

# Evidence-Based Dentistry and Clinical Implementation by Third-Year Dental Students

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*Abstract:* Over the last two decades, the concept of evidence-based medicine (EBM) has become the standard of medical care. Defined by Sackett et al. as “the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients,” EBM recognizes that the practitioner should combine individual clinical expertise with the best available external evidence for optimal care. Consideration of the patient’s needs and preferences is also an integral component of the clinical application. Dental educators have to account for the fact that not all dental treatment outcomes have been researched with randomized clinical trials. Dogmas in dentistry still exist regarding restorative treatments and methods taught to next generations of practitioners, while limited evidence is available. The purpose of this study was to determine how third-year dental students at one U.S. dental school select articles to provide supportive evidence related to treatment planning. The results show that knowledge provided in a three-week course in evidence-based dentistry (EBD) for first-year dental students was not efficiently applied when the students reached their third year. A significant percentage of the students perceived the use of literature as not beneficial for sustaining clinical aspects of a treatment plan, and they did not use appropriate tools to access best available resources. As a result of these findings, the article proposes incorporation of specific learning objectives related to EBD principles throughout the curriculum and a simplified method to search for best available evidence that has the advantage of not requiring knowledge and training in rigorous formulation of clinical questions.

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Over the last two decades, the concept of evidence-based medicine (EBM) has become the standard of medical care.<sup>1</sup> Defined as “the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients,”<sup>2</sup> EBM recognizes that the practitioner has to use both “individual clinical expertise and the best available external evidence, and neither alone is enough.”<sup>2</sup> Consideration of the patient’s needs and preferences is also an integral component of the clinical application.<sup>3</sup> As in medicine, dentistry has adopted the concept of evidence-based practice. In evidence-based dentistry (EBD), patients present with situations that may be addressed with various treatment plans that may differ among practitioners.<sup>4</sup> The dental team also includes technicians who may have a significant influence on treatment decisions.<sup>4</sup>

Despite well-articulated rules and methods for searching, appraising, and applying evidence,<sup>5-7</sup> the dental profession is still looking for the best approach to teaching future dentists the concepts of

EBD.<sup>8</sup> The ADEA Competencies for the New General Dentist approved in 2008 state that graduates must be able to “evaluate and integrate best research outcomes with clinical expertise and patient values for evidence-based practice,”<sup>9</sup> and Werb and Matear recommend that dental schools include this topic in their curricula.<sup>10</sup> Standard 2-21 of the Commission on Dental Accreditation (CODA)’s accreditation standards states that “Graduates must be competent to access, critically appraise, apply, and communicate scientific and lay literature as it relates to providing evidence-based patient care.”<sup>11</sup> The standards also state that “Patient care must be evidence-based, integrating the best research evidence and patient values” (Standard 5-2).

The dental profession is in a transitional phase regarding EBD because faculty members who are supposed to educate students about EBD principles lack training, support, and specific knowledge about the methodology; this inadequacy is a common barrier for implementation.<sup>10</sup> Additional barriers

have been identified for practitioners: many dentists rely on what was taught (or not taught) during their training; EBD is perceived as being rigid, time-consuming, and infeasible in practice; and scientific articles are not always accessible or require subscriptions.<sup>1,12-15</sup> It has been suggested that as little as 8 percent of dental care is justified by appropriately designed, reviewed, and analyzed dental research.<sup>16</sup> Other obstacles are patient preferences based on personal desire and insurance benefits, lack of clinical practice guidelines, and financial incentives.<sup>16</sup>

Little attention has been paid to efficient dissemination of new information for the dental profession, and the literature describes significant delays in research findings becoming integrated into practice.<sup>15,17</sup> There are gaps in understanding how health care professionals change their clinical practice, and it is also clear that simply reviewing and circulating clinical guidelines have a limited effect on routine procedures.<sup>18</sup> It has been proposed that, in order to address these concerns in the long range, dental education should provide graduates with tools that empower them to continuously adapt to evolving new evidence.<sup>17,19</sup> Critical appraisal of biomedical literature taught in the early stages of the curriculum has been reported to have a beneficial effect in the clinic;<sup>20</sup> however, stand-alone teaching will not achieve substantive clinical outcomes if the process is confined to the classroom.<sup>21</sup>

Dental educators have to account for the fact that not all dental treatment outcomes have been researched with randomized clinical trials (RCTs).<sup>16,22</sup> For example, clinical results of teeth-supported fixed partial dentures have not been compared with implants in a well-designed RCT.<sup>23</sup> Dogmas in dentistry still exist regarding restorative treatments and methods taught to next generations of practitioners, while limited evidence is available; use of face-bow records, need for denture border molding, need to completely remove caries, aspects of occlusion, and temporomandibular disorders (TMD) are just some examples.<sup>12,23</sup> Treatment planning in dentistry is the first step towards providing patients with comprehensive care to stop the progression of disease, maintain existing structures, and restore function and quality of life.<sup>24</sup> Treatment planning integrates considerations sustained by knowledge ranging from basic sciences to clinical evidence.

At Case Western Reserve University School of Dental Medicine, we identified treatment planning courses as an opportunity to incorporate evidence-based dentistry into the clinical curriculum. Students

are taught formal critical literature assessment and evaluation during the first three weeks of the first year of their studies in the Epidemiology for Public Health and Clinical Practice course. In this course, students are trained to formulate PICO (Population, Intervention, Control/Comparator, Outcomes) questions<sup>19</sup> that will guide them to find the best available information. This knowledge is used in the preclinical years in many problem-based learning (PBL) courses; however, the curriculum and learning objectives of the PBL courses do not include formal assessment of the evidence. The clinical curriculum includes two treatment planning courses. The first is presented at the end of the second year and integrates basic concepts such as diagnosis, treatment sequencing, occlusion, the masticatory system, and caries. It consists of five lectures and three PBL sessions. The second course (Treatment Planning 2) is presented at the beginning of the third year and consists of eight lectures that deal with topics such as considerations for single-tooth restorations, missing teeth replacement, tooth pathologic migration/movement, and failing dentition.

