

Research

Knowledge, Attitudes, Practices of Dental Professionals Regarding the Infection Control Guidelines for Dentistry Prior to the COVID-19 Pandemic

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Abstract

Purpose: The purpose of this study was to explore the knowledge, attitudes, practices and barriers faced by dental health care professionals (DHCP) regarding the Centers for Disease Control and Prevention (CDC) infection control guidelines in dental settings and summary (2003, 2016) prior to onset of the SARS-CoV-2 (COVID-19) pandemic.

Methods: A descriptive, cross-sectional study design was used to create a 42-item electronic survey. A convenience sample of dental assistants registered dental hygienists, and dentists (n=397) was recruited through professional dental social media groups, face-to-face recruitment, and snowball sampling. Descriptive statistics were used to analyze the data.

Results: The completion rate was 66.7% (n=265). The mean knowledge score for the CDC infection control guidelines was 58%. Less than half (39%) of the respondents were able to correctly identify hand hygiene as the most important measure in preventing the spread of infections among patients and DHCP. One third (33%) of the respondents were unaware of the CDC guidelines regarding respiratory hygiene/cough etiquette measures in dental settings. Participants indicated that the greatest barrier in following infection control guidelines was a heavy workload (37%), followed by time restraints (25%), and expense (15%).

Conclusion: Although DHCPs reported familiarity (perceived knowledge) with 2003/2016 CDC infection control guidelines in dentistry, their knowledge and practices were inadequate. This information may serve as a baseline for future consideration of infection control continuing education as a requirement for licensure, particularly given the impact of the COVID-19 pandemic.

Keywords: dental health care providers, infection control, knowledge, attitudes, infection control practices

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Introduction

One of the most noteworthy influences on the oral healthcare profession was the emergence of the human immunodeficiency virus (HIV) in 1981.¹ This epidemic transformed the clinical oral health care setting, leading to better understanding of disease transmission and prevention and a greater application of infection prevention and control measures in the dental setting.¹ Prior to the COVID-19 pandemic, dental healthcare professionals (DHCP) ensured infection control in dentistry by following the guidance of the Centers for Disease Control and Prevention (CDC). The CDC document, Guidelines for Infection Control in Dental Health Care Settings, 2003,² provided key recommendations

to prevent and control infectious disease transmission in dental settings. In 2016, the CDC published a summary guide based on the 2003 guidelines. This guide highlights the existing CDC recommendations on the basic infection prevention principles, reaffirms standard precautions as the foundation for preventing the transmission of infectious agents during patient care, and provides links to the full guidelines and source documents for more detailed background on the recommendations. Another feature of the 2016 summary document was more detailed descriptions and checklists regarding administrative measures for instrument processing and disinfection, infection prevention education and training,

respiratory hygiene and cough etiquette, dental unit waterline quality, and safe injection practices.³ While these resources have been free and readily available for all DHCP in the United States (US), research shows not all DHCP were in compliance with the CDC guidelines.⁴

Although reports of transmissions of bloodborne pathogens (BBPs) in dental settings are uncommon, there is evidence that breaches in infection control protocols by DHPs are the leading cause of these transmissions.⁵⁻⁷ Breaches include a case of patient-to-patient transmission of Hepatitis B Virus (HBV) in a dental practice setting, the acute HBV infection of five individuals in a free dental clinic, and the first recorded case of patient-to-patient transmission of Hepatitis C Virus (HCV) within an oral surgery practice.⁵ Research continues to show inconsistencies in infection control compliance in all aspects of the dental setting.^{1,4,8} Both the CDC as well as the Occupational Safety and Health Administration (OSHA) guidelines are frequently breached within dental laboratories, making these settings one of the most vulnerable infection control areas within dentistry.⁸ In studies conducted in the US, there continues to be a low level of compliance in regard to having an exposure control plan (ECP),⁹ maintaining and monitoring dental unit water quality, medical safety device use, recording percutaneous injuries, and having a designated infection control coordinator.⁴ Underreporting of violations, failure to link dental setting transmissions due to the long incubation period of HBV, HCV and the asymptomatic progression of Human Immunodeficiency Virus (HIV), are common limitations found in research focused on disease transmission in dentistry.⁵⁻⁶

Knowledge, attitudes, and perceptions of infection control protocols have a direct connection to infection control compliance, and breaches within the dental profession¹⁰⁻¹³ Though research has shown compliance in infection control protocols to be generally lower in developing countries due to financial constraints, basic knowledge in this area should not be deficient regardless of location and economic status.¹¹ Furthermore, the recent discovery of the novel COVID-19 virus should encourage all members of the dental team to be well versed in such guidelines, and the attitudes of DHCPs in following CDC infection control guidelines should be closely observed. The purpose of this study was to examine DHCPs knowledge, attitudes, practices and barriers regarding the CDC infection control guidelines in dentistry (2003, 2016). The study was completed prior to identification of COVID-19 in the US.

