prepared using mitis salivarius agar (HiMedia Ltd., India) and blood agar plates (HiMedia Ltd., India). Mitis salivarius agar is a selective medium for viridans streptococci, including *Streptococcus mutans, Streptococcus salivarius, Streptococcus mitis,* and *Streptococcus sanguis* from mixed flora. The plates were incubated with 5% CO_2 at 37 °C for 48 h. Blood agar is an enriched medium that facilitates the growth of all fastidious organisms. It is ideal to use this medium for isolating and counting commensal flora of the oral cavity like *Klebsiella* spp., *Enterococcus* spp., *Staphylococcus* spp., and *Candida* spp. (10). The plates were incubated at 37 °C for 48 h. The bacterial count was assessed using a colony counter and expressed in colony-forming units per square centimeter (CFU/cm^2).

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) Statistics for Windows, version 20.0 (IBM. Corp., Armonk, NY, 2011) was used for the data analysis. The distribution normality for continuous variables was tested using the Shapiro-Wilk test. Since the values were not normally distributed, Mann-Whitney U test was used to compare the variables. The significance threshold was set at 0.05.

Results

The questionnaire part of the study included 334 responses, including 205 undergraduate dental students, 72 dental postgraduates, and 57 dentists (Figure 1). Of the participants, 51.8% thought their LCU needed disinfection after every patient. Other responses were disinfection occasionally (18.3%), at the beginning of the day (15.5%), at the end of the day (8.1%), and never (6.3%).

Only 49.5% of the participants thought using a protective cover for the LCU was essential. Other responses were occasional covering (19.5%) or never (31%). In most clinics, the auxiliary staff (dental assistant/nurse, or housekeeping staff) were responsible for cleaning of LCU (81.1%). On the other hand, there were no specific dental health care practitioners (DHCPs) assigned to this duty in some sites. Of the participants, 79% thought they needed gloves while disinfecting the LCU.

The most commonly used disinfectant was alcohol-based (50%). A significant part of the participants (38.3%) were not aware of the disinfectant composition. Others used hydrogen peroxide, glutaraldehyde, or water-based disinfectants. Most participants (62.3%) had no information about the type of disinfectant used in their clinic. Only 27.3% selected the response that the disinfectant should have tuberculocidal properties. Less than a third of the participants (27.8%) thought there was no specific time for disinfection.

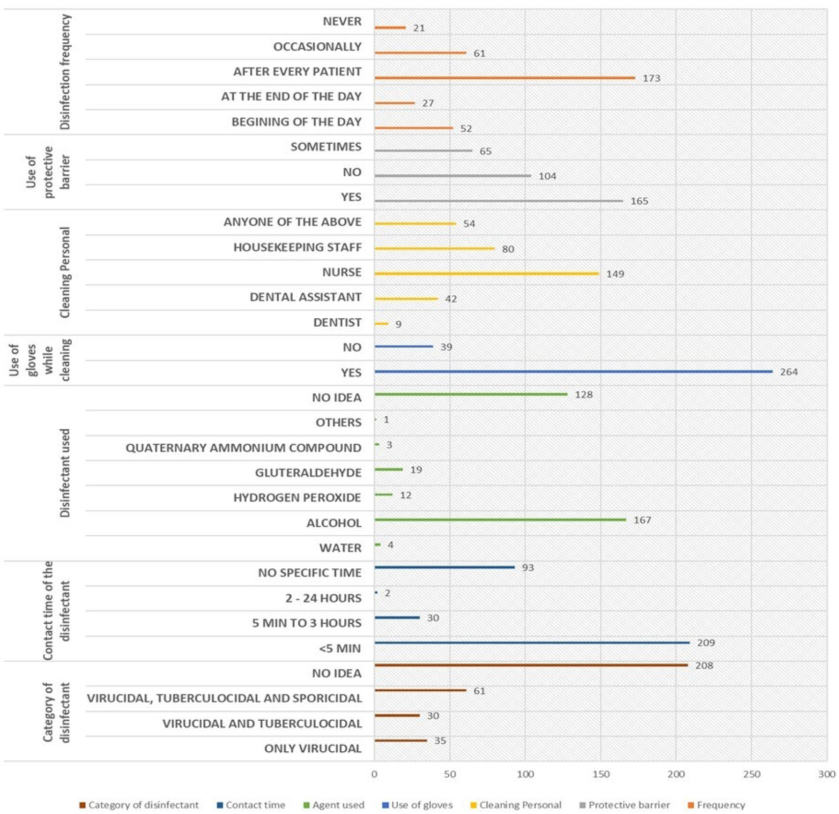

Figure 1. Frequency distribution of participants' knowledge and practice regarding the disinfection of the LCU
LCU: Light curing unit