The purpose of this article is to describe how the third-year students selected articles as part of their Treatment Planning 2 course assignment to provide supportive evidence related to treatment planning. We hypothesized that, as a result of their initial training in the first year, the third-year students would be proficient in identifying the best available evidence related to a clinical aspect of the treatment plan.

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## Methodology

The final assignment in the third-year treatment planning course consisted of a clinical case for which the students received the patient's medical history and clinical documentation of oral status. Students were asked to design an optimal and alternate treatment plan for the patient. Students also were required to submit the full text of one article in PDF format that justifies any aspect of the treatment plans designed for the case and was not presented in formal lectures. Criteria used in evaluating the assignment for choosing and evaluating the article included the following: 1) consideration of any aspect of either the optimal or alternate treatment plans (this broad definition was given to not limit choices); 2) strength of study design (meta-analysis of randomized trials, systematic review, RCT, etc.); and 3) conclusions of the study supported by adequate facts and data, i.e.,

the quality and strength of evidence. Students were not instructed which resources to use for searching and retrieving the full text of the article for this assignment. All students used the same laptop system (HP Compaq tc4400 Tablet PC) with a standardized software package that includes a Virtual Private Network (VPN) application that allows access to the university's resources.

Following completion of the assignment, a survey was sent to the students, and results were anonymously collected online using the Survey Monkey tool. The following questions were on the survey:

1. The material presented in the course was clear (strongly agree, agree, disagree, strongly disagree)
2. The material presented in the course was relevant to the case you were requested to treatment plan (strongly agree, agree, disagree, strongly disagree)
3. The material presented in the course biased (constrained) my thinking about alternative options for treatment planning (strongly agree, agree, disagree, strongly disagree)
4. How beneficial for your learning process was the request to identify a paper that is related to your treatment plan but has not been presented in the class? (very beneficial, beneficial, not beneficial, actually detracted)
5. Did you use VPN software to gain access to resources through the university's network? (yes, no, I don't know what VPN is)

Two of the authors (STT, director of the Treatment Planning course, and CAD, director of the Epidemiology for Public Health and Clinical Practice course in the first year) reviewed the articles chosen

by the students and together assigned a study design score ranging from 1 to 10 (Table 1) and a level of evidence score ranging from 1 to 5.<sup>25</sup> For both parameters, lower scores denoted better design or evidence level. One of the authors (STT) performed a search through Google Scholar and PubMed without being connected to VPN to determine which of the articles submitted by students were available in full text without VPN access to the university's resources.

Finally, one of the authors (STT) searched for the best available evidence related to each article. The search strategy was to use a combination of keywords from the title of each article submitted by students as part of their assignment. The search was done by accessing online the PubMed website through the Cleveland Health Science Library website using a VPN connection, to allow access to all the journals the university subscribes to. The search was done using the PubMed "Clinical Queries" tool ([www.ncbi.nlm.nih.gov/pubmed/clinical](http://www.ncbi.nlm.nih.gov/pubmed/clinical)) that provides a separate list containing only systematic reviews related to the topic in question. For each search, we recorded the number of systematic reviews published in English until August 1, 2011. We also recorded how many of these systematic reviews were available in full text through the university's resources. This research project was reviewed and exempted by the Case Western Reserve University Institutional Review Board.

## Results

Sixty-seven students (100 percent of the class) submitted fifty articles as part of the assignment; fifty-five students answered the five questions on the survey (response rate of 82.1 percent). Table 2 summarizes the answers provided by the students to the five survey questions (Q1-Q5). The results showed overwhelming agreement that the material presented in the course was clear and relevant (agree plus strongly agree=96.3 percent for Q1 and 98.2 percent for Q2). Interestingly, despite the course material being clear and relevant, a significant portion of respondents responded that it biased their thinking about alternative options for treatment planning (agree plus strongly agree=40.0 percent for Q3). Furthermore, a significant percentage of the students answered that identifying a paper related to the treatment plan was not beneficial for their learning process (not beneficial plus actually detracted responses=45.4 percent for Q4). Finally, 36.3 percent

**Table 1. Study design scores applied to articles chosen by students**

Study Design	Design Score
Opinion/position paper; expert review	10
Case report; cross-sectional study	9
Case series (<10); no controls or comparisons	8
Case-control study	7
Low quality, quasi-systematic review	6
Retrospective cohort; treatment outcomes	5
Prospective cohort/trial with controls (non-randomized)	4
Systematic review/meta-analysis of observational studies	3
Randomized, controlled trial (RCT)	2
Systematic review/meta-analysis of RCT	1

Note: Lower scores designate better design.

of the respondents to Q5 reported that they did not use the VPN to access the full text of the articles through the university's resources.

Table 3 summarizes the articles cited, including the title, journal, and year of publication. For each article, the table shows how many students cited it, the design scores, the levels of evidence assigned, and its availability online without the need to access the university's resources using VPN. Fifty unique titles were submitted. One article was cited by five students, two other articles were cited by four students, and seven other articles were cited by two students.

The cross-tabulation between the level of evidence assigned to the submitted papers and full text availability of these articles through VPN only is summarized in Table 4. Twenty-three out of the sixty-seven citations (34.3 percent) submitted by the students were available online as full text without using VPN. This number is in the same range as the percentage of students who reported in Q5 of the survey that VPN was not used (36.3 percent). The results also showed that there was no difference in the distribution of the evidence levels among VPN-only citations and citations that were VPN-optional (Pearson chi-square test,  $p=0.719$ ). Similar results were obtained when the number of articles submitted by the students was analyzed by the study design score and the availability of the material exclusively via VPN use (Figure 1). The empirical observation that the preponderant categories were 3 (systematic review/meta-analysis of observational studies) and 10 (opinion/position paper, expert review) was confirmed by the Kolmogorov-Smirnov test for uniform distribution ( $z=2.19$ ,  $p<0.001$ ).