Methods

The MCPHS University's Institutional Review Board granted this study an exempt status under 45 CFR 46.104d(2)

(i) and assigned protocol number IRB120419B. The study design was a descriptive, cross-sectional survey, with a convenience sample of DHCPs (dental assistants, dental hygienists, and dentists; n= 397) within the United States. In order to participate the DHCP needed to be at least 18 years of age, must be assisting with or providing patient care in a clinical setting in the US at least one day/week, and be fluent in reading and speaking English. Dental assistants did not have to be DANB certified, licensed, or graduated from a CODA accredited program. Those not meeting one or more of the criteria were excluded from participation. A power analysis (G*Power) for the most conservative planned statistical test (one-way ANOVA, two-tailed, four groups) using a medium effect size ($f=0.25$), $\alpha=.05$, and 80% power suggested a minimum sample size of n=180. Adjusting for expected attrition of 30% the final recommended sample size was n=257.

Survey Instrument

This survey was designed based on the literature consisted of the following sections: demographics (4 items), familiarity with the 2003 CDC infection control guidelines and the 2016 Summary (9 items), infection control knowledge (10 items), participants' current practices in infection control (8 items), barriers with one open-ended question to report additional barriers (8 items), attitudes in seeking information on infection control (3 items) for a total of 42 items. The ten familiarity (perceived knowledge) questions were paired with the ten related knowledge questions. The pairing of these sections helped to identify the knowledge of each participant more accurately and to subsequently compare these responses to how familiar the individual reported being with each subject. A Likert scale of 1 (not familiar) to 5 (very familiar) was used to measure respondent's familiarity while the Likert scale of 1 (extremely unlikely) to 7 (extremely likely) was used to determine the likelihood of DHCP to further their infection control knowledge within the next 12 months.¹⁵

The survey instrument was validated using the content validity index (CVI) to evaluate the relevance of each survey questions to the study variables¹⁶ and was conducted with five content raters who had background and expertise in infection control. The validation process resulted in a S-CVI= 0.97 and revisions were made based on feedback. The survey was pilot tested with dental professionals (n= 10) who met inclusion criteria to assess comprehension and readability. Feedback given by the content raters resulted in slight edits to the survey content as well as to the implementation of an additional question.

The survey was administered to a convenience sample recruited through professional dental social media groups including, Facebook, LinkedIn, and Instagram, as well as face-to-face recruitment at a large dental conference in New England. Snowball sampling to obtain a larger sample size of practicing dentists was also used.¹⁷

Data Analysis

For the descriptive portion of this study, the sample demographic information and response to survey questions was summarized and reported with measures of variance (e.g. standard deviation). Next, all variables were analyzed for statistical assumptions including normalcy and co-linearity. Variables were assessed for transformation to address issues of non-normal distributions. Outliers were identified and removed, however if the findings are consistent when including outliers, those cases were used in the main analysis. The data was analyzed for missing data and any participant with less than 80% completion was removed from parts or the whole analysis.

Two or more predictors were used to explore the relationship between variables, for continuous variables correlation (Pearson or Spearman), for categorical variables chi-square tests of independence, and multiple regression (linear, logistic, ordinal, multinomial) for modeling. To test for differences in means between categorical variables t-tests or ANOVA was used, and in the cases where the distribution did not meet assumptions for the Normal model, the non-parametric equivalent (Wilcoxon U, Kruskal-Wallis) was utilized. Whenever appropriate adjustments to family wise error (e.g. Bonferroni) were made for multiple statistical tests. The acceptable alpha level for was set at .05 for hypothesis testing and all measures of effect size (e.g. 95% Confidence Interval, R², Phi Coefficient) were determined and reported.

Results

A total of 397 DHCPs opened the survey link; the completion rate was 67%. The mean age of the participants was 42.3 years and had 19.4 years in practice. Most participants were dental hygienists; two-thirds of the respondents were from the Midwest. Sample demographics are shown in Table I.

Participants were asked a series of familiarity (perceived knowledge) questions regarding CDC Infection Control Guidelines (2003, 2016) as shown in Table II. Three-quarters of the respondents reported infection control training was mandatory in their state for license renewal while 10% did not know. All state of practice responses were recoded into the five US regions (West, Southwest, Midwest, South, and

Table I. Demographics (n=265).

