

Treating Patients with Herpes Simplex Virus Infections: Dental and Dental Hygiene Students' Knowledge, Attitudes, and Professional Behavior

**Preetha P. Kanjirath, B.D.S., M.D.S., M.S.; Mathilde C. Peters, D.M.D., Ph.D.;
Marita Rohr Inglehart, Dr. phil. habil.**

Abstract: Dental and dental hygiene students frequently interact with patients with herpes simplex virus (HSV) infections, often simply referred to as cold sores. The objectives of this study were to assess dental and dental hygiene students' knowledge, attitudes, and professional behavior concerning the treatment of patients with HSV infections and to investigate the relationships among knowledge, attitudes, and professional behavior. Questionnaire data were collected from 337 dental and seventy-three dental hygiene students at regularly scheduled classes. Dental and dental hygiene students did not differ in their overall knowledge concerning HSV infections. Dental hygiene students were more apprehensive about treating patients with these infections, but used more appropriate professional behavior compared to dental students. Dental students' knowledge and appropriateness of professional behavior increased over the course of their education. Overall, it was found that an increase in student knowledge was associated with increased apprehension related to treating these patients. However, the more apprehensive they were, the more they engaged in appropriate professional behavior. Educating future health care providers about the treatment of patients with infectious and communicable diseases can potentially increase the students' apprehension/negative attitudes concerning providing care, while at the same time increasing appropriate professional behavior during their education. Addressing students' apprehensions might be a crucial moderator that will determine whether they will provide the best possible care for these patients in their future professional lives.

Dr. Kanjirath is Clinical Assistant Professor, Department of Periodontics and Oral Medicine, School of Dentistry, University of Michigan; Dr. Peters is Professor, Department of Cariology and Restorative Dentistry, School of Dentistry, University of Michigan; and Dr. Inglehart is Associate Professor, Department of Periodontics and Oral Medicine, School of Dentistry and Adjunct Associate Professor, Department of Psychology, College of Literature, Science, and Arts, University of Michigan. Direct correspondence and requests for reprints to Dr. Marita Rohr Inglehart, Department of Periodontics and Oral Medicine, School of Dentistry, University of Michigan, 1011 North University Avenue, Ann Arbor, MI 48109-1078; 734-763-8073 phone; 734-763-5503 fax; mri@umich.edu.

Key words: herpes simplex virus infections, herpes labialis, cold sores, dental students, dental hygiene students, health care practices, professional behavior, dental education, dental hygiene education, infectious diseases, communicable diseases

Submitted for publication 2/26/07; accepted 5/24/07

The herpes simplex virus (HSV) can cause infections ranging from asymptomatic and mild to life-threatening presentations. The primary infection with herpes simplex type 1 (HSV-1) classically occurs in one-to-three-year-old children and is most often clinically manifested by fever and painful aphthous stomatitis.¹ The common infection is usually acquired from direct contact with infected secretions from parents, caregivers, siblings, or playmates.² Following symptomatic or asymptomatic primary infection, antibody and cellular immunity develops and usually lasts for life. Despite this fact, HSV infections occur in about 30 to 50 percent of those persons who have been infected in the past. Recurrences commonly

occur in the form of cold sores or fever blisters that appear on the outer surface of the lips typically in the vermillion border, but also in the circumoral skin and nares.² Lifetime prevalence of recurrent herpes labialis in the United States is estimated to be between 20 and 45 percent of the adult population, with approximately 100 million episodes occurring annually in immunocompetent individuals.^{3,4} The recurrences range from rare episodes to monthly or even more frequent outbreaks per year.^{5,6} The largest reservoir of HSV is associated with herpes labialis, most commonly resulting from primary infection with HSV-1 during childhood. In fact, more than 85 percent of the world's population is seropositive for HSV-1.⁷

Incidence of HSV-1 infection has been associated with age, race, female sex, lower educational background, and lower socioeconomic status.⁸⁻¹³ However, few studies have examined the confounding effects of these factors.¹⁴ Individuals in developing countries and from lower socioeconomic backgrounds tend to acquire antibodies against HSV-1 at an earlier age than individuals from industrialized countries or from more affluent backgrounds.¹⁵ Herpes simplex viruses are transmitted during close personal contact through the exchange of virus-containing secretions like vesicle fluid from active lesions, saliva, semen, and cervical fluid. The virus must contact mucosal surfaces or abraded skin, where it then first replicates and initiates infection.^{16,17} Initial replication of the HSV-1 often occurs in the oropharyngeal mucosa and establishes latency in the trigeminal ganglia.¹⁸

Research has shown that while recurrences of infections are spontaneous, they are associated with various triggers such as physical or emotional stress, fever, exposure to ultraviolet light, nerve or tissue damage, immunosuppressant, heat, cold, menses, concurrent infection, and fatigue.¹⁹ Both herpes simplex type 1 and herpes simplex type 2 are responsible for primary oral herpes simplex infections, with HSV-1 accounting for 75 to 90 percent of the cases.²⁰ With the increasing prevalence of orogenital contact, cases of HSV-2 oral and HSV-1 genital infections are increasing in frequency.^{21,22}

Spruance et al. isolated HSV from 89 percent of oral lesions and 25 percent of saliva samples during active disease.²³ Viral shedding is found to occur anywhere from prodrome to after crusting of the lesions, even while asymptomatic. Gilbert used PCR to detect quantity and frequency of shedding in his study and reported that, in 87 percent of adults with herpes labialis lesions, the HSV-1 was detectable for an average of four days.²⁴ The shedding was most frequent in the vesicle and ulcer stage, but was also common in clinical and subclinical stages. Given these findings, it is not surprising that several studies reported the risk of transmission of HSV in dental clinics.²⁵⁻³⁰ The incidence of herpetic whitlow, an infection of the thumb and fingers caused by contact with a herpetic lesion, was found to be higher in dental personnel than in the general population,^{31,32} especially before the general use of gloves. Richards et al. reported that certain dental materials, notably acrylic monomer, chloroform, and orange solvent, all rendered latex gloves permeable to HSV.³³ There is conflicting evidence with regard to the viability of HSV virus after disinfection.³⁴ Epstein et al. recovered infectious

HSV virions for up to two hours from door handles that were inoculated with HSV-1 in saliva or water³⁵ (see also Bardell³⁶). HSV-1 has also been shown to survive in a patient's dental chart for several hours.²⁹ The shedding period of the virus varies depending on the type of detection systems used.