The results of the searches for systematic reviews based on key words from the titles of articles submitted by the students are shown in Table 5. One article submitted by a student was a report of a committee of the American Academy of Restorative Dentistry, and the title did not contain any key words that could be used for a search.<sup>26</sup> Out of forty-nine searches based on unique titles submitted by students, we found that in forty-six cases (93.9 percent) at least one systematic review title was available and in forty-five cases (91.8 percent) at least one systematic review full text in electronic format was available through the university's resources. A total of 287 systematic reviews were identified based on searches derived from the titles of the forty-nine unique articles; 200 of these (69.7 percent) were available through the university's resources. Nine articles of these forty-nine appeared in the results of

**Table 2. Summary of students' answers to the survey (N=55)**

Answer Options	Response Percentage	Response Count
Q1: The material presented in the course was clear.		
Strongly agree	34.5%	19
Agree	61.8%	34
Disagree	3.6%	2
Strongly disagree	0	0
Q2: The material presented in the course was relevant to the case you were requested to treatment plan.		
Strongly agree	36.4%	20
Agree	61.8%	34
Disagree	1.8%	1
Strongly disagree	0	0
Q3: The material presented in the course biased (constrained) my thinking about alternative options for treatment planning.		
Strongly agree	3.6%	2
Agree	36.4%	20
Disagree	56.4%	31
Strongly disagree	3.6%	2
Q4: How beneficial for your learning process was the request to identify a paper that is related to your treatment plan?		
Very beneficial	5.5%	3
Beneficial	49.1%	27
Not beneficial	43.6%	24
Actually detracted	1.8%	1
Q5: Did you use VPN software to gain access to resources through the university's network?		
Yes	63.6%	35
No	32.7%	18
I don't know what VPN is	3.6%	2

Note: Percentages may not total 100% because of rounding.

the search, i.e., were systematic reviews; however, newer systematic reviews were available. Six additional articles submitted by the students were the most recent systematic reviews available. A search based on key words from the titles of three articles<sup>27-29</sup> did not elicit any systematic review; interestingly, all these articles discussed topics related to teeth movement. Another search based on an article<sup>30</sup> related to teeth movement yielded one systematic review with no restorative relevance.

## Discussion

The challenges of applying EBD techniques in the clinic have been previously described.<sup>16</sup> However, there is no agreement as to whether clini-

**Table 3. Articles cited by students in support of an aspect of their treatment plans**

Number of Times Cited	Journal	Year of Publication	Title	Design Score	Level of Evidence	Available Without VPN
5	JADA	1999	Uprighting molars without extrusion	10	5	no
4	JADA	2007	The use of temporary anchorage devices for molar intrusion	9	4	no
4	Annals Perio	2003	Effect of maxillary sinus augmentation on the survival of endosseous dental implants: a systematic review	3	2	no
2	Clin Oral Impl	2004	A systematic review of the survival and complication rates of fixed partial dentures (FPDs) after an observation period of at least 5 years	3	2	no
2	J Pros Dent	2010	Strategic considerations in treatment planning: deciding when to treat, extract, or replace a questionable tooth	6	3	no
2	JADA	1996	Sinus-lift graft: using the maxillary sinuses to support implants	10	5	no
2	J Dent	2007	A systematic review of single crowns on endodontically treated teeth	3	2	yes
2	J Clinic Perio	2008	A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation	3	2	yes
2	JADA	2005	A review of the management of endodontically treated teeth: post, core, and the final restoration	10	5	no
2	Acta Ortho Italy	2008	ENT assessment in the integrated management of candidate for (maxillary) sinus lift	10	5	yes
1	Int J Dent	2010	Occlusion and temporomandibular function among subjects with mandibular distal extension removable partial dentures	4	2	yes
1	J Perio	2009	A systematic review and meta-analysis on the effect of implant length on the survival of rough-surface dental implants	3	2	yes
1	Int J Oral Max Impl	1998	Long-term success of sinus augmentation using various surgical approaches and grafting materials	8	4	yes
1	JDR	2001	Occlusal stability in shortened dental arches	3	2	no
1	JADA	2001	Implant failures associated with asymptomatic endodontically treated teeth	9	4	no
1	J Pros Dent	2010	Annual review of selected scientific literature: report of the Committee on Scientific Investigation of the American Academy of Restorative Dentistry	6	3	no
1	J Clinic Perio	2002	Clinical significance of non surgical periodontal therapy: an evidence based perspective of scaling and root planing	10	5	no
1	JADA	2005	Teeth with large amalgam restorations and crowns: factors affecting the receipt of subsequent treatment after 10 years	5	2	no
1	Clin Oral Impl Res	2011	Sinus bone formation and implant survival after sinus membrane elevation and implant placement: a 1-to-6-year follow-up study	8	4	no
1	BDJ	2004	Eruptive tooth movement: the current state of knowledge	9	4	yes
1	J Pros Dent	2007	Treatment history of teeth in relation to the longevity of the teeth and their restorations: outcomes of teeth treated and maintained for 15 years	5	2	no