		Mean	SD
Age		42	13
Years in practice		19	14
		n	%
What is your most current profession in dentistry?	Dental Assistant	36	14
	Dental Hygienist	218	82
	Dentist	11	4
Where do you practice?	West	18	6.9
	Southwest	12	4.6
	South	20	7.7
	Midwest	180	69.0
	Northeast	31	11.9

Northeast) (Table I). A chi-square test of independence was used to evaluate the relationship between region of practice and infection control licensure requirement. The Midwest had the highest number of participants indicating infection control continuing education was a requirement for licensure (n=155, 86%) while the Southwest had the lowest (n=6, 50%, $\chi^2(8)=24.1, p=0.002, \phi=0.30$).

Participants stated they were very familiar to extremely familiar with CDC recommendations regarding dental unit waterline maintenance (63%); dental handpiece infection control practices (80%); the term and meaning of standard precautions (73%); hand hygiene (96%); OSHA bloodborne pathogen standard (85%); CDC recommendations regarding critical items (81%); biological testing (67%); and respiratory hygiene and cough etiquette (73%) (Table II).

Knowledge of CDC Guidelines

Two-thirds of respondents correctly answered 6-9 (out of 13) of the knowledge questions while just one-third of the participants correctly answered items related to the guidelines for treatment of dental unit water lines, the provision of tissues and no-touch disposal receptacles, and hand hygiene as the most important measure to prevent spread of infection (Table III). Only a small percentage of respondents (15%) correctly answered the knowledge regarding the dental health care setting's need to encourage persons with symptoms of respiratory infections to sit as far away from others as possible. An independent sample t-test test of independence was calculated to investigate the relationship between state licensure requirement and knowledge score, but was not statistically significant, $p=0.75$.

Table II. Familiarity (perceived knowledge) responses (n=265).

		n	%			n	%
Is Infection Control training mandatory in your state for license renewal?	Yes	207	78	CDC recommendations regarding hand hygiene.	Extremely familiar	192	73
	I don't know	26	10		Very familiar	61	23.
	No	32	12		Moderately familiar	4	2
CDC recommendations regarding dental unit waterline maintenance concerning infection control practices.	Extremely familiar	79	30		Slightly familiar	5	2
	Very familiar	87	33		Not familiar at all	3	1
	Moderately familiar	74	28	The OSHA Blood Borne Pathogen Standard.	Extremely familiar	152	57
	Slightly familiar	19	7		Very familiar	75	28
	Not familiar at all	6	2		Moderately familiar	29	11
CDC recommendations regarding dental handpiece infection control practices.	Extremely familiar	123	46		Slightly familiar	7	3
	Very familiar	90	34		Not familiar at all	2	1
	Moderately familiar	38	14	The CDC recommendations regarding critical care items.	Extremely familiar	128	48
	Slightly familiar	9	3		Very familiar	88	33
Not familiar at all	5	2	Moderately familiar		34	13	
CDC recommendations regarding how often infection control education should be completed.	Extremely familiar	126	48		Slightly familiar	9	3
	Very familiar	67	25	Not familiar at all	6	2	
	Moderately familiar	39	15	CDC recommendations regarding biological testing	Extremely familiar	119	45%
	Slightly familiar	20	8		Very familiar	59	22%
Not familiar at all	13	5	Moderately familiar		50	19%	
The term and meaning of standard precautions.	Extremely familiar	176	66		Slightly familiar	25	9%
	Very familiar	73	28		Not familiar at all	12	5%
	Moderately familiar	11	4	CDC recommendations regarding respiratory hygiene/cough etiquette	Extremely familiar	132	50%
	Slightly familiar	3	1		Very familiar	61	23%
	Not familiar at all	2	1		Moderately familiar	43	16%
			Slightly familiar		14	5%	
			Not familiar at all		15	6%	

Infection Control Practices

Infection control practices are shown in Table IV and V. Providing a mask for people with a visible respiratory infection while in the reception area was the category reported with the least compliance (41%). Three-quarters (77%) of respondents completed an infection control continuing education course annually. Nearly half (43%) of the respondents did not know how often their dental unit waterlines were tested to ensure Environmental Protection Agency (EPA) standards of drinking water while a majority (87%) reported completing weekly biological testing on their sterilizers.