Health care workers such as dental and dental hygiene students are trained to practice good hygiene measures such as frequent hand washing and to follow standard precautions when treating patients. In addition, students need to be informed that when they have active lesions, they need to be especially careful not to transmit HSV to their patients and that it is even advisable for them to temporarily refrain from working with immunocompromised patients and neonates. If they encounter active lesions in their patients, they should avoid any type of contact with these lesions such as handling infected tissue or saliva without gloves.

Dental and dental hygiene students are frequently exposed to patients who suffer from recurrent HSV infections.²⁻⁶ As many dental students come from middle- or higher income homes, they may not yet have acquired the antibodies. Brooks et al. found, for example, that 43 percent of dental students were not serologically positive.³⁷ These students are therefore at higher risk of acquiring a primary infection. If their lack of immunity is coupled with an incomplete understanding of the disease process, these students will be vulnerable to these infections. It is therefore crucial to educate the students in the best possible manner about these infections and recommended professional behavior when providing care to patients with cold sores, for their own well-being as well as their patients'. In light of these issues, this study was conducted to assess and compare dental and dental hygiene students' knowledge, attitudes, and professional behavior concerning the treatment of patients with HSV infections and to investigate how students' knowledge, attitudes, and professional behavior are related.

Methods

This study was approved by the Institutional Review Board (IRB) for the Health Sciences at the University of Michigan.

Questionnaire data were collected from 337 students in the four dental classes (response rate=79.10 percent; 159 [47.60 percent] male and seventeen [52.40 percent] female) and seventy-two students in

the three dental hygiene classes (response rate=80.90 percent; 98.6 percent female) at the University of Michigan School of Dentistry. Response rates of students in the four classes of the dental school program ranged from 62.38 percent for fourth-year students (N=63) to 96.08 percent for second-year students (N=100). The response rate for first-year dental students was 90 percent (N=99) and for third-year dental students 67.57 percent (N=75). Response rates for students in the three classes of the dental hygiene program were 89.29 percent for the first-year students, 44 percent for the junior students, and 100 percent for the senior students. The dental hygiene program at the University of Michigan does not have a first-year class because students are admitted to the program after they have completed a first year of general studies. Surveys were distributed at the end of regularly scheduled classes in November/December 2005. Due to this procedure, only students who were present responded to the survey in this classroom setting. Some of the students were missing due to illness, external rotations, or personal reasons. To protect the students' anonymity, no efforts were made to track down the students who were missing in the class period in which the survey was distributed.

The respondents volunteered to complete the survey after they were informed about the study and received a questionnaire at the end of a regularly scheduled class. The students were instructed to answer anonymously and honestly and to return the survey in sealed envelopes to the researchers who waited outside of the classrooms. The average time to complete the survey was approximately 5 minutes. All students were informed that their participation was voluntary and that refusing to participate would not affect their grade.

The students responded to self-administered surveys that included questions concerning their personal background (gender) and educational situation (type of student and year in program) as well as four sections of additional questions. Section 1 consisted of thirteen questions assessing the students' knowledge (for the wording of these questions see Table 1). These knowledge questions consisted of seven general knowledge statements for which the respondents were asked if they were true or false and six questions with a yes/no answer format concerning what a person with cold sores should do to avoid transmission of the disease to other persons. To test the reliability of these knowledge questions, a sum score of correct responses to the first seven items and a sum score of correct answers to the following six

items were computed, and the Cronbach alpha reliability coefficient was determined. This coefficient was $\alpha=.60$. In addition to having the two separate knowledge scores for students' general knowledge (questions a to g) and students' knowledge concerning transmission of the virus (questions h to m), a sum score of the number of correct answers to all knowledge questions was computed as an index of the students' overall knowledge about this topic.

Section 2 of the survey consisted of two Likert-type questions concerning students' apprehension/attitudes when treating patients with cold sores ("When I treat a patient with a cold sore, I feel uncomfortable" and "When I treat a patient with a cold sore, I am concerned about getting infected"). Respondents had to indicate how much they agreed with these two statements on a scale from 1=disagree strongly to 5=agree strongly. The Cronbach alpha reliability coefficient for these two attitudinal items was $\alpha=.76$. For the purpose of these analyses, the responses of the two attitudinal items were averaged, and this average score was used as an indicator of the students' attitudes concerning providing care for patients with cold sores.

Section 3 consisted of four Likert-type questions concerning students' professional behavior ("When I treat a patient with a cold sore, I check the patient history"; "When I treat a patient with a cold sore, I use proper infection control"; "When I treat a patient with a cold sore, I want to educate them about cold sores"; and "I might not treat a patient with a cold sore on this day"). Respondents indicated their level of agreement with these questions on the same five-point answer scale they used for the attitudinal items. A factor analysis (Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization) with the two attitudinal items and the four items concerning professional behavior showed that the responses to the two attitudinal items plus the responses to the behavioral item "I might not treat the patient on this day" loaded on a first factor, while the responses to the three behaviors related to the students' interaction with the patients in the dental chair ("I check the patient history"; "I use proper infection control"; and "I want to educate them about cold sores") loaded on a second factor. For the purpose of this study, the responses to the items that loaded on the second factor were averaged, and the average score was used as an indicator of the students' behavioral responses when providing care for patients with cold sores. Responses to the fourth item, "I might not treat the patient on this day," were analyzed separately.

