Received: 3 February 2022 | Revised: 23 April 2022 | Accepted: 12 May 2022

DOI: 10.1002/jdd.12964

ADEA THE VOICE OF DENTAL EDUCATION WILEY

ORIGINAL ARTICLE

Diagnosis and treatment planning using the 2017 classification of periodontal diseases among three dental schools

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Funding information
the Indiana University School of Dentistry Graduate Student Research Fund

Abstract

Objectives: The American Academy of Periodontology and the European Federation of Periodontology developed a new classification system for periodontal diseases in 2017. The next step in its widespread implementation involves training dental students to improve consistency in clinical decisions. This study conducted in 2020–2021 aimed to evaluate knowledge in periodontal diagnosis and treatment planning using the new classification, among first, second, third- and fourth-year dental students at Indiana University School of Dentistry (IUSD), University of Texas School of Dentistry at Houston (UTSD), and University of Louisville School of Dentistry (ULSD).

Methods: A minimum of 20 dental students per class year from each of the three schools participated. Ten HIPPA de-identified case records and a questionnaire with a fixed list of answer options, comprising two demographic questions and two questions on diagnosis and treatment planning of each case, were presented to the participants. A group of three board-certified periodontists established the answers for all cases which were used to score the appropriateness of diagnosis and treatment planning among the participants.

Results: A total of 263 students participated. Overall, 22.6% of IUSD responses, 25.2% of UTSD, and 27.6% of ULSD responses were correct for diagnosis (no statistically significant differences). For the treatment plan, 64.9% of IUSD responses, 66.2% of UTSD, and 68.9% of ULSD responses were correct (no statistically significant differences).

Conclusion: Based on the findings from our study, we suggest that additional training be considered to improve the understanding of the 2017 classification of periodontal and peri-implant diseases among dental students.

KEYWORDS
classification, dental education, diagnosis, periodontal disease, treatment plan

1 | INTRODUCTION

A classification scheme is necessary for clinicians and scientists to diagnose and treat patients and investigate the etiology, pathogenesis, and treatment of periodontal diseases.[1] Common classification systems also provide a common language for clear communication between clinicians, patients, and researchers.[2] The classification of periodontal disease has been revised four times (1977, 1986, 1999, and 2017) since it was first proposed at the 1966 World Workshop of Periodontics.[2] The American Academy of Periodontology (AAP) and the European Federation of Periodontology (EFP) 2017 used several review papers and consensus reports to develop a new classification system for periodontal diseases. The extensive discussion between reviewers and workgroups led to the release of an introductory paper in June 2018 presenting the new classification system.[1] This new classification is a dynamic system that incorporates emerging advances in clinical and biological knowledge, such as tissue and chemical biomarkers, to diagnose periodontitis.[3]

The 1999 classification classified periodontitis into four types: 1) chronic periodontitis, 2) aggressive periodontitis, 3) necrotizing ulcerative periodontitis, and 4) periodontitis as a manifestation of systemic disease.[3] The 2017 classification eliminated aggressive periodontitis and introduced a staging and grading system to diagnose periodontitis. The staging/grading system captures two important patient elements: history of periodontal disease, which is measured as clinical attachment loss and bone loss; and rate of disease progression, which predicts the future risk of disease progression in the absence of treatment and control of risk factors.[4] Other important changes included a definition of periodontal health, recognition of peri-implant diseases, and introduction of new terms including supracrestal tissue attachment, traumatic occlusal force, and gingival/periodontal phenotype.[5] The 2017 classification system also included for the first-time definitions of patients with an intact periodontium, those with a reduced periodontium due to periodontitis, and those with a reduced periodontium due to causes other than periodontitis.[6]

One of the aims of the 2017 World Workshop was to design a classification system that could be implemented in general dental practice, where over 95% of periodontal disease is diagnosed and managed.[4] One example of such dissemination effort was the British Society of Periodontology webinars. These webinars aimed at explaining the contents of the four working groups that drew up the design of the new classification system for UK dentists and dental hygienists on the new classification.[5] This type of effort is commendable because the integration of information for determining the stage and grade of periodontitis may appear challenging in the beginning. Additionally, as there are several subjective factors that go into formulating a periodontal diagnosis and treatment plan; there is a high chance of variability in clinical decision making, especially with the many changes from the 1999 classification. The next important step in the widespread implementation of the new classification system should therefore involve educational plans and training of dental students. Consistency in clinical decision-making is necessary for both teaching effectiveness and reliable assessment of student performance.[7]