**Table 3. Articles cited by students in support of an aspect of their treatment plans** (continued)

Number of Times Cited	Journal	Year of Publication	Title	Design Score	Level of Evidence	Available Without VPN
1	J Pros Dent	1994	A randomized clinical trial of two basic removable partial denture designs. Part I: comparisons of five-year success rates and periodontal health	2	1	no
1	AJO-DO	2011	Intrusion of supra-erupted molars using mini-screws: clinical success and root resorption	8	4	yes
1	CODE	2003	Chewing ability of subjects with shortened dental arches	9	4	no
1	I J Prosth	2009	Randomized controlled clinical trial of zirconia-ceramic and metal-ceramic posterior fixed dental prostheses: a 3-year follow-up	2	1	yes
1	ISRN Dent (online)	2011	Comparison of the success rate of endodontic treatment and implant treatment	3	2	yes
1	Implant Dent	2011	Effect of sinus membrane perforation on dental implant integration: a retrospective study on 128 patients	5	2	yes
1	J Oral Rehabil	2008	Orthodontic space closure versus implant placement in subjects with missing teeth	6	3	no
1	AJO-DO	2003	Intrusion of posterior teeth using mini-screw implants	10	5	no
1	JADA	2010	Contemporary crown-lengthening therapy	10	5	no
1	J Prosth	2007	Occlusal changes following posterior tooth loss in adults. Part 2: clinical parameters associated with movement of teeth adjacent to the site of posterior tooth loss	7	3	no
1	J Clinical Perio	2008	A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation. Part II: transalveolar technique	3	2	no
1	JADA	1999	Evidence-based care in orthodontics and periodontics: a review of the literature	10	5	no
1	J Oral Rehabil	2006	A review of the shortened dental arch concept focusing on the work by the Käyser/Nijmegen group	6	3	yes
1	JADA	2010	The role of cone-beam computed tomography in the planning and placement of implants	10	5	yes
1	JADA	2008	Three-unit fixed prostheses versus implant-supported single crowns	10	5	no
1	Clinical Oral Implant	2002	Long-term clinical effectiveness of oral implants in the treatment of partial edentulism	5	2	no
1	Med Oral Spain	2009	Influence of perforation of the sinus membrane on the survival rate of implants placed after direct sinus lift: literature update	9	4	yes
1	JADA	2008	The clinical success of all-ceramic restorations	6	3	yes
1	OSOMOPOR	2010	Late signs and symptoms of maxillary sinusitis after sinus augmentation	5	2	no
1	Clin Oral Implant	2009	Cost-effectiveness modeling of dental implant vs. bridge	6	3	no
1	JADA	2007	Survival and reasons for failure of amalgam versus composite posterior restorations placed in a randomized clinical trial	2	1	no
1	J Physiol & Pharm	2009	3-year clinical and radiographic study of implants placed simultaneously with maxillary sinus floor augmentations using a new nanocrystalline hydroxyapatite	8	4	yes

**Table 3. Articles cited by students in support of an aspect of their treatment plans (continued)**

Number of Times Cited	Journal	Year of Publication	Title	Design Score	Level of Evidence	Available Without VPN
1	JADA	1998	Survival rates of teeth adjacent to treated and untreated posterior bounded edentulous spaces	5	2	no
1	Eur J Orthod	2007	Three-dimensional changes in the position of unopposed molars in adults	8	4	yes
1	J Pros Dent	2004	The shortened dental arch: a review of the literature	10	5	yes
1	JADA	2011	Alternative treatments to replacement of defective amalgam restorations	4	2	no
1	Eur J Orthod	2008	Treatment effects of intraoral appliances with conventional anchorage designs for non-compliance maxillary molar distalization	6	3	yes
1	Quintess Int	2005	Restoring endodontically treated teeth with posts and cores: a review	3	2	yes
1	J Oral Rehabil	2010	The orthodontic-periodontic interrelationship in integrated treatment challenges: a systematic review	3	2	no

cians should try implementing EBD using a very structured method<sup>13</sup> or if newer approaches should be designed.<sup>31</sup> Some argue that using generic scales for the quality of evidence may not be applicable in all situations<sup>32</sup> and propose alternative hierarchies to provide “evidence-for-practice.”<sup>33</sup> These roadblocks may account for the fact that even though doctors generate questions during patient care, one study found that physicians only search for answers to a third of the questions.<sup>34</sup>

Our study is unique because the students had participated in a three-week EBD course at the beginning of the first year of dental school. Despite the assumption that these techniques may have been used sporadically in other courses in the first and second years of studies, it was not until the third year that a specific EBD assignment was given, with the aim of checking students’ abilities to search, identify, and apply the best available evidence to a complex clinical, real-life situation. It has been reported that

**Table 4. Cross-tabulation between level of evidence and full-text availability**

levels_evidence		VPN only		Total
		No	Yes	
1	Count	1	2	3
	% within VPN_only	4.3%	4.5%	4.5%
2	Count	9	15	24
	% within VPN_only	39.1%	34.1%	35.8%
3	Count	3	6	9
	% within VPN_only	13.0%	13.6%	13.4%
4	Count	6	7	13
	% within VPN_only	26.1%	15.9%	19.4%
5	Count	4	14	18
	% within VPN_only	17.4%	31.8%	26.9%
Total	Count	23	44	67
	% within VPN_only	100.0%	100.0%	100.0%

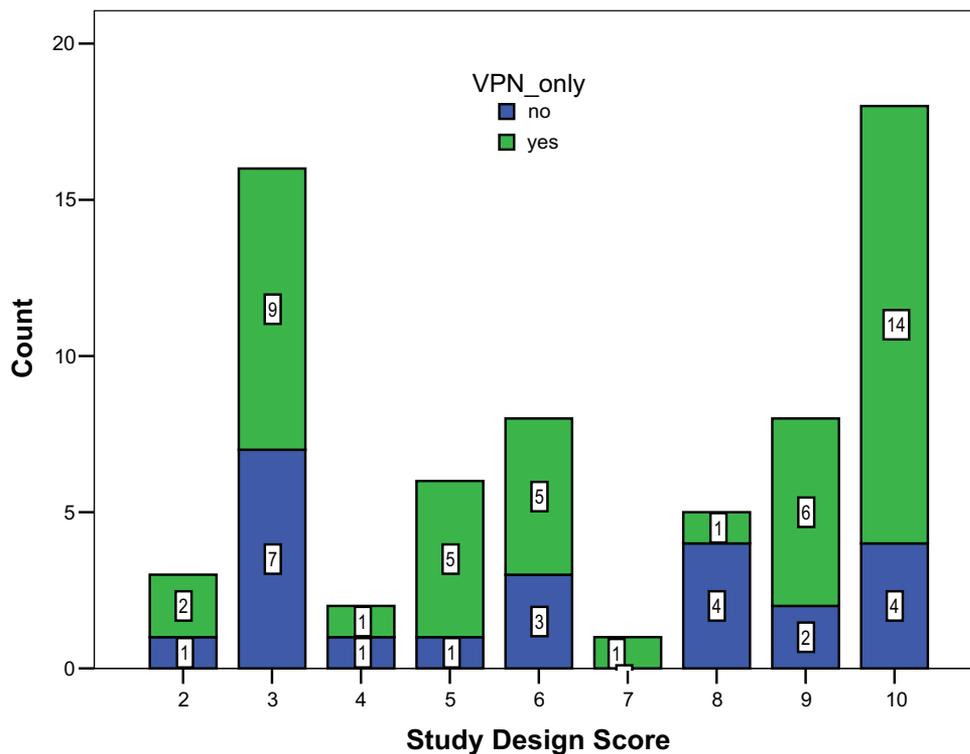


Figure 1. Study design score and availability of material exclusively via the university's VPN