Table 1. Percentages of dental and dental hygiene students' responses to questions concerning their knowledge about cold sores

Statements (correct answer)	Type of Students	Correct	Wrong	p
a. Cold sores are caused by (virus).*	Dental Hygiene	94.3% 97.3%	5.7% 2.7%	.104
b. At any given time, what percentage of the adult U.S. population has cold sores? (20-50%)	Dental Hygiene	52.9% 58.9%	47.1% 41.1%	.240
c. Cold sores can be transmitted through tears. (no)	Dental Hygiene	89.7% 91.8%	10.3% 8.2%	.311
d. Cold sores can be transmitted through saliva. (yes)	Dental Hygiene	75.7% 76.7%	24.3% 23.3%	.516
e. Cold sores can be transmitted through kissing. (yes)	Dental Hygiene	89.9% 90.4%	10.1% 9.6%	.563
f. Cold sores can be transmitted through hands. (yes)	Dental Hygiene	44.8% 57.5%	55.2% 42.5%	.041
g. Cold sores can be transmitted through sexual intercourse. (yes)	Dental Hygiene	62.0% 50.7%	38.0% 49.3%	.040
General Knowledge Score (=average sum score of correct responses to items a to g)**	Dental Hygiene		5.11 5.24	.387
<i>If a person has cold sores, should he or she do any of the following to avoid transmission to other people?</i>				
h. Wash hands more frequently. (yes)	Dental Hygiene	58.8% 64.4%	41.2% 35.6%	.251
i. Avoid shaking hands. (yes)	Dental Hygiene	18.7% 28.8%	81.3% 71.2%	.036
j. Avoid kissing on cheeks. (yes)	Dental Hygiene	33.5% 58.9%	66.5% 41.1%	<.001
k. Avoid kissing on lips. (yes)	Dental Hygiene	87.5% 89.0%	12.5% 11.0%	.465
l. Avoid sexual intercourse. (yes)	Dental Hygiene	49.3% 41.1%	50.7% 58.9%	.149
m. Tell partner that they have cold sores. (yes)	Dental Hygiene	80.7% 84.9%	19.3% 15.1%	.270
Knowledge About Transmission Score (=average sum score of correct responses to items h to m)	Dental Hygiene		3.28 3.68	.051
Overall Knowledge Score (=sum score of correct answers to all 13 knowledge items; range from 0 to 13 correct answers)	Dental Hygiene		9.48 9.79	.300

*Chi square tests were used to compare the percentages of dental vs. dental hygiene students who responded correctly vs. incorrectly to each single item.

**T-tests for independent samples were used to compare the dental and dental hygiene students' average knowledge scores (=sums of correct answers to items a to g, h to m, and all 13 items).

At the end of the first page of the survey and after these three sets of questions were asked, the students indicated in a last section of the survey if they had ever had cold sores themselves. If they had not ever had a cold sore, they were thanked and the survey was finished. If they reported that they had had cold sores at some point in their life, they continued with twelve questions about their own experiences with cold sores, their attitudes towards having cold sores themselves, and their behavioral responses concerning managing their own disease.

Results

In total, 337 dental students and seventy-two dental hygiene students completed the survey. The overall response rate was 79.03 percent, with 60.6 percent of the respondents being female students and 39.4 percent male students. This slight imbalance in the gender distribution is in part due to the fact that the dental hygiene program had only one male student.

Objective 1 was to assess and compare dental and dental hygiene students' knowledge, attitudes, and professional behavior concerning the treatment of patients with HSV infections. As can be seen in Table 1, the vast majority of the students knew that cold sores are caused by a virus (dental students: 94.3 percent; dental hygiene students: 97.3 percent) and that they cannot be transmitted through tears (dental students: 89.7 percent; dental hygiene students: 91.8 percent), but that they can be transmitted through kissing on the lips (dental students: 89.9 percent; dental hygiene students: 90.4 percent). However, only approximately five out of ten dental students and six out of ten dental hygiene students knew the prevalence rate of cold sores at any given time in the adult U.S. population. In addition, it is important to note that only 44.8 percent of the dental students and 57.5 percent of the dental hygiene students knew that cold sores can be transmitted through hands and, even more strikingly, that only 18.7 percent of the dental students and 28.8 percent of the dental hygiene students knew that hand shaking should be avoided when a person has an HSV infection. Given the type of interactions between student providers and their patients, it is quite likely that the providers will shake patients' hands when they first meet their patients in the waiting area and are not yet wearing protective gloves—a behavior that can put the students and their patients at risk for the transmission of cold sores if either has one at that time.

Concerning the comparison of the number of correct responses of dental and dental hygiene students, Table 1 shows that dental and dental hygiene students did not differ in their average number of correctly answered questions overall (out of thirteen correct responses: mean of dental students=9.48; mean of dental hygiene students=9.79; $p=.300$). However, dental hygiene students had significantly more correct responses than dental students concerning the behaviors that should be used to avoid the transmission of the disease to other persons (3.68 vs. 3.28; $p=.051$). Specifically, dental hygiene students were more likely than dental students to know that casual behaviors such as shaking hands could transmit this virus (percentages of correct responses: 57.5 percent versus 44.8 percent; $p=.041$) and that hand shaking should be avoided (28.8 percent vs. 18.7 percent; $p=.036$).

The results concerning the attitudinal statements showed that while, overall, only 22.3 percent of the students agreed or agreed strongly that they were uncomfortable when treating patients with cold

sores, about one third of the students (33.8 percent) were concerned about getting infected (see Table 2). A comparison of the responses of dental hygiene versus dental students showed that, on average, dental hygiene students agreed more strongly with these two statements and were thus more apprehensive than dental students (on a five-point scale with 1=disagree strongly and 5=agree strongly: mean of dental hygiene students=3.28 vs. mean of dental students=2.65; $p<.001$).