Such consistency has been a key point of interest at Indiana University School of Dentistry (IUSD) in the Department of Periodontology. The department holds monthly consensus training meetings for periodontics residents and faculty members to help maintain consistency while teaching pre-doctoral students.[8] This attention to calibration started in 2013 when John et al. measured variations in periodontal diagnosis and treatment planning of pre-doctoral periodontics faculty members. Periodontal faculty members underwent consensus training as part of the department calibration and their clinical performance was compared with those of third- and fourth-year dental students. Agreement among faculty members and agreement among students was relatively low, for both diagnosis and treatment planning.[9] In a follow-up study, Lane et al. compared the level of calibration in diagnosis and treatment planning of periodontal clinical cases among dental students at three schools. These included IUSD, Marquette University School of Dentistry, and West Virginia University School of Dentistry. Students at IUSD had higher agreement in diagnosis and treatment planning than the Marquette University students and the West Virginia University students,[8] attributable to the calibration program.

In 2018, Marlow et al. compared diagnosis and treatment plans among different groups using case-based clinical scenarios. The groups included full-time and part-time periodontology faculty at IUSD, full-time and part-time general practice faculty, full-time periodontists in private practice, and full-time general practitioners. The goal

was to evaluate if calibration sessions improved the diagnosis and treatment planning ability of the group. The authors found that the calibrated periodontal faculty had a better agreement and more correct responses for diagnoses and treatment plans than the other three groups in the study.[10]

Our present study builds upon those previous studies and is a part of the ongoing calibration studies in the IUSD Department of Periodontology. The aim of the present study was to evaluate the level of knowledge in periodontal/peri-implant diagnosis and treatment planning using the 2017 AAP/EFP classification among first, second, third- and fourth-year dental students (D1 through D4) of 3 dental schools. These were the IUSD, University of Texas School of Dentistry at Houston (UTSD), and University of Louisville School of Dentistry (ULSD).

2 | MATERIALS AND METHODS

Ethical approval (IU IRB #2004128486) was obtained. No identifiable information of participants, except the disclosure of their status as D1, D2, D3, or D4 dental students, was collected.

2.1 | Recruitment for the study

The study recruited a minimum of 20 dental students from each class at all three schools. Potential participants were recruited via email requests from a staff member who was neither involved in the study nor the clinical training of students. Study participation was voluntary, and refusal to participate involved no penalty.

2.2 | Study design and procedure

Ten HIPAA de-identified case records were presented to the participants via an online survey, encompassing a fixed list of answer options: two demographic questions and two questions on the diagnosis and treatment planning of each case. Question 1 collected information about the participant's current year in dental training. Question 2 asked about the participant's prior dental experience, such as dental hygiene, dental assistant, and/or being a foreign-trained dentist. Questions 3 and 4 sought the participant's response to an accompanying case scenario in periodontal diagnosis using 2017 AAP/EFP classification and treatment planning. All participants have distributed the new periodontal classification scheme to aid in answering Questions 3 and 4. For each case, the maximum time allotted to a participant to respond was 10 min. This was based on the estimate of a 5-min response time observed during consensus training sessions conducted in the Graduate Periodontics Department at IUSD in the past and an additional 5 min to allow data entry in the computer. Thus, a total of approximately 100 min was needed to complete the questionnaire. Study participants were requested to participate in the survey on a desktop or laptop computer to avoid image distortion and were encouraged to minimize noise and devote complete attention to the survey.

The cases included were acquired from the archived repository of the principal investigator. All cases included the medical and dental history, complete periodontal chart, full mouth radiographic series, and intraoral photographs.