stand-alone teaching might improve knowledge but does not affect skills, attitudes, and behavior,<sup>21</sup> but we found no report in the literature that checked predoctoral students' ability to use EBD principles two years following the first intervention. Previous evidence suggests that predoctoral learning is driven by external factors such as curriculum and examinations.<sup>21</sup> Therefore, we assumed that if no structured examination was performed regarding using this knowledge, the students used very little of it, if at all. This is not the case with graduate learning, which is driven by self-motivation and relevance to clinical practice.<sup>21</sup> In the latter case, it was shown that an intervention (EBD journal club) that occurred on average 9.5 months before the application was tested was efficient in significantly enhancing residents' critical appraisal skills.<sup>35</sup>

The survey questions in our study revealed that the overwhelming majority of the students found that the material presented in the treatment planning course in the third year was clear and relevant to the assigned clinical case. The fact that 40 percent of

the students answered that the material presented in the course constrained their thinking about alternative options for treatment planning was unexpected. Unfortunately, the survey did not have a follow-up question to identify the precise reason for this answer. One possible explanation is that the material presented in the course was seen by the students as incorporating a "cookbook"-style approach so that any clinical situation not within the specific boundaries of the designated material was perceived as a challenge. We think this finding is linked to the same trend in predoctoral learning mentioned above.<sup>21</sup> This conclusion is further supported by responding students' answers to the fourth question in the survey: 45.5 percent reported that the request to provide a single article related to their treatment plan was not beneficial to their learning process. This result reflects students' attitude towards an assignment that requires a high level of integration; a similar trend was reported in a study with medical students in which literature seminars did not lead to effective use of such information.<sup>36</sup> In that study,

**Table 5. Search results based on keywords retrieved from titles of articles submitted by students**

Title	Search String Strategy*	Number of Systematic Reviews**	Digital Full Text Available***	Remarks
Uprighting molars without extrusion	uprighting molars	1	1	±
The use of temporary anchorage devices for molar intrusion	molar intrusion	2	2	
Effect of maxillary sinus augmentation on the survival of endosseous dental implants: a systematic review	sinus augmentation implants survival	15	10	†
A systematic review of the survival and complication rates of fixed partial dentures (FPDs) after an observation period of at least 5 years	survival complication "fixed partial dentures"	6	4	‡
Strategic considerations in treatment planning: deciding when to treat, extract, or replace a questionable tooth	treatment planning considerations tooth	7	4	‡
Sinus-lift graft: using the maxillary sinuses to support implants	sinus lift implants	11	7	
A systematic review of single crowns on endodontically treated teeth	crowns endodontically treated	15	7	†
A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation	survival implants sinus floor elevation	7	6	†
A review of the management of endodontically treated teeth: post, core, and the final restoration	endodontic teeth management	11	9	
ENT assessment in the integrated management of candidate for (maxillary) sinus lift	sinus lift	14	10	
Occlusion and temporomandibular function among subjects with mandibular distal extension removable partial dentures	"removable partial denture" occlusion	1	1	
A systematic review and meta-analysis on the effect of implant length on the survival of rough-surface dental implants	implant surface length survival	5	2	†
Long-term success of sinus augmentation using various surgical approaches and grafting materials	success sinus augmentation grafting materials	6	4	
Occlusal stability in shortened dental arches	occlusal stability dental arches	1	1	
Implant failures associated with asymptomatic endodontically treated teeth	implant failure endodontics	4	4	
Annual review of selected scientific literature: report of the Committee on Scientific Investigation of the American Academy of Restorative Dentistry	NA	NA		
Clinical significance of non-surgical periodontal therapy: an evidence-based perspective of scaling and root planing	"periodontal therapy" scaling "root planing"	20	14	†
Teeth with large amalgam restorations and crowns: factors affecting the receipt of subsequent treatment after 10 years	amalgam crown	9	5	
Sinus bone formation and implant survival after sinus membrane elevation and implant placement: a 1-to-6-year follow-up study	sinus elevation "implant survival"	4	3	
Eruptive tooth movement: the current state of knowledge	eruptive tooth movement	0	0	
Treatment history of teeth in relation to the longevity of the teeth and their restorations: outcomes of teeth treated and maintained for 15 years	longevity teeth restorations	20	14	