Table 1. Characteristics of the dental LCUs assessed

Item	Observation	Number (%)
Type of operatory	Hospital attached dental clinic	22 (81.5)
	Private dental clinic	5 (18.5)
Tip debris status	Visible debris present	18 (66.7)
	Visible debris absent	9 (33.3)
Bacterial count on blood agar (no. of CFUs/cm^2)	No growth	5 (18.5)
	1-10 CFU/cm^2	7 (25.9)
	10-100 CFU/cm^2	11 (40.7)
	>100 CFU/cm^2	4 (14.8)
Bacterial count on mitis salivarius agar (no. of CFUs/cm^2)	No growth	6 (22.2)
	1-10 CFU/cm^2	12 (44.5)
	10-100 CFU/cm^2	8 (29.6)
	>100 CFU/cm^2	1 (3.7)

CFU: Colony forming unit, LCUs: Light curing units

Of the 27 LCUs visible debris was identified by 67%. Culture studies showed that around 80% of the LCU tips were contaminated (Table 1). Additionally, the bacterial counts in both the agar mediums were significantly higher on the LCU tips with visible debris (p<0.001) (Table 2). The most common microorganisms were *Staphylococcus* spp., members of viridans *Streptococci* like *Streptococcus mutans, Candida* spp., and a few coliforms.

Discussion

This study evaluated attitudes, knowledge, and practices of dental healthcare workers toward infection control practices about reprocessing semi-critical items. LCU, the heat-sensitive reusable semi-critical item in this study is used in everyday dental practice in the polymerization of photo-initiated dental materials (11). Since these devices are used intra-orally and can be contaminated with saliva and blood, they pose a risk of cross-infection (12,13). In the current scenario of the global pandemic, the need for clearer guidelines on infection control procedures in dental practice should be emphasized.

In our study, only half of the participants thought that there was a need to sterilize or disinfect the LCU after every patient, which may be related to why more than 80% of the LCUs tested showed microbial contamination. Janowalla et al. (13) detected bacterial contamination on approximately 40% of the LCUs before they were used, which was attributed by the authors to non-compliance with the recommended protocol. Such a major lapse in infection control practices (ICPs) needs to be addressed. In this regard, adequate education and training of DHCPs should be a priority (14,15). In our study, the auxiliary dental staff (dental assistant/nurse or housekeeping staff) was mainly responsible for disinfecting the LCU. Nevertheless, there was no specifically assigned DHCP at several sites, which could cause confusion among the working staff and lead to deficiencies in ICPs. Therefore, it is prudent that dentists and the auxiliary staff undergo compulsory task-specific education and training at regular intervals (14).

Based on the tolerance of the microorganisms to chemical disinfectants, it can resistance increases from the enveloped viruses (e.g., coronavirus) to vegetative bacteria (e.g., *Staphylococcus aureus*) fungi (e.g., *Candida*), non-enveloped-viruses (e.g., adenovirus, rhinovirus), mycobacteria (e.g., *Mycobacteria tuberculosis*) and highly resistant spores (e.g., *Clostridium difficile*). Concerning such a hierarchy of tolerance, if a disinfectant can inactivate resistant microorganisms such as mycobacteria, it should be able to inactivate the least resistant COVID-19 virus (16). The chemical disinfectants that inhibit or destroy the microorganisms include liquid chemical sterilants (those which destroy all microorganisms including bacterial spores), HLD (those which may destroy all microorganisms but not necessarily high numbers of bacterial spores; used for shorter immersion time), intermediate level disinfectant or hospital disinfectant with a tuberculocidal claim (those which may destroy vegetative bacteria, most fungi, and most viruses; inactivates *Mycobacterium tuberculosis var bovis*, but not necessarily capable of killing bacterial spores) and low-level disinfectant also referred to as hospital disinfectant without a tuberculocidal claim (those that destroy most vegetative bacteria, some fungi, and some viruses, but does not inactivate *Mycobacterium tuberculosis var bovis*) (6,17). Therefore, the presence of vegetative bacteria in most LCUs tested in this study is of major concern.