The level of knowledge of the new classification system was expected to vary according to the year of education the student was in at the time of the study. Accordingly, it stands to reason that D1 students will have less experience and knowledge than D2 students who will have less experience and knowledge than D3 students, and so on. Students' access to the new classification system was ensured by offering relevant information for them to familiarize themselves with the classification system. This was provided by way of access to PowerPoint presentations used at their respective institutions.

A group of three board-certified periodontists established the diagnosis and treatment planning for all included cases. These consensus diagnoses and treatment plans (gold standards) were used to score the appropriateness of diagnosis and treatment planning of the participants.

2.3 | Statistics and data analysis

With a sample size of a minimum of 20 students per class year from each school, and with 10 cases evaluated per student, the study was designed to have 80% power to detect a difference in the percentage of correct responses of 20% or less between two classes of students or between two schools, assuming a two-sided 5% significance level for each test, no interaction between class year and school, and within-student correlation of at most 0.8, based on a generalized linear mixed-effects model for a binary outcome with a logit link. Diagnosis and treatment planning responses were tabulated by school and class year for each case. The percentages of correct diagnosis and treatment planning responses were tabulated by school and class year for each case and across all cases. Generalized linear mixed-effects models were used to examine the effects of class year and school on the percentage of correct diagnosis and treatment planning responses. This model is an extension of a logistic regression model that

TABLE 1 Number of responses and past dental experience

Schools	Responses #	Past dental experience			
		Dental Assistant	Dental Hygienist	Foreign-trained Dentist	None
IUSD					
D1	24	7	1	0	16
D2	20	2	1	4	13
D3	23	0	0	9	14
D4	22	2	1	3	16
ULSD					
D1	22	4	2	0	16
D2	22	5	0	0	17
D3	24	4	0	0	20
D4	24	3	0	0	21
UTSD					
D1	20	3	0	0	17
D2	20	6	0	0	14
D3	22	4	0	0	18
D4	20	3	0	0	17
Total	263	43 (16.3%)	5 (6.6%)	16 (6.6%)	199 (75.7%)

includes random effects to account for correlation among responses for multiple cases evaluated by each student and correlation among responses for multiple students evaluating each case. Chi-square tests were used to perform secondary analyses to compare the distributions of the diagnosis and treatment planning responses between schools and between class years for each case. Additional secondary analysis used multi-rater kappa statistics to assess the agreement for the diagnosis and treatment responses among the students within each class for each school. The kappa and its standard error were used to calculate 95% confidence intervals as well as to compare the kappas between classes and between schools. A 5% significance level was used for all tests. All the analysis was done using SAS version 9.4 (SAS Institute, Inc., Cary, NC).

3 | RESULTS

A total of 263 students from the three schools participated in the study (Table 1). Forty-three (16.3%) students reported previous dental assisting experience, five (2%) had previous experience as a dental hygienist, and 16 (6.6%) were foreign-trained dentists (Table 1).

3.1 | Periodontal diagnosis responses/question 3

Overall, only 25.2% of the responses for the diagnosis matched the gold standard (Table 2): 22.6% of IUSD responses, 25.2% of UTSD responses, and 27.6% of ULSD responses matched the diagnosis and were consistent with the consensus diagnosis that had been established (Table 3). None of the comparisons between schools reached statistical significance (Table 5). Table 4 presents the comparisons across year classes of students. The percentages of correct answers were significantly higher in D2 compared to D1, D3, and D4 compared to D1 and D2 (Table 5). However, the difference between D3 and D4 was not significant (Table 5). Kappa values for school agreement and the class agreement were low, ranging between

TABLE 2 Overall descriptive statistics for the number of correct and incorrect responses

Variable: diagnosis	*n* (%)
Incorrect responses	1968 (74.8%)
Correct responses	662 (25.2%)
Variable: Treatment	
Incorrect responses	875 (33.3%)
Correct responses	1755 (66.7%)

TABLE 3 Descriptive statistics of each school

Variable	IUSD, *n* (%)	ULSD, *n* (%)	UTSD, *n* (%)
Diagnosis			
Incorrect	689 (77.4%)	666 (72.4%)	613 (74.8%)
Correct	201 (22.6%)	254 (27.6%)	207 (25.2%)
Treatment			
Incorrect	312 (35.1%)	286 (31.1%)	277 (33.8%)
Correct	578 (64.9%)	634 (68.9%)	543 (66.2%)