**Table 5. Search results based on keywords retrieved from titles of articles submitted by students (continued)**

Title	Search String Strategy*	Number of Systematic Reviews**	Digital Full Text Available***	Remarks
A randomized clinical trial of two basic removable partial denture designs. Part I: comparisons of five-year success rates and periodontal health	“removable partial denture” design	4	1	
Intrusion of supra-erupted molars using miniscrews: clinical success and root resorption	intrusion molars	2	2	
Chewing ability of subjects with shortened dental arches	shortened dental arch	2	1	
Randomized controlled clinical trial of zirconia-ceramic and metal-ceramic posterior fixed dental prostheses: a 3-year follow-up	zirconia metal ceramic fixed dental	9	5	
Comparison of the success rate of endodontic treatment and implant treatment	success endodontic implant	7	5	‡
Effect of sinus membrane perforation on dental implant integration: a retrospective study on 128 patients	sinus membrane perforation implant	2	2	
Orthodontic space closure versus implant placement in subjects with missing teeth	orthodontic implant “missing teeth”	1	1	‡
Intrusion of posterior teeth using mini-screw implants	intrusion posterior teeth	0	0	
Contemporary crown-lengthening therapy	crown lengthening	1	1	
Occlusal changes following posterior tooth loss in adults. Part 2: clinical parameters associated with movement of teeth adjacent to the site of posterior tooth loss	occlusal posterior tooth loss	3	3	
A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation. Part II: transalveolar technique	sinus elevation implants survival	9	8	†
Evidence-based care in orthodontics and periodontics: a review of the literature	orthodontics periodontics care	6	5	†
A review of the shortened dental arch concept focusing on the work by the Käyser/Nijmegen group	shortened dental arch	2	1	‡
The role of cone-beam computed tomography in the planning and placement of implants	tomography implants dental	8	6	
Three-unit fixed prostheses versus implant-supported single crowns	fixed prosthesis implant “single crown”	2	2	
Long-term clinical effectiveness of oral implants in the treatment of partial edentulism	implants edentulism	8	6	
Influence of perforation of the sinus membrane on the survival rate of implants placed after direct sinus lift: literature update	perforation sinus membrane implants	2	2	‡
The clinical success of all-ceramic restorations	success all-ceramic	5	4	
Late signs and symptoms of maxillary sinusitis after sinus augmentation	sinusitis sinus augmentation	1	1	
Cost-effectiveness modeling of dental implant vs. bridge	cost dental implant bridge	1	0	
Survival and reasons for failure of amalgam versus composite posterior restorations placed in a randomized clinical trial	failure amalgam composite posterior	5	3	
3-year clinical and radiographic study of implants placed simultaneously with maxillary sinus floor augmentations using a new nanocrystalline hydroxyapatite	implants sinus floor	11	8	
Survival rates of teeth adjacent to treated and untreated posterior bounded edentulous spaces	survival teeth posterior edentulous	4	2	

**Table 5. Search results based on keywords retrieved from titles of articles submitted by students (continued)**

Title	Search String Strategy*	Number of Systematic Reviews**	Digital Full Text Available***	Remarks
Three-dimensional changes in the position of unopposed molars in adults	unopposed molar	0	0	
The shortened dental arch: a review of the literature	shortened dental arch	2	1	
Alternative treatments to replacement of defective amalgam restorations	replacement amalgam restorations	6	5	
Treatment effects of intraoral appliances with conventional anchorage designs for non-compliance maxillary molar distalization	maxillary molar distalization	5	5	†
Restoring endodontically treated teeth with posts and cores: a review	endodontically post core teeth	13	7	
The orthodontic-periodontic interrelationship in integrated treatment challenges: a systematic review	orthodontic periodontic	7	5	†

\*Based on key words from the title  
 \*\*Number of results relevant to dentistry under "Systematic Reviews" column in PubMed (articles published in English until August 2011)  
 \*\*\*Digital full text available with VPN at CWRU (search through CWRU library PubMed)  
 ±Systematic review available had no restorative relevance.  
 †One systematic review was the cited article; however, newer systematic reviews were available.  
 ‡The cited article was the latest systematic review.

only 3 percent of the students were concerned with the quality of the articles cited. At the same time, 96 percent mentioned that time constraints limited their capability to read literature, while 76 percent felt that the literature was overwhelming. It seems that the perception that use of evidence is not valuable in clinical dental care continues after students graduate. Only 14 percent of practitioners have been reported to use EBD resources, but more experienced clinicians are significantly more likely to use these resources than are recent graduates.<sup>37</sup> Only 2 to 7 percent of the practitioners in other studies reported frequent use of electronic databases, whereas consultation with peers was the preferred method to address clinical challenges.<sup>38,39</sup>

In response to the fifth question of our survey, 36.3 percent of the respondents reported that they did not take the opportunity to use the VPN software installed on their computers. In addition, only 40.3 percent used evidence based on studies with an evidence level of 1 or 2 (Table 4). Our analysis showed that, of sixty-seven articles submitted by students, forty-four (65.7 percent) citations were available exclusively through the use of the VPN. We cannot ascertain if the remaining students (34.3 percent) who submitted articles that could be obtained without the VPN software did not use it. It is interesting that 36.3 percent of the students reported in the survey

that they did not use the VPN. Therefore, it can be concluded that the vast majority of the students who submitted articles that were "VPN optional" did not use the VPN.

A previous study found that educators assume students should be competent with operating computers and looking for information "simply because they are young."<sup>40</sup> It has been shown that students overestimate both their computer and online search skills and their ability to use evidence.<sup>40-42</sup> The fact that in our study a significant percentage of the students neglected to use the VPN shows that their proficiency with computers is limited and that their understanding is diminished regarding how this affects their capability to access full-text articles. Intuitively, one may hypothesize that articles available only through the VPN would be of a higher quality, but our results do not support this hypothesis. We found no statistically significant difference between the quality of evidence in articles available through the VPN only versus articles that were "VPN optional." It should be noted that only 28.4 percent of the students submitted studies with a design level of 3 or better, whereas 63.7 percent reported that they used the VPN for the search. This discrepancy leads to the conclusion that even if students were aware of the need to use the VPN, their ability to search and evaluate evidence was less than optimal. Even

students who were aware of the advantages provided by better access to the university's resources did not have sufficient expertise in distinguishing and choosing higher quality articles.

A previous report also concluded that it is important to evaluate not only the search skills, but also the ability to use and apply the resulting information.<sup>43</sup> Another study found that dental students frequently used computers to access the Internet, but only 14.5 percent used Medline on a weekly basis to find information related to their dental studies.<sup>44</sup> Another study<sup>34</sup> found that 14.8 percent of the dental students had never used Medline in the first three years of a six-year program and that 48.1 percent of the students were not using full-text articles at all, even during the clinical years. This study reported that the major predictor for using Medline and full-text articles was information-searching skills. It is clear that two factors have to coexist for one to use research findings to provide an answer to a clinical question: the clinician must have both search abilities and the ability to evaluate and use the results of the search.<sup>43</sup>