Concerning the responses about professional behavior when treating patients with cold sores, it was found that overall approximately eight out of ten students indicated that they check the patient history for information about cold sores (76.7 percent), and nine out of ten that they use proper infection control (92.5 percent). However, only two thirds of the students agreed or strongly agreed that they would educate their patients with cold sores about these infections (67.6 percent). A comparison of the responses of the dental versus dental hygiene students showed that, on average, the dental hygiene students agreed more strongly than the dental students with the statements concerning the three professional behaviors when treating patients with cold sores (4.35 vs. 4.14; $p=.008$). While it is appropriate professional behavior to not treat a patient with a cold sore, only 40.1 percent of dental students but 69.4 percent of dental hygiene students agreed or strongly agreed with the statement that they might not treat the patient on this day.

In addition to assessing and comparing dental and dental hygiene students' knowledge, attitudes, and professional behavior overall, it is also worthwhile to study whether there is a positive trend over the course of the students' educational programs. To be able to compare dental and dental hygiene students' responses over the course of the two programs, the responses of the first- and second-year dental students had to be combined because the dental hygiene students spend only three years of their professional education in the dental hygiene program after completing a year of general college education. As shown in Table 3, while the senior dental students' overall knowledge score (here described as "Year 3") was higher than the junior dental students' score ("Year 2"), the first- and second-year dental students ("Year 1") had the lowest score (number of correct responses: first- and second-year dental students: 9.23; junior dental students: 9.69; and senior dental students: 10.03; $p=.034$). However, the dental hygiene students showed a different pattern of responses, with

Table 2. Percentages of dental and dental hygiene students' responses to the items concerning their attitudes and professional behavior when treating patients with cold sores

Attitudinal statements*

		1	2	3	4	5	Mean (SD)
<i>When I treat a patient with a cold sore,</i>		Disagree Strongly	Disagree	Neutral	Agree	Agree Strongly	p**
I feel uncomfortable.	Dental	22.7%	28.8%	30.3%	12.1%	6.1%	2.50 (1.147)
	Hygiene	9.9%	14.1%	32.4%	29.6%	14.1%	3.21 (1.153)
	All	20.6%	26.3%	30.8%	15.0%	7.3%	(p<.001)
I am concerned about getting infected.	Dental	17.6%	24.6%	26.7%	22.2%	8.8%	2.80 (1.221)
	Hygiene	9.9%	12.7%	29.6%	26.8%	21.1%	3.35 (1.235)
	All	16.3%	22.6%	27.3%	22.8%	11.0%	(p=.001)
Average Attitude Score	Dental Hygiene	-	-	-	-	-	2.65 (1.062) 3.28 (1.063) (p<.001)

Professional behaviors

<i>When I treat a patient with a cold sore,</i>		1	2	3	4	5	Mean (SD)
		Disagree Strongly	Disagree	Neutral	Agree	Agree Strongly	p**
a. I check the patient history.	Dental	2.7%	3.3%	18.4%	40.4%	35.2%	4.02 (.957)
	Hygiene		4.2%	15.3%	22.2%	58.3%	4.37 (.882)
	All	2.2%	3.5%	17.6%	37.2%	39.5%	(p=.005)
b. I use proper infection control.	Dental	0.9%	1.5%	6.0%	16.8%	74.8%	4.63 (.744)
	Hygiene		1.4%	1.4%	12.7%	84.5%	4.80 (.525)
	All	.7%	1.5%	5.2%	16.1%	76.4%	(p=.028)
c. I want to educate them about cold sores.	Dental	1.5%	9.9%	22.2%	44.1%	22.2%	3.76 (.959)
	Hygiene	1.4%	9.7%	15.3%	43.1%	30.6%	3.90 (.988)
	All	1.5%	9.9%	21.0%	44.1%	23.5%	(p=.252)
Average Behavior Score (items a, b, c):	Dental Hygiene	-	-	-	-	-	4.14 (.629) 4.35 (.624) (p=.008)
I might not treat the patient on this day.	Dental	26.8%	17.2%	16.0%	21.1%	19.0%	2.88 (1.485)
	Hygiene	2.8%	8.3%	19.4%	22.2%	47.2%	4.03 (1.127)
	All	22.6%	15.6%	16.6%	21.3%	23.8%	(p<.001)

*All answers were given on five-point scales with 1=disagree strongly and 5=agree strongly.

**T-tests for independent samples were conducted to test whether the dental and dental hygiene students' average answers were significantly different.

the junior students having the highest percentage of correct responses overall (first-year dental hygiene students: 9.04; junior dental hygiene students: 11.36; and senior dental hygiene students: 9.81; p=.028).

Concerning the attitudinal responses, it was found that the average apprehensiveness of the first- and second-year dental students was the lowest, while the scores of the junior dental students were higher and the scores of the senior dental students were relatively the highest scores (on a five-point scale with 5 indicating "most apprehension": mean of the first- and second-year dental students=2.48; mean of the junior dental students=2.85; mean of the senior

dental students=2.95; p=.002). The average attitude scores of the dental hygiene students in Years 1, 2, and 3 did not differ significantly in their attitudes (Year 1: 3.21; Year 2: 2.86; Year 3: 3.45; p=.264).

However, there was a tendency for the dental hygiene students to have the highest professional behavior score in Year 3 of their program compared to the students in Year 1 and Year 2 (Year 1: 4.24; Year 2: 4.09; Year 3: 4.52; p=.071). While the senior dental students had a higher professional behavior score (mean=4.21) than the junior (mean=4.01) and first- and second-year dental students (mean=4.16), this comparison was not significant (p=.108).