Infection Control Barriers

DHCPs ranked barriers to following infection control guidelines in practice from one to seven, with one being the most relevant barrier within their practice and seven being the least barrier within their practice. The greatest barrier found

was a heavy workload (34%), followed by time restraints (25%), expense (15%), and lack of training (13%). The barrier DHCPs found to be the least relevant barrier was lack of good role models (2%) which was ranked as seventh. In the open-ended question, a common trend stated by DHCPs was lack of supplies. In particular, there were not enough handpieces available to comply with proper sterilization methods.

Infection Control Education

Most DHCPs (75%) were extremely likely to further their infection control knowledge by attending an infection control continuing education class within the next 12 months. Less than half of participants (44%) reported they were extremely likely to read the CDC guidelines regarding infection control in dentistry or take an online infection control course (44%) within the next 12 months.

Table III. Knowledge items (n=265).

	Incorrect		Correct	
	n	%	n	%
All dental units should use systems that treat water to meet EPA drinking water standards of _____. <i>Correct response: 550 CFU/ml</i>	185	70	80	30
Dental Handpieces (low and high speed) <i>Correct response: Should be heat sterilized after every patient.</i>	10	4	255	96
Infection Control training should be provided at a minimum, annually. <i>Correct response: True</i>	20	8	245	92
Standard precautions _____. <i>Correct response: Apply to all patient care</i>	3	1	262	99
The most important measure to prevent the spread of infections among patients and dental personnel is _____. <i>Correct response: Hand hygiene</i>	162	61	103	39
The OSHA BBP Standard was created to _____. <i>Correct response: Help protect DHCP from blood exposure and sharps injuries</i>	171	65	94	36
_____ items should always be heat sterilized. <i>Correct response: Critical</i>	32	12	233	88
If a/an _____ item is heat sensitive, dental healthcare personnel should replace it with a heat tolerant or disposable alternative. <i>Correct response: Semi-critical</i>	201	76	64	24
What is the most accepted method for monitoring the sterilization process? <i>Correct response: Biological indicators</i>	51	19	214	81
The CDC recommends dental practices encourage persons with symptoms of respiratory infections to sit as far away from others as possible. <i>Correct response: True</i>	225	85	40	15
The CDC recommends dental practices post signs at entrances to patients with symptoms of respiratory infection to cover their mouth and noses when coughing or sneezing. <i>Correct response: True</i>	105	40	160	60
The CDC recommends dental practices provide tissues and no-touch receptacles for disposal of tissues <i>Correct response: True</i>	184	70	81	31

Discussion

This study explored the level of knowledge, practices, attitudes and barriers faced by DHCPs regarding the CDC Guidelines for Infection Control in Dental Health Care Settings (2003) and the Summary of Infection Prevention Practices in Dental Settings: Basic expectations for safe care in dentistry (2016), prior to the COVID-19 pandemic. In the area of knowledge, the findings in this study were consistent with the systematic review by Khanghahi¹² concerning the overall knowledge of infection control practices. Although the majority of participants stated they were moderately to extremely familiar with CDC guidelines pertaining to dental unit waterlines; hand hygiene; OSHA bloodborne pathogen standard; and respiratory and cough etiquette, these were the areas where participants in this study were found to be the least knowledgeable.

Infection control practices carried out in clinical settings prior to COVID-19 were examined and it was found that almost half of participants did not know if their dental unit waterlines were tested to ensure compliance with the established Environmental Protection Agency standards for drinking water. Furthermore, 70% could not correctly identify the standards raising concerns regarding whether the CDC regular training on infection control policies and guidelines is taking place.³ Lack of knowledge regarding the contamination levels of dental unit waterlines can ultimately be detrimental to immunocompromised patients in addition to posing a public health concern.³

While most participants reported performing weekly biological testing to monitor sterilizers, some respondents did not follow this CDC recommendation at all. Similarly, participants stated there were times when both high and low speed handpieces do not go through the proper sterilization process after each patient. Wiping dental handpieces with a disinfectant in between patients is a direct breach of infection control guidelines which could result in disease transmission as was the case for five individuals

Table IV. Mean responses to practice items (n=265).