The fact that, for over 90 percent of the topics, we found at least one related systematic review using a simple search strategy confirms that the gap in the students' performance was not only related to their capability to evaluate an article but also to the search strategy and the tools used to implement this strategy. Our findings suggest an alternative to rigorous question formulations that can be easily taught and applied in order to reach the best evidence available. The alternative strategy has the following stages. First, the student or the clinician will search available resources until he or she finds an article whose title describes a report or research related to the topic of interest. Second, using key words from the title of the article, a search using the "Clinical Queries" tool in PubMed will generate a list of systematic reviews related to the topic of interest. Third, the clinician will evaluate these systematic reviews to retrieve best available information related to the topic of interest. If none of the reviews provides the necessary information, the process can be repeated using key words from the titles of the systematic reviews found in previous iterations. This approach has the advantage of not requiring knowledge and training in rigorous formulation of clinical questions. Our results confirm such training is unnecessary to find the best available evidence; this should not be confused with the need for a rigorous formulation of a research question when a research project is

designed. Another advantage of this approach is that it is time-effective and that the clinician will not be overwhelmed by information, which has been found to be an obstacle to implementation of EBD.<sup>16,18</sup>

The main limitation of the "non-rigid" search approach is that a small change in the search strategy can lead to a significant change in the results. For example, the search strategy that we used based on the article "Three-Unit Fixed Prostheses Versus Implant-Supported Single Crowns"<sup>45</sup> (see Table 5) used the following terms: fixed prosthesis, implant, and "single crown." When the term "single crown" was used with the quotes search operator, we sought material that included the exact set of words in a specific order. This strategy retrieved two systematic reviews. Using the exact same search terms but without using the quotes operator for single crown, however, retrieved twenty-three systematic reviews published before August 1, 2011, when the PubMed Clinical Queries function was used. This problem is minor when we consider that using this search strategy in the main search box in PubMed led to 203 citations, whereas in Google Scholar it generated about 16,000 results. In both instances, the results are not sorted, and it is nearly impossible to identify the systematic reviews.

Another limitation of our study is that the study was done on a group of students who do not necessarily represent the dental student population in the United States or worldwide. However, the findings presented can serve as a starting point for other schools. We might ask this question: will the results of the study vary with different subjects who were exposed to exactly the same training, exam, and survey? The answer is probably yes, as it happens with every sample. The next question is this: will this variability significantly affect the conclusions? Our assumption is that the answer is no, but this is subject to future research.

The current definitions of evidence in dental practice may not be adequate. For example, Bader<sup>46</sup> states that "evidence means all the evidence, as assembled and assessed through a systematic review," whereas Abt et al.<sup>12</sup> define it as "the sum total of what is known about a particular specific clinical question." These definitions ignore the simple fact that most dentists do not have access to resources that usually require expensive subscriptions; we therefore suggest that the definition of evidence should reflect also the clinician's access to resources. The term "best available evidence" should be interpreted as best evidence that the clinician has access to. In an era

when billions of dollars are allocated to ensure access to care for all patients, it is necessary to realize that clinician access to scientific information is still an unmet need because of the significant costs involved. This problem is accentuated in dentistry where most practitioners are not affiliated with hospitals or academic institutions with libraries that provide access to myriad professional journals.

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## Conclusions

Knowledge provided in a three-week course in EBD given to first-year dental students was not efficiently applied when the students reached the third year in our study. This can be attributed to the lack of formal application of this knowledge between the time the course was given and the EBD assignment in the third year. In our study, a significant percentage of the students perceived the use of literature as not beneficial for sustaining clinical aspects of a treatment plan. Therefore, we conclude that the curriculum should incorporate learning objectives aimed at clarifying the importance of clinical decision making based on best available evidence. Students should also be trained as to which tools should be used (such as the VPN and PubMed Clinical Queries) in order to access best available resources. This training should include incorporation of specific learning objectives related to EBD principles through the curriculum. The optimal frequency of specific EBD training and application throughout the curriculum is still to be determined.

The use of a simplified search strategy using appropriate tools to access (VPN) and sort (PubMed Clinical Queries) information led to at least one full text systematic review in 91.8 percent of the cases and therefore proved a viable alternative for finding best evidence. The results of this study lead to the rejection of our hypothesis, but the study showed that there are relatively simple and efficient ways to access best available evidence, which could lead to improved clinical performance.

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## REFERENCES

1. Guyatt G, Cairns J, Churchill D, et al. Evidence-based medicine. *JAMA* 1992;268(17):2420-5.
2. Sackett DL, Rosenberg W, Gray J, Haynes RB, Richardson WS. Evidence-based medicine: what it is and what it isn't. *BMJ* 1996;312(7023):71-2.
3. ADA positions and statements: policy on evidence-based dentistry. Chicago: American Dental Association, 2008.
4. Anderson JD. Need for evidence-based practice in prosthodontics. *J Prosth Dent* 2000;83(1):58-65.
5. Sutherland SE. The evidence hierarchy. *J Can Dent Assoc* 2001;67:375-8.
6. Sutherland SE. Critical appraisal of the dental literature: papers about therapy. *J Can Dent Assoc* 2001;67(8):442-5.
7. Sutherland SE. Critical appraisal of the dental literature: papers about diagnosis, etiology, and prognosis. *J Can Dent Assoc* 2001;67(10):582-5.
8. Richards D. Evidence-based dentistry: a challenge for dental education. *Evid Based Dent* 2006;7(3):59.
9. ADEA competencies for the new general dentist (as approved by the 2008 ADEA House of Delegates). *J Dent Educ* 2013;77(7):899-902.
10. Werb SB, Matear DW. Implementing evidence-based practice in undergraduate teaching clinics: a systematic review and recommendations. *J Dent Educ* 2004;68(9):995-1003.
11. Commission on Dental Accreditation. Accreditation standards for dental education programs. Chicago: American Dental Association, 2010.
12. Abt E, Bader JD, Bonetti D. A practitioner's guide to developing critical appraisal skills: translating research into clinical practice. *J Am Dent Assoc* 2012;143(4):386-90.
13. Chiappelli F, Prolo P, Newman M, et al. Evidence-based practice in dentistry: benefit or hindrance. *J Dent Res* 2003;82(1):6-7.
14. Pitts N. Understanding the jigsaw of evidence-based dentistry: 1. Introduction, research, and synthesis. *Evid Based Dent* 2004;5(1):2-4.
15. Pitts N. Understanding the jigsaw of evidence-based dentistry: 3. Implementation of research findings in clinical practice. *Evid Based Dent* 2004;5(3):60-4.
16. Kao RT. The challenges of transferring evidence-based dentistry into practice. *J Evid Based Dent Pract* 2006;6(1):125-8.
17. Pitts N. Understanding the jigsaw of evidence-based dentistry: 2. Dissemination of research results. *Evid Based Dent* 2004;5(2):33-5.
18. McGlone P, Watt R, Sheiham A. Evidence-based dentistry: an overview of the challenges in changing professional practice. *Br Dent J* 2001;190(12):636-9.
19. Azarpazhooh A, Mayhall JT, Leake JL. Introducing dental students to evidence-based decisions in dental care. *J Dent Educ* 2008;72(1):87-109.
20. Forester JP, Cole MS, Thomas PP, McWhorter DL. Introducing critical appraisal of biomedical literature to first-year medical students in histology. *J Int Assoc Med Sci Educ* 2007;13(1):21-9.
21. Coomarasamy A, Khan KS. What is the evidence that postgraduate teaching in evidence based medicine changes anything? A systematic review. *BMJ* 2004;329(7473):1017.
22. Jacob RF, Carr AB. Hierarchy of research design used to categorize the "strength of evidence" in answering clinical dental questions. *J Prosth Dent* 2000;83(2):137-52.
23. Carlsson G. Critical review of some dogmas in prosthodontics. *J Prosthodont Res* 2009;53(1):3-10.
24. Rich B, Goldstein GR. New paradigms in prosthodontic treatment planning: a literature review. *J Prosth Dent* 2002;88(2):208-14.