Table 3. Dental and dental hygiene students' knowledge, attitudes, and professional behavior scores in the different years of the program

	Year 1*	Year 2	Year 3	Main Effect "Time"
Overall Knowledge	All: 9.21 Dental: 9.23 Hygiene: 9.04	All: 9.91 Dental: 9.69 Hygiene: 11.36	All: 9.95 Dental: 10.03 Hygiene: 9.81 ($p=.065$)**	$p=.004$ $p=.034$ $p=.028$
Average Attitude Score	All: 2.56 Dental: 2.48 Hygiene: 3.21	All: 2.85 Dental: 2.85 Hygiene: 2.86	All: 3.13 Dental: 2.95 Hygiene: 3.45 ($p=.216$)**	$p=.055$ $p=.002$ $p=.264$
Average Behavior Score	All: 4.20 Dental: 4.16 Hygiene: 4.24	All: 4.05 Dental: 4.01 Hygiene: 4.09	All: 4.37 Dental: 4.21 Hygiene: 4.52 ($p=.422$)**	$p=.023$ $p=.108$ $p=.071$
I might not treat the patient on this day.***	All: 3.19 Dental: 2.41 Hygiene: 3.96	All: 3.65 Dental: 3.12 Hygiene: 4.18	All: 4.04 Dental: 4.08 Hygiene: 4.00 ($p<.001$)**	$p<.001$ $p<.001$ $p=.861$

*Note that the dental hygiene students are admitted after their first year of undergraduate education and therefore spend only three years in the dental hygiene program. In order to compare the dental and dental hygiene students' responses over the course of the programs, the first- and second-year dental student data were combined and compared with the sophomore dental hygiene student data under Year 1, the third-year dental student data and the junior dental hygiene data were compared under Year 2, and the fourth-year dental student data and the senior dental hygiene student data were compared under Year 3.

**These values are the significance levels for the interaction effects "Time x Type of Student" for all students.

***Answers were given on a five-point scale with 1=disagree strongly and 5=agree strongly.

Concerning the responses to the statement "I might not treat the patient on this day," which indicates appropriate professional behavior, an interaction effect between the two factors "Year in Program" and "Type of Program" was found. While the first- and second-year dental students disagreed with this statement on average, and the junior dental students were on average neutral, the senior dental students agreed with this appropriate statement on average (first- and second-year dental students: 2.41; junior dental students: 3.12; senior dental students: 4.08; $p<.001$). However, the dental hygiene students in the three years of the program did not differ significantly in their responses (Year 1: 3.96; Year 2: 4.18; Year 3: 4.00; $p=.861$). This different pattern of responses of the dental and the dental hygiene students resulted in a significant interaction effect of the two factors "Type of Program" and "Year in Program" ($p<.001$).

Objective 2 was to investigate the relationships among knowledge, attitudes, and professional behavior concerning treating patients with cold sores. As shown in Table 4, the more knowledge the students had, the more apprehensive they became overall

($r=.230$; $p<.001$). However, this relationship was not found when the data for the dental hygiene students were analyzed separately.

While there was no significant relationship between knowledge and overall professional behavior, the overall knowledge score did correlate significantly with responses to the statement "I might not treat the patient on this day." The more knowledge the students had, the more likely they were to agree with this appropriate statement ($r=.200$; $p<.001$).

In addition, there was a significant relationship between the students' level of apprehension about treating patients with cold sores and their professional behavior. The more apprehensive the students were about treating patients with cold sores, the more they agreed that they engaged in appropriate professional behavior ($r=.209$; $p<.001$), and the more likely they were to agree with the correct statement that they would not treat the patient on this day ($r=.476$; $p<.001$). Not surprisingly, there was a strong correlation between the overall behavior score and the responses to the statement "I might not treat the patient on this day" ($r=.726$; $p<.001$).

Table 4. Correlations among knowledge, attitudes, and professional behavior scores

	Overall Knowledge Scores	Average Attitude Scores	Average Behavior Scores
Average Attitude Scores:			
Dental Students	r=.274 (p<.001)		
Dental Hygiene Students	r=-.004 (p=.976)		
All Students	r=.230 (p<.001)		
Average Behavior Scores:			
Dental Students	r=.076 (p=.169)	r=.160 (p=.004)	
Dental Hygiene Students	r=-.031 (p=.799)	r=.299 (p=.012)	
All Students	r=.064 (p=.205)	r=.209 (p<.001)	
I might not treat the patient on this day.*			
Dental Students	r=.219 (p<.001)	r=.482 (p<.001)	r=.701 (p<.001)
Dental Hygiene Students	r=.043 (p=.721)	r=.208 (p=.084)	r=.748 (p<.001)
All Students	r=.200 (p<.001)	r=.476 (p<.001)	r=.726 (p<.001)

*Answers were given on a five-point scale with 1=disagree strongly and 5=agree strongly.

Discussion

Concerning the objective to assess and compare dental and dental hygiene students' knowledge, attitudes, and professional behavior, some surprising results were found. First of all, it is quite noteworthy that only three out of four students knew that cold sores can be transmitted through saliva and that even fewer students were aware that they can be transmitted through contacts with hands (dental students: 44.8 percent; hygiene students: 57.5 percent) and that hand shaking should therefore be avoided (dental students: 18.7 percent; hygiene students: 28.8 percent). This lack of specific knowledge is alarming because it can put student providers and patients at risk for infections and can be especially problematic if a patient or provider is immunocompromised.¹⁹ This lack of knowledge together with the finding that over 40 percent of the hygiene students and nearly half of the dental students underestimated the prevalence of the disease within the population should alert dental educators to ensure that dental and dental hygiene students are educated appropriately about HSV infections. This is especially critical because a significant percentage of dental students might not yet have acquired the antibodies to this virus.³⁷