TABLE 4 Descriptive statistics for each year of each school

Variable	D1			D2			D3			D4		
	IUSD, *n* (%)	ULSD, *n* (%)	UTSD, *n* (%)	IUSD, *n* (%)	ULSD, *n* (%)	UTSD, *n* (%)	IUSD, *n* (%)	ULSD, *n* (%)	UTSD, *n* (%)	IUSD, *n* (%)	ULSD, *n* (%)	UTSD, *n* (%)
Diagnosis												
Incorrect	192 (80%)	198 (90%)	162 (81%)	172 (86%)	143 (65%)	164 (82%)	161 (70%)	154 (64.2%)	155 (70.5%)	164 (74.5%)	171 (71.3%)	132 (66%)
Correct	48 (20%)	22 (10%)	38 (19%)	28 (14%)	77 (35%)	36 (18%)	69 (30%)	86 (35.8%)	65 (29.5%)	56 (25.5%)	69 (28.7%)	68 (34%)
Treatment												
Incorrect	111 (46.3%)	124 (56.4%)	88 (44%)	98 (49%)	70 (31.8%)	97 (48.5%)	48 (20.9%)	44 (18.3%)	46 (20.9%)	55 (25%)	48 (20%)	46 (23%)
Correct	129 (53.7%)	96 (43.6%)	112 (56%)	102 (51%)	150 (68.2%)	103 (51.5%)	182 (79.1%)	196 (81.7%)	174 (79.1%)	165 (75%)	192 (80%)	154 (77%)

0.03 and 0.25, thus indicating poor agreement in diagnosis (Table 6).

3.2 | Periodontal treatment plan responses/question 4

Overall, 66.7% of the responses to the treatment plan were correct (Table 2). Note that, 64.9% of IUSD responses, 66.2% of UTSD responses, and 68.9% of ULSD responses were correct for the treatment plan as being consistent with the consensus treatment plan established by the three certified periodontists (Table 3). Differences between schools were not statistically significant (Table 5). Table 4 presents the comparisons across year classes of students. The percentage of correct answers was significantly higher in D3 and D4 compared to D1 and D2 (Table 5). However, the difference between D1 and D2 and the difference between D3 and D4 were not significant (Table 5). Kappas for school agreement and class agreement was low, ranging between 0.06 and 0.53, thus indicating poor to a fair agreement in periodontal treatment plan (Table 6).

4 | DISCUSSION

The new classification framework for periodontal disease centers on a multidimensional staging and grading system.[1,11] The presence of many changes in the new classification system from the 1999 classification may cause considerable variations in the diagnosis and treatment planning of periodontal disease. Although consensus training programs for dental students have been introduced, consistency in clinical decision-making among dental students is less than ideal.[12] To our knowledge, no studies have examined the consistency in clinical decision-making among dental students using the new classification of periodontal disease.

Multiple contributing factors to periodontal diseases, such as smoking and diabetes, often exacerbate variability in periodontal diagnosis and treatment planning.[9,10,11] In our study, the percentage of correct responses for periodontal diagnosis was low compared to treatment planning. The lower rate of correct responses in periodontal diagnosis could be attributed to the new classification being more extensive and detailed, compared to the previous 1999 classification.[13] It may therefore become more challenging for dental students to consider all the factors involved in an accurate periodontal diagnosis.[14] It seemed counterintuitive to find that the percentage of correct responses for periodontal treatment plans was higher than for periodontal diagnosis. Such inconsistencies in the under-or overestimation of the disease have been

TABLE 5 Analysis of variance (ANOVA) for the correctness of diagnosis and treatment answers