As per Centers for Disease Control and Prevention guidelines, if a reusable semi-critical device or item cannot be autoclaved, it should be processed at least with HLD (14). Most sporicidal HLDs, such as glutaraldehyde and peracetic acid, are highly toxic and can pose a risk to a DHCP (18). Additionally, soaking these high-tech devices in these aggressive chemicals can sometimes damage the equipment. Therefore, the best practice for reprocessing heat-intolerant expensive semi-critical items would be to use an appropriate disposable plastic sheath or barrier to avoid contamination. This must be supplemented with an intermediate-level disinfectant with tuberculocidal properties (14). In our study, less than half of the participants thought it was essential to cover the LCU with a protective barrier. Such a low frequency of using a clear plastic sheath was in accordance with the findings of Mitton and Wilson (11).

Interestingly, we showed that LCU tips with visible debris had a significantly high microbial load, suggesting that the accumulated debris interfered with the disinfection process. Hence, using an effective barrier on the tip could assist in reducing the debris on the LCU, thereby reducing the bacterial

Table 2. Comparison between soiled LCU tips and microbial colony counts

Type of agar culture plate used	Debris on the LCU tip	No. of LCU	No. of colony forming units/cm^2			z	p
			Mean±SD	Median (IQR)	Range		
Bacterial count on blood agar	Absent	9	3.33±7.83	0 (0.2)	0-24	-3.561	**<0.001**
	Present	18	57.94±92.28	29 (12.52)	1-386		
Bacterial count on mitis salivarius agar	Absent	9	0.78±1.39	0 (0.1)	0-4	-4.141	**<0.001**
	Present	18	28.56±40.63	12.5 (9.33)	3-174		

LCU: Light curing unit, SD: Standard deviation, IQR: Interquartile range count. Other than the tip of the device, microorganisms were frequently identified on the body of the equipment, including the on/off buttons, in agreement with the study by Janowalla et al. (13). Therefore, these areas must be wiped, disinfected, and covered with cling film before use.

According to the current survey, the use of alcohol-based disinfectants was common. However, many participants were not aware of the disinfectant compositions. More so, they were unaware of the nature of the disinfectant and the time required for adequate disinfection. The selection of disinfectants while reprocessing heat-sensitive semi-critical items should comply with the manufacturer's instruction manual. Any chemical used should be at least tuberculocidal, compatible with the item, and should not pose undue occupational exposure risks (15), which should include any of the commercial products registered under the Environmental Protection Agency having tuberculocidal action (19). The contact time and dilution should be consistent with the chemical manufacturer's instructions. Alcohol (ethanol/isopropyl) in a concentration of ≥70% or even dental bleach (a minimum of 5000 ppm available chlorine i.e., 0.5% sodium hypochlorite) can also be considered as an intermediate disinfectant (20-22). Concerning the SARS-CoV-2, 1000 ppm or 0.1% for surfaces and 10,000 ppm or 1% for blood spills, 0.5% hydroxy peroxide, and 62-71% ethanol may be effective within 60 seconds of contact time (23,24). Of note, instead of spraying directly onto the device, the disinfectant should be wrapped onto a cloth soaked in the disinfectant for the recommended time. The toxic/irritant residue needs to be rinsed off with sterile water and dried (18). The reprocessed semi-critical items should be wrapped (if possible) and stored in a secure place to protect them from environmental contamination. Also, they should be kept in closed drawers, cupboards, or lidded containers to protect them from aerosols and splatters (15).

As mentioned earlier, the most crucial aspect of preventing infection control-related disasters is education and training in infection prevention. The dental operators should have written infection prevention policies and procedures aligned with national and international evidence-based recommendations (16). Reprocessing of heat-sensitive semi-critical items has a narrower margin of safety, and any deviation from the reprocessing protocol can lead to the survival of microorganisms and an increased risk of infection (14). Therefore, to assist dental practitioners in developing an evidence-based strategy to reprocess reusable heat-intolerant semi-critical items, we propose a flow chart as Figure 2.