It is conceivable that the relative lack of knowledge concerning HSV infections is related to the fact that the herpes simplex virus is mostly latent and often does not cause any overt disease presentations. It could be that, in the case of other infectious and communicable diseases such as AIDS, attention is

drawn to the disease because of the increased morbidity and mortality, which might affect students' assumptions about its transmissibility and the infectious nature of the disease. While this might increase the likelihood of taking more precautions when treating patients with these other infections, students should be made aware that the transmissibility of the herpes simplex virus is far more likely.^{16-18,23,24} Dental and dental hygiene students need to be aware of the research that demonstrated the risk of transmission of HSV in dental clinics,²⁵⁻³⁰ as well as the findings that the incidence of herpetic whitlow was found to be higher in dental personnel than the general population.^{31,32} Students should be made aware that certain dental materials, notably acrylic monomer, chloroform, and orange solvent, all rendered latex gloves permeable to HSV in research conducted by Richards et al.³³ While there is conflicting evidence concerning the viability of HSV virus after disinfection,³⁴ it is crucial to inform students about the findings by Epstein et al., who recovered infectious HSV virions for up to two hours from door handles that were inoculated with HSV-1 in saliva or water³⁵ (see also Bardell³⁶), and that HSV-1 also survived in a patient's dental chart for several hours.²⁹ Dental and dental hygiene educators need to use these research findings as incentives to ensure that all future oral health care providers are educated comprehensively about these seemingly innocuous infections and the problems they can cause.

In addition, by educating our students about this viral transmission and the prevention of HSV

infections, their awareness concerning the transmission of other infectious and communicable diseases, which might be less prevalent but more serious, could potentially be raised. While the majority of students in this study were aware that the virus can be transmitted through kissing, more students focused on the prevention of the transmission by kissing on the lips versus cheeks. This finding can perhaps be explained as the perception of direct contact with the lesion, which is usually in the circumoral area rather than the cheeks. However, if the students had a more comprehensive understanding of the transmission process, they might become aware that viral shedding and the transmission of a virus can occur even after healing through contact with secretions. The students should therefore not assume that kissing the cheek or shaking hands is safe, although it may be less risky. Only roughly half of the respondents were aware that the virus can be spread through hands, and even lower percentages knew that hand shaking should be avoided when a patient (or provider) has a cold sore. This finding is surprising and highlights the rather complacent nature with which these lesions may be viewed by some of our students.

In addition, it is worthwhile to reflect on the fact that the answers concerning the transmission of the virus through sexual intercourse were ambiguous and that not all students considered it necessary to inform their partners if they had cold sores. While this finding is likely to be related to the fact that a stigma is attached to having this disease and that the students do not want to be identified as harboring the virus, this result raised serious concerns about the ethical issues involved.

Overall, the dental hygiene students were more knowledgeable than the dental students about both the transmission and prevention of the transmission of the virus. However, along with this increased knowledge came a raised concern about treating these patients. Could it be that increased information about HSV infections (and infections with other viruses) without a more complex discussion of the issues around professionalism could lead to more apprehension and a generally less positive attitude concerning the treatment of these patients? It is possible, if not likely, that increasing knowledge per se might not result in a true understanding of the disease process, its transmission, and the prevention of its transmission and thus might not result in an honest commitment to provide the best possible care for patients with these infections. As depicted in Figure 1, it might be that efforts to increase knowledge

need to be paired with efforts to raise awareness of the complexity of treating these patients if a true understanding is to result. Based on this humanistic model of professional education,³⁸ it is predicted that an increase in knowledge alone will not result in true expertise when providing care nor in a solid understanding of the complexities of the disease nor a commitment to provide the best possible care for patients with these infections. Considering this model and its predictions, it is therefore not surprising that the correlations between the knowledge scores and the overall professional behavior scores were not significant, while the apprehensiveness about treating these patients was correlated with more appropriate professional behavior. One might draw the conclusion that the students' professional behavior was related to their apprehension about infections, and not driven by a solid understanding of the disease process or their understanding of the transmission of the disease and prevention of the transmission. Such an interpretation of the findings raises serious concerns about the students' future professional commitment and even their ability to provide the best possible professional care for patients with infectious and communicable diseases.

Concerning changes over the course of the two programs, it is interesting to note that the average knowledge of the three groups of dental students differed in the predicted manner, while the junior dental hygiene students' knowledge score was surprisingly high compared to the average scores of all other groups. This finding may be due to the fact that fewer than half of the junior dental hygiene students responded to the survey and that this group of respondents might have been self-selected based on their knowledge scores. However, this finding highlights the fact that this study was cross-sectional in design, so caution should be applied when interpreting differences among the three groups of students in each program.

Finally, it is worthwhile to mention that only twenty-seven of the 337 dental students (8.1 percent) indicated that they had cold sores and sixteen of the seventy-three dental hygiene students (22.9 percent) responded that they had cold sores ($p < .001$). However, personal experiences with cold sores did not affect the student's knowledge, attitudes, or professional behavior. This finding could be because cold sores usually do not have high morbidity, which might result in patients being less likely to seek professional help where they might receive information about the disease. However, this finding should alert dental and