ANOVA for correctness for diagnosis answers					
Between schools					
School	**Difference**	**Standard error**	***p*-value**	**Lower CI**	**Upper CI**
IUSD versus ULSD	−0.27	0.16	0.09	−0.59	0.04
IUSD versus UTSD	−0.14	0.17	0.38	−0.47	0.184
ULSD versus UTSD	0.13	0.16	0.43	−0.19	0.45
Between the year of study					
Year of study					
D1 versus D2	−0.43	0.20	**0.034**	−0.82	−0.03
D1 versus D3	−0.98	0.194	**<0.01**	−1.35	−0.61
D1 versus D4	−0.84	0.194	**<0.01**	−1.21	−0.46
D2 versus D3	−0.56	0.19	**<0.01**	−0.92	−0.19
D2 versus D4	−0.41	0.19	**0.034**	−0.78	−0.04
D3 versus D4	0.14	0.18	0.42	−0.21	0.494
ANOVA for correctness for treatment answers					
Between schools					
School					
IUSD versus ULSD	−0.20	0.17	0.25	−0.53	0.14
IUSD versus UTSD	−0.054	0.18	0.76	−0.40	0.29
ULSD versus UTSD	0.11	0.18	0.41	−0.20	0.49
Between the year of study					
Year of study					
D1 versus D2	−0.30	0.20	0.13	−0.69	0.09
D1 versus D3	−1.57	0.20	**<0.01**	−1.97	−1.18
D1 versus D4	−1.38	0.20	**<0.01**	−1.78	−0.99
D2 versus D3	−1.27	0.20	**<0.01**	−1.67	−0.87
D2 versus D4	−1.08	0.20	**<0.01**	−1.48	−0.68
D3 versus D4	0.19	0.21	0.36	−0.21	0.594

previously reported.[8] Many patients with periodontal disease, irrespective of the stage of the disease, respond well to mechanical therapy and chemical plaque control.[10] Therefore, partial commonality in treatment protocols could have resulted in higher accuracy in treatment planning compared to periodontal diagnosis. In general, clinicians should not argue over a diagnosis if the treatment protocols proposed are the same irrespective of the disease condition.[15] However, accurate diagnosis may lead to better health outcomes as treatment objectives are better defined,[16] as well as supporting better communication between clinicians, patients, and insurance companies.[8]

No significant differences were reported among students of all three dental schools in terms of their correct responses on periodontal diagnosis or treatment planning. All three schools were in more agreement on treatment plans than diagnoses. As suggested above, variability in diagnosis could be attributed to the inclusion of newer parameters such as staging and grading of periodontal diseases in the new classification. Although accurate staging and grading of the disease are important for the comprehensive management of periodontal disease, the presence of overlapping criteria may increase the difficulty for dental students to differentiate between stages III and IV.[17] Similarly, grading of the disease (which determines the rate of disease progression based on the patient's characteristics and risk factors involved) becomes more complex to calculate as it is based on attachment loss/bone loss over 5 years.[13] Although additional guidance and practical tips to apply different criteria and how to calculate clinical attachment loss and tooth loss are provided in the guidelines, training dental students to use the guidelines for staging and grading the disease is essential.[12] An evaluation of the consistency and accuracy of the periodontitis staging and grading classification system among periodontal experts, general dentists, and undergraduate dental students found that general dentists performed poorly compared to periodontists and dental students.[12] Also, all participants performed better in the staging component than in the grading portion. These findings suggested that

TABLE 6 Multi-rater Kappa's by school and year of study for diagnosis and treatment