25. Oxford Centre for Evidence-Based Medicine. Levels of evidence, 2011. At: [www.cebm.net/mod\\_product/design/files/CEBM-Levels-of-Evidence-2.1.pdf](http://www.cebm.net/mod_product/design/files/CEBM-Levels-of-Evidence-2.1.pdf). Accessed: September 9, 2012.
26. Donovan TE, Becker W, Cagna DR, Hilton TJ, Rouse J. Annual review of selected scientific literature: report of the Committee on Scientific Investigation of the American Academy of Restorative Dentistry. *J Prosth Dent* 2010;104(1):13-47.
27. Craddock H, Youngson C. Eruptive tooth movement: the current state of knowledge. *Br Dent J* 2004;197(7):385-91.
28. Park YC, Lee SY, Kim DH, Jee SH. Intrusion of posterior teeth using mini-screw implants. *Am J Orthod Dentofacial Orthop* 2003;123(6):690-4.
29. Christou P, Kiliaridis S. Three-dimensional changes in the position of unopposed molars in adults. *Eur J Orthod* 2007;29(6):543-9.
30. Shellhart WC, Oesterle LJ. Uprighting molars without extrusion. *J Am Dent Assoc* 1999;130(3):381-5.
31. Glasziou P, Vandembroucke J, Chalmers I. Assessing the quality of research. *BMJ* 2004;328(7430):39-41.
32. Liberati A, Buzzetti R, Grilli R, Magrini N, Minozzi S. Evidence-based case review: which guidelines can we trust? Assessing strength of evidence behind recommendations for clinical practice. *Western J Med* 2001;174(4):262.
33. Daly J, Willis K, Small R, et al. A hierarchy of evidence for assessing qualitative health research. *J Clin Epidemiol* 2007;60(1):43-9.
34. Romanov K, Aarnio M. A survey of the use of electronic scientific information resources among medical and dental students. *BMC Med Educ* 2006;6(1):28.
35. Parkes J, Hyde C, Deeks J, et al. Teaching critical appraisal skills in health care settings. *Cochrane Database Syst Rev* 2001;3.
36. Landry FJ, Pangaro L, Kroenke K, Lucey C, Herbers J. A controlled trial of a seminar to improve medical student attitudes toward, knowledge about, and use of the medical literature. *J Gen Intern Med* 1994;9(8):436-9.
37. Haj-Ali RN, Walker MP, Petrie CS, Williams K, Strain T. Utilization of evidence-based informational resources for clinical decisions related to posterior composite restorations. *J Dent Educ* 2005;69(11):1251-6.
38. Iqbal A, Glenny AM. General dental practitioners' knowledge of and attitudes towards evidence-based practice. *Br Dent J* 2002;193(10):587-91.
39. Straub-Morarend CL, Marshall TA, Holmes DC, Finkelshtein MW. Informational resources utilized in clinical decision making: common practices in dentistry. *J Dent Educ* 2011;75(4):441-52.
40. Mattheos N, Schitteck MJ, Nattestad A, Shanley D, Attström R. A comparative evaluation of computer literacy amongst dental educators and students. *Eur J Dent Educ* 2005;9(1):32-6.
41. Fritsche L, Greenhalgh T, Falck-Ytter Y, Neumayer H, Kunz R. Do short courses in evidence-based medicine improve knowledge and skills? Validation of Berlin questionnaire and before and after study of courses in evidence based medicine. *BMJ* 2002;325(7376):1338-41.
42. Levine AE, Bebermeyer RD, Chen JW, Davis D, Harty C. Development of an interdisciplinary course in information resources and evidence-based dentistry. *J Dent Educ* 2008;72(9):1067-76.
43. Hersh WR, Crabtree MK, Hickam DH, et al. Factors associated with success in searching MEDLINE and applying evidence to answer clinical questions. *J Am Med Assoc* 2002;287(3):283-93.
44. Uribe S, Mariño R. Internet and information technology use by dental students in Chile. *Eur J Dent Educ* 2006;10(3):162-8.
45. Christensen GJ. Three-unit fixed prostheses versus implant-supported single crowns. *J Am Dent Assoc* 2008;139(2):191-4.
46. Bader JD. Stumbling into the age of evidence. *Dent Clin North Am* 2009;53(1):15-22.