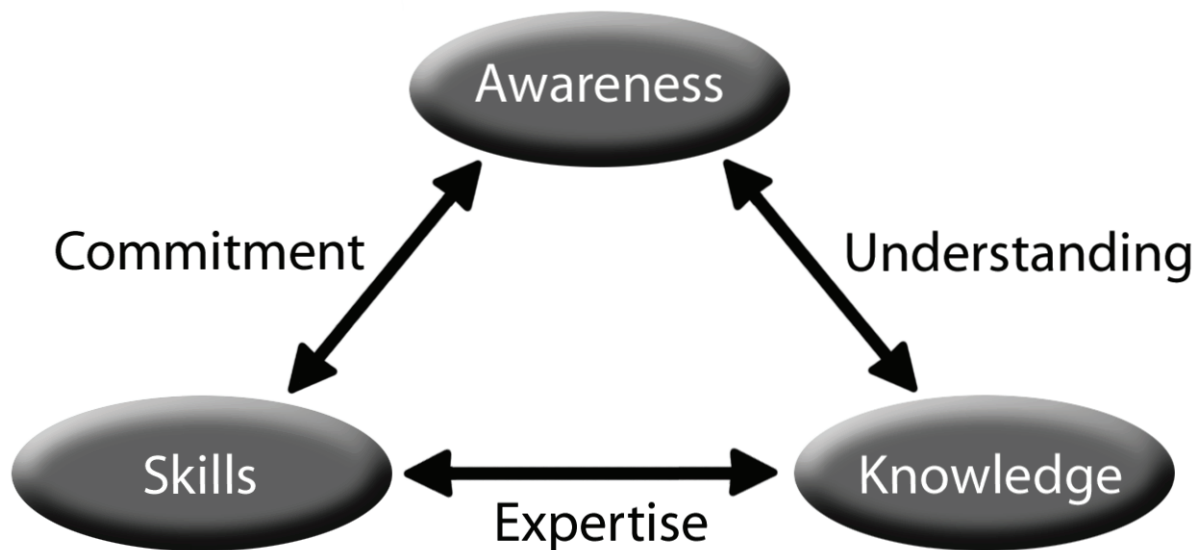


Figure 1. The humanistic model of professional education

dental hygiene educators even more urgently to the fact that their students need to be educated about the disease, because these student providers might have cold sores and their ignorance concerning the transmission of the virus might put their patients at risk.

Limitations

The generalizability of the findings from this study may be limited because the data were collected from dental and dental hygiene students at only one institution, the University of Michigan School of Dentistry. While the dental school classes have quite large numbers of students (over 100 per class), the dental hygiene classes are relatively smaller (around thirty per class), which should be a caution against overgeneralizing the findings.

Conducting this study in a longitudinal format would have shed more light on the process of educating students about HSV infections and other infectious and communicable diseases. A cross-sectional design limits the generalizability of the findings because a particular class may be more knowledgeable per se or may just have received information

about these issues, which could affect their level of current knowledge.

Finally, one additional limitation concerning the interpretation of the findings may be that the knowledge questions were not open-ended, but had a true/false or yes/no answer format, which allowed a 50 percent chance of guessing the correct response. In future studies, it could be helpful either to use open-ended knowledge questions or to at least use multiple choice questions with five answer alternatives, which would reduce the probability of guessing a correct answer to 20 percent.

Conclusions

The results of this study should alert all educators of future dental care providers to consider how their students are educated about providing care for patients with HSV infections and, more importantly, patients with infectious and communicable diseases in general. Specifically, this study showed that

- not all students had the knowledge they needed to provide the best possible care for patients if either they or the patient had a cold sore;

- with an increase in knowledge may come an increase in apprehension about treating patients with cold sores. It seems therefore crucial to address the treatment of patients with infectious and communicable diseases not just by providing basic information, but by framing this information in the larger context of professional education and the students' role as professionals and health care providers; and
- increased knowledge did not necessarily lead to more appropriate professional behavior, while increased apprehension did. These findings again seem to point to the importance of having a comprehensive approach to educating future dental care providers. As the model of humanistic education³⁸ suggests, only by increasing knowledge, raising awareness for the issues involved, and engaging the students in concrete skills training can we assume that they gain a true understanding of the issues, develop solid expertise when providing care, and will show a genuine commitment to providing the best possible care for their patients in the future.

In summary, these findings should stimulate reflection about whether our students receive sufficient education about HSV infections to provide the best possible care for their future patients. Additionally, it should stimulate discussion of how this education is structured to enable our future dental care providers to understand the issues involved, function as experts when treating their patients, and have a solid commitment to providing the best possible care for all patients, independent of whether they have an infectious and communicable disease or not.

Acknowledgments

We want to thank Meghan Shetney, R.D.H., and Michelle Neuhalfen, R.D.H., for their help with this study, and the dental and dental hygiene students at the University of Michigan School of Dentistry for responding to this survey.