Study Limitations

The major limitation of this cross-sectional study was the time of the investigation. The assessment of knowledge and practice for disinfecting a reusable heat-intolerant semi-critical item was carried out much before the COVID-19 pandemic. On the other hand, although the scenarios were different concerning dental practice before and after the COVID-19 pandemic, there has been no major change in the guidelines concerning the disinfection protocols recommended for reusable heat-intolerant semi-critical items such as LCU tips and digital intraoral radiographic sensors. Hence, the validity of the questionnaire holds good even at this point.

This survey demonstrated insufficient knowledge and training regarding the disinfection of these items among dental healthcare providers and dental students. A note of caution is that the results would be different if the investigations were performed during the COVID-19 pandemic. This is because of the increased exposure of healthcare providers to information related to ICPs. However, there are post-COVID-19 studies demonstrated that dental health professionals and students still have insufficient knowledge of disinfection (25-27). Therefore, accurate information on disinfecting different surfaces and devices used in dental practice is imperative to prevent infections.

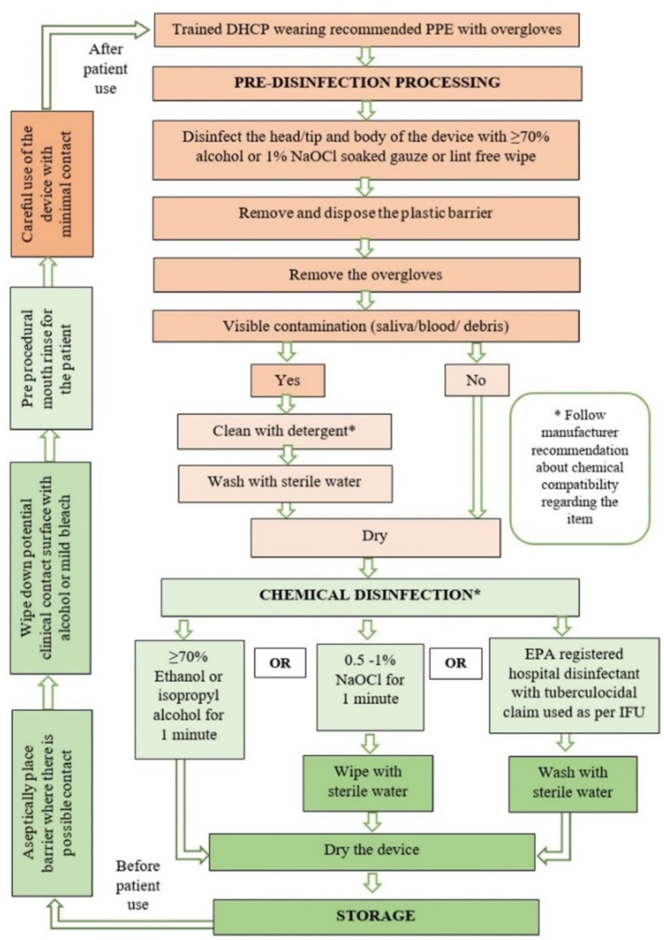

Figure 2. Recommendation for reprocessing heat-sensitive semi-critical items

DHCP: Dental health care practitioner, PPE: Personal protective equipment, IFU: Information for use, NaOCl: Sodium hypochlorite

Conclusion

The majority of the LCUs tested in this study demonstrated bacterial contamination. This could be related to the insufficient knowledge and practice of reprocessing heat-sensitive semi-critical items among dental healthcare workers. In these post-COVID-19 years, one should be more cautious in using such instruments since bacterial contamination can cause serious viral contamination. Hence, dentists and auxiliary staff must undergo compulsory task-specific education and training in infection control procedures at regular intervals.

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Ethics

Ethics Committee Approval: This cross-sectional study was conducted in 2015 after obtaining Institutional Ethical Committee clearance (protocol no: MCODS/I98/2013, date: 07.12.2013; and amended the protocol on 09.07.2020).

Informed Consent: A consent form was filled out by all participants.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: V.N.M., S.G., M.S.T., E.S., Concept: V.N.M., M.S.T., E.S., S.N., Design: V.N.M., M.S.T., E.S., S.N., Data Collection or Processing: V.N.M., S.G., M.S.T., Analysis or Interpretation: M.S.T., E.S., S.N., Literature Search: V.N.M., S.G., M.S.T., Writing: V.N.M., S.G., M.S.T., E.S.

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