Diagnosis					
Year and school	**Kappa**	**SE**	***p*-value**	**Lower CL**	**Upper CL**
D1, IUSD	0.13	0.01	<**0.01**	0.03	0.22
D2, IUSD	0.07	0.01	<**0.01**	0.01	0.12
D3, IUSD	0.20	0.01	<**0.01**	0.08	0.33
D4, IUSD	0.18	0.01	<**0.01**	0.07	0.29
D1, ULSD	0.03	0.01	<**0.01**	0.01	0.05
D2, ULSD	0.18	0.01	<**0.01**	0.12	0.24
D3, ULSD	0.25	0.01	<**0.01**	0.13	0.38
D4, ULSD	0.19	0.01	<**0.01**	0.10	0.28
D1, UTSD	0.05	0.01	<**0.01**	0.03	0.08
D2, UTSD	0.06	0.01	<**0.01**	0.02	0.10
D3, UTSD	0.18	0.01	<**0.01**	0.09	0.28
D4, UTSD	0.24	0.01	<**0.01**	0.15	0.33
Treatment					
Year and school					
D1, IUSD	0.13	0.01	<**0.01**	0.002	0.25
D2, IUSD	0.14	0.01	<**0.01**	0.05	0.23
D3, IUSD	0.23	0.01	<**0.01**	0.04	0.41
D4, IUSD	0.48	0.01	<**0.01**	0.22	0.74
D1, ULSD	0.06	0.01	<**0.01**	0.02	0.09
D2, ULSD	0.14	0.01	<**0.01**	−0.02	0.29
D3, ULSD	0.53	0.01	<**0.01**	0.24	0.81
D4, ULSD	0.37	0.01	<**0.01**	0.17	0.57
D1, UTSD	0.07	0.01	<**0.01**	−0.01	0.15
D2, UTSD	0.14	0.01	<**0.01**	0.04	0.23
D3, UTSD	0.38	0.01	<**0.01**	0.2	0.56
D4, UTSD	0.43	0.01	<**0.01**	0.24	0.63

additional training is essential to improve the application of the new classification system. Another recent study determined the degree of consistency in staging, grading, and extent among individuals trained to manage severe periodontitis cases and with prior exposure to the new periodontitis classification. They found that agreement between raters and gold-standard panel was staging 76.6%, grading 82%, and extent 84.8%. In six of nine cases included in the study, 77%–99% of raters consistently agreed with the gold-standard panel, which is in contrast to the lower agreements observed in our study. However, our result cannot be directly compared to this study, due to differences in study design and population.[11]

A higher percentage of correct periodontal diagnosis responses were given by IUSD D1 students, ULSD D2 and D3 students, and UTSD D4 students. In the case of treatment planning, UTSD D1 students and ULSD D2, D3, and D4 students gave a higher percentage of correct responses. Better performance of ULSD students could be associated with exposure to training programs for periodontal faculty and dental students in the new classification system that was conducted. Conducting calibration programs helps to maintain standardization.[18] Calibrations in dental education not only ensure that a group of individuals can assess the same situation consistently and validly but also helps to improve students learning abilities and in developing their diagnostic and clinical skills.[8] Innovative approaches such as, for example, the blended learning approach (combination of online and face-to-face instructions) compared to traditional means (face to face instructions), suggested that there is ample room to expand familiarity and proficiency in training students in the new periodontal classification.[19]

Given the higher clinical experience of D4 students in treating periodontal disease patients, we would intuitively expect them to perform better than D3 students. However, this was not the case. Moreover, the results of our study were not aligned with findings by John et al and Lane et al.[8,9] John et al. compared the calibration between predoctoral periodontal faculty and D3- and D4 students at IUSD using web-based case presentations.[9] They found higher agreements among D4 students compared to D3 students.[9] Lane et al. evaluated the calibration of

periodontal diagnosis and treatment planning among dental students at three dental schools and found that agreements among D3 students were lower than among D4 students.[8]

Among the strengths of the present study were providing dental students with additional new classification system material, and the utilization of real clinical cases. However, some of our study design features might have led to limitations in the research. Potential stress among students while answering the questionnaire within a stipulated time frame, and the fact that the questionnaire sharply focused on a few conditions in closed question format are possible study limitation. Since this study was restricted to three specific schools, the results may not be generalizable.

5 | CONCLUSION

Overall, all three schools and students were in more agreement on treatment plans than the diagnosis of the periodontal conditions. Based on the findings from our study, we suggest that additional training be considered to improve the understanding of the 2017 classification of periodontal and peri-implant diseases among dental students.

ACKNOWLEDGMENTS

The authors would like to thank the study respondents who participated in this project and Dr. Nikola Angelov, Department of Periodontics, UTSD for his support in data gathering.

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How to cite this article: Gandhi KK, Katwal D, Chang J, et al. Diagnosis and treatment planning using the 2017 classification of periodontal diseases among three dental schools. *J Dent Educ*. 2022;1-8. https://doi.org/10.1002/jdd.12964