	Mean	SD*	95% Lower CL**	95% Upper CL**
What percentage of time do all handpieces (low, high speed) get heat sterilized after each patient?	80%	33	76	84
How often do you perform hand hygiene during a typical 8-hour workday? Times per day	32	25	29	35
What percentage of time do critical items get heat sterilized after each patient?	94%	19	92	96
What percentage of time do semi-critical items get heat sterilized after each patient?	86%	26	83	90
What percentage of time does your office provide a mask for people with a visible respiratory infection while in the reception area?	41%	46	35	46

*SD = standard deviation of the mean

**Lower and Upper CI = 95% confidence interval of the mean.

Table V. Practice items (n=265).

	n	%
How often do you test dental unit waterlines to ensure it meets the EPA standard for drinking water?	Once a month	38
	Once a year	7
	Every 6 months	13
	I do not know	43
How often do you complete infection control continuing education?	Once a year	77
	Twice a year	3
	Biannually	13
	I do not complete	6
How often does your practice perform biological testing?	Once a week	87
	Once a month	8
	Once every 3 months	1
	We have no set standard	4

who became infected with HBV after visiting a portable dental clinic.¹⁸ Blood borne disease transmission is a possible consequence of not following CDC guidelines for sterilization and monitoring sterilizer efficacy^{2,3} due to the long incubation period of some of these pathogens.

Participants in this study reported washing their hands a total of 32 times in a typical 8-hour workday, yet the majority of respondents were unable to correctly identify that hand hygiene was classified by the CDC as the most important measure in preventing the spread of infections among patients and providers.³ This finding leads researchers to hypothesize that while the practice of hand hygiene may be high within DHCPs, the knowledge behind the rationale for the practice is lacking. Lack of knowledge can be associated with poor hand hygiene practices leading to bacterial transmission to patients. This was exemplified in the case of an oral surgery patient who died due to bacterial endocarditis complications traced to the lack of hand hygiene and aseptic technique compliance of a DHCP during the administration of medications.⁷

Results from this study identified the top three barriers to following the CDC infection control guidelines to be a heavy workload, time restraints, and expense, which were consistent with findings in previous studies.¹⁰ Dental health care providers should develop team-based strategies to alleviate these barriers with the goal of protecting their patients as well as themselves. In general, dentists in the US are the direct supervisors of both dental hygienists and dental assistants, and ultimately oversee supply costs and patient load within a dental practice. Targeting more intense infection control instruction strategies toward practice owner employers/supervisors may promote positive change and foster a culture that follows CDC guidance more closely.¹⁰

One of the most significant findings in this study was the lack of knowledge regarding respiratory hygiene and cough etiquette in dentistry.^{2,3} One-third of the respondents were not aware of the CDC guidelines for respiratory hygiene and cough etiquette guidelines for dental health care settings and patients with a visible respiratory infection were provided with a mask while in the reception area only 41% of the time. Varying answers to the respiratory hygiene, cough etiquette, and hand hygiene items revealed areas needing to be further addressed by the dental profession prior to the emergence of the novel respiratory disease, COVID-19.¹⁹ More emphasis needs to be placed on the significance and the mitigation of the transmission respiratory diseases in infection control courses for DHCPs.

Although the study attempted to analyze state and regional differences regarding continuing education licensure requirements for infection control, the only state with an adequate sample size was Massachusetts and the only region was the Midwest, which limited the analysis. This area needs further research with a larger sample for each state. Given the gaps in actual versus perceived knowledge regarding infection control guidelines, it may also be prudent to also assess the way continuing education is delivered. Currently the norm is passive lecture with no assessment mechanism. An emerging trend for a variety of professions is for the licensee to develop a comprehensive plan for continuing professional development (CPD) rather than simply listing the number of hours of continuing education.^{20,21} Continuing professional development plans require the licensee to demonstrate application of learning, evaluation, and reflection to verify continuing competence within their discipline.^{20,21}

Limitations of this study included convenience sampling, self-report bias, self-selection bias, and misrepresentation of DHCPs who do not participate in social media forums, or who do not have regular access to the Internet, and social desirability. The sample was largely made up of mostly registered dental hygienists and is not representative of the demographic balance of DHCPs. Some states do not require licensure of dental assistants so there could have been a wide range of educational experiences and background for this group; however, they were only a percentage of the sample. More research is needed regarding infection control practices in dental laboratories. In addition, infection control knowledge (perceived and actual), practices and education related to interim and updated CDC and OSHA guidelines post-COVID-19 warrant further investigation. Findings from this study may serve as a baseline for comparison.

Conclusion

Although DHCPs reported familiarity (perceived knowledge) with the CDC Guidelines for Infection Control in Dental Health Care Settings (2003) and the Summary of Infection Prevention Practices (2016) their actual knowledge and practices prior to the COVID-19 pandemic were not consistent with the perceived knowledge. The lack of basic knowledge regarding CDC infection control guidelines in dental health care settings is particularly concerning given the global emergence of the novel COVID-19 virus. Evidence-based infection control protocols will continue to evolve in dentistry and DHCPs must be responsible for incorporating the latest guidance into practice. Results of this study also provides evidence supporting the need for infection control continuing education as a requirement for licensure.

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