REFERENCES

1. Nahmias AJ, Roizman B. Infection with herpes-simplex viruses 1 and 2. *N Engl J Med* 1973;289:667-74,719-25,781-9.
2. Rand K. Herpes simplex virus: clinical syndromes and current therapy. *Compr Ther* 1982;Feb:44-50.
3. Higgins CR, Schofield JK, Tatnall FM, Leigh IM. Natural history, management, and complications of herpes labialis. *J Med Virol* 1993;1(Suppl):22-6.
4. Spruance SL, Overall JC, Kern ER, Krueger GG, Pliam V, Miller W. The natural history of recurrent herpes simplex labialis. *N Engl J Med* 1997;297:69-75.
5. Spruance SL, Rea TL, Thoming C, Tucker R, Saltzman R, Boon R. Penciclovir cream for the treatment of herpes simplex labialis: a randomized, multicenter, double-blind, placebo-controlled trial. Topical Penciclovir Collaborative Study Group. *JAMA* 1997;277(17):1374-9.
6. Spruance SL. Cold sores: a new understanding of their pathophysiology and the need for a new treatment. *Virus Life*, June 1996:7-10.
7. Spruance SL, Kriesel JD, Evans TG, McKeough MB. Susceptibility to herpes labialis following multiple experimental exposures to ultraviolet radiation. *Antiviral Res* 1995;28(1):57-67.
8. Becker TM, Magder L, Harrison HR, Stewart JA, Humphrey DD, Hauler J, Nahmias AJ. The epidemiology of infection with the human herpes virus in Navajo children. *Am J Epidemiol* 1988;127:1071-8.
9. Siegal D, Golden E, Washington E, Morse SA, Fullilove MT, Cataria JA, et al. Prevalence and correlates of herpes simplex infections: the population-based AIDS in multi-ethnic neighborhoods study. *JAMA* 1992;268:1702-8.
10. Rosenthal SL, Stanberry LR, Biro FM, Slaoui M, Francotte M, Koutsoukos M, et al. Seroprevalence of herpes simplex virus types 1 and 2 and cytomegalovirus in adolescents. *Clin Infect Dis* 1997;24:135-9.
11. Gibson JJ, Hornung CA, Alexander GR, Lee FK, Potts WA, Nahmias AJ. A cross-sectional study of herpes simplex virus types 1 and 2 in college students: occurrence and determinants of infection. *J Infect Dis* 1990;162:306-12.
12. Wultzer P, Doerr HW, Farber I, Eichbom U, Helbig B, Sauerbrei A, et al. Seroprevalence of herpes simplex virus type 1 and 2 in selected German populations: relevance for the incidence of genital herpes. *J Med Virol* 2000;61:201-7.
13. Hashido M, Lee FK, Nahmias AJ, Tsugami H, Isomura S, Nagata Y, et al. An epidemiologic study of herpes simplex virus type 1 and 2 infection in Japan based on type-specific serological assays. *Epidemiol Infect* 1998;120:179-86.
14. Schillinger JA, Xu F, Sternberg MR, Armstrong GL, Lee FK, Nahmias AJ, et al. National seroprevalence and trends in herpes simplex virus type 1 in the United States, 1976-1994. *J Am Sexually Transmitted Dis Assoc* 2004;31:753-60.
15. Whitley RJ, Kimberlin DW, Roizman B. Herpes simplex viruses. *Clin Infect Dis* 1998;26(3):541-53; quiz 554-5.
16. Corey L, Spear PG. Infections with herpes simplex viruses (1). *N Engl J Med* 1986;314(11):686-91.
17. Corey L, Spear PG. Infections with herpes simplex viruses (2). *N Engl J Med* 1986;314(12):749-57.
18. Corey L. The current trend in genital herpes: progress in prevention. *Sex Transm Dis* 1994;21(2 Suppl):S38-44.
19. Severson JL, Tyring SK. Viral disease update. *Curr Probl Dermatol* 1999;11:37-72.
20. Fleming DT, McQuillan GM, Johnson RE, Nahmias AJ, Aral So, Lee FK, St Louis ME. Herpes simplex virus type 2 in the United States, 1976 to 1994. *N Engl J Med* 1997;337(16):1105-11.
21. Dekker CL. Herpes virus. In: Joklik WK, Willett HP, Amos DB, eds. *Zinsser microbiology*. 18th ed. Norwalk, CT: Appleton-Century-Crofts, 1984:999.

22. Zheng ZM, Mayo DR, Hsiung GD. Comparison of biological, biochemical, immunological, and immunochemical techniques for typing herpes simplex virus isolates. *J Clin Microbiol* 1983;17:396.
23. Spruance SL, Overall JC Jr, Kern ER, Krueger GG, Pliam V, Miller W. The natural history of recurrent herpes simplex labialis: implications for antiviral therapy. *N Engl J Med* 1977;297(2):69-75.
24. Gilbert SC. Oral shedding of herpes simplex virus type 1 in immunocompetent persons. *J Oral Pathol Med* 2006;35(9):548-53.
25. Miller CS, Redding SW. Diagnosis management of orofacial herpes simplex viral infections. *Dent Clin North Am* 1992;36:879-95.
26. Hochman N, Ehrlich J, Zakay-Rones Z. Oral cavity herpes simplex virus: a risk factor to dental personnel and patients—an overview. *Isr J Dent Res* 1989;2:158-61.
27. Merchant VA. Herpes viruses and other microorganisms of concern in dentistry. *Dent Clin North Am* 1991;35(2):283-98.
28. Jolivald JR, Perrin D, Nicolas JC. Herpes simplex virus in dental practice: longitudinal epidemiologic study. *Acta Odontostomatol (Paris)* 1990;44(171):501-6 (French).
29. Thomas LE, Sydiskis RJ, DeVore DT, Krywolap GN. Survival of herpes simplex virus and other selected microorganisms on patient charts: potential source of infection. *J Am Dent Assoc* 1985;111(3):461-4.
30. Herbert AM, Bagg J, Walker DM, Davies KJ, Westmoreland D. Seroepidemiology of herpes virus infections among dental personnel. *J Dent* 1995;23:339-42.
31. Manzella JP, McConville JH, Valenti W, Menegus MA, Swierkosz EM, Arens M. An outbreak of herpes simplex virus type 1 gingivostomatitis in a dental hygiene practice. *JAMA* 1984;252:2019-22.
32. Rowe NH, Heine CS, Kowalski CJ. Herpetic whitlow, an occupational disease of practicing dentists. *J Am Dent Assoc* 1982;105(3):471-3.
33. Richards JM, Sydiskis RJ, Davidson WM, Josell SD, Lavine DS. Permeability of latex gloves after contact with dental materials. *Am J Orthod Dentofacial Orthop* 1993;104:224-9.
34. Ongradi J, Varnai G, Bendinelli M, Kulscar G, Dan P, Nasz I. Transfer and interaction of oral viruses and bacteria. *Acta Microbiol Hung* 1993;40:201-16.
35. Epstein JB, Rea G, Siabu L, Sherlock CH. Rotary dental instruments and the potential risk of transmission of infection: herpes simplex virus. *J Am Dent Assoc* 1993;124:55-9.
36. Bardell D. Survival of herpes simplex type 1 in saliva and tap water containing some common objects. *Microbios* 1993;74:81-7.
37. Brooks SL, Rowe NH, Drach JC, Shipman C, Young SK. Prevalence of herpes simplex virus disease in a professional population. *J Am Dent Assoc* 1981;102(1):31-4.
38. Inglehart MR, Tedesco LA, Valachovic RW. Quality of life: refocusing dental education. In: Inglehart MR, Bagramian RA, eds. *Oral health and quality of life*. Chicago: Quintessence Publishing Company, 2002.