



# The Contents, Methods and assessment of Evidence-Based Dentistry Education: A Scoping Review

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REVIEW ARTICLE

# The Contents, Methods and Assessment of Evidence-Based Dentistry Education: A Scoping Review

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## **ABSTRACT**

**Introduction:** With evidence-based dentistry (EBD) having a far-reaching influence on oral healthcare, dental educators worldwide have made joint efforts to integrate EBD-related knowledge and skills into dental education. The present scoping review aims to identify and summarize the existing teaching contents, teaching methods, and assessment strategies of EBD education.

**Methods:** Electronic (PubMed and Embase) and manual searches were performed to identify articles related to both ‘dental education’ and ‘evidence-based practice’. Based on pre-determined eligibility criteria, articles were selected by two reviewers, independently and in duplicate. Data synthesis was conducted based on teaching contents, teaching strategies and teaching assessment.

**Results:** Of the 1758 articles found in the literature searches, 74 were deemed eligible and included in this review. A total of four basic skills (problem formulation, literature searching, critical appraisal, and research methodology), five teaching methods, and six assessment strategies were identified. In most of the articles, two or more skills were taught, and a combination of traditional strategies for teaching and its assessment (e.g., courses and questionnaire survey) was involved. Other teaching methods, such as journal clubs and workshops, were seldom used, and validated assessment tools accounted for a relatively small proportion of the assessment strategies involved.

**Conclusions:** The contents, methods and assessment of EBD education have been widely studied and discussed. However, the current literature focuses mainly on teaching of critical appraisal skills, traditional teaching methods, and short-term outcome assessments. Future research in this area can be aimed at integrating all EBD-related skills into educational models, studying multifaceted teaching approaches, and developing comprehensive teaching outcome assessment methods based on validated tools and dental patient-reported outcomes.

**Keywords:** Evidence-based dentistry, Evidence-based practice, Dental education, Clinical decision-making, Teaching method

## 1. INTRODUCTION

Since the establishment of Cochrane Oral Health Group in 1994,<sup>1,2</sup> evidence-based dentistry (EBD) has been evolving for almost thirty years, exerting profound effects on oral healthcare. The traditional dental practice has been shifting gradually to a new paradigm based on evidence-informed clinical decision-making. Contrary to the traditional approach which relies heavily on clinicians' personal experience, evidence-based dental practice provides personalized oral healthcare via the judicious combination of the best available research evidence, the dentist's clinical expertise and the patient's values and preferences.<sup>3</sup>

In order to promote the wide adoption of evidence-based dental practice, it is imperative that EBD-related principles and skills become an integral component of dental education. The past three decades have witnessed a concerted push globally to equip dental professionals with requisite EBD-related techniques and tools. Multiple competence profiles for new dentists have been put forward as instruments for education reform.<sup>4-7</sup> As such, the United States Commission on Dental Accreditation (CODA) stipulates that oral health clinical programs should teach and evaluate graduates on their competency to access, critically appraise, and apply scientific literature as it relates to delivering evidence-based care.<sup>8</sup> The need to modify dental educators' teaching strategies parallels the prospect of preparing oral healthcare providers as critical thinkers, problem solvers, and life-long learners. Moreover, carefully developed and validated assessment methods for EBD educational initiatives are needed for the monitoring of students' progress, as well as the documentation of achievements in improving patients' outcomes.<sup>9</sup>

Given the increasingly recognized importance of evidence-based practice (EBP) concepts in dental education and clinical practice and the explosion of the literature in this field, the need for evidence regarding EBD teaching is greater than ever before. A systematic review in 2004 reported an effective way of implementing evidence-based principles in dental teaching clinics.<sup>10</sup> However, reviews that synthesize information regarding EBD-related education are limited, especially for newly developed teaching concepts and educational methods. In recent years, scoping reviews have been accepted as an exploratory and descriptive approach to comprehensively summarize emerging evidence in a specific field.<sup>11</sup> Therefore, this scoping review was carried out to identify and summarize the existing literature regarding EBD education, and to answer the following questions: 1) what skills have been taught in EBD-related education; 2) what methods and concepts have been developed and used in EBD-related education; and 3) how are EBD-related teaching activities assessed?

## 2. METHODS

This review was conducted according to the Joanna Briggs Institute (JBI) Manual for Evidence Synthesis,<sup>12</sup> and reported in line with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines extension for Scoping Reviews (PRISMA-ScR).<sup>13</sup> The review protocol was registered at the Open Science Framework (<https://osf.io/q3c27>).

### 2.1 Eligibility Criteria

Inclusion criteria were journal articles focusing on EBD-related education for dental students and oral healthcare workers. Exclusion criteria were articles including students or healthcare workers in other disciplines (e.g., medicine or nursing). We also excluded articles that were surveys regarding

dental students' or practitioners' knowledge, attitudes, and perceptions of EBD, in which no specific teaching methods or programs were involved. The search was limited to articles published between February 1<sup>st</sup>, 1994 and July 28<sup>th</sup>, 2022, based on the development history of EBD which dates back to the establishment of Cochrane Oral Health Group.<sup>1, 2</sup> Literature reviews, conference papers, commentaries and case reports were excluded. Articles that were published in languages other than English and Chinese were excluded as well.

## **2.2 Information Sources and Search Strategy**

To identify articles relevant to our objectives, we performed a systematic search up through July 2022 on two major electronic databases: PubMed and Embase. The search strategy for the literature focused on two main concepts, namely 'dental education' and 'evidence-based practice'. The detailed search strategies used for each database are listed in [Supplementary Table 1](#). After electronic searches, a manual search was carried out in *Journal of Dental Education* and *European Journal of Dental Education* for eligible articles. In addition, the reference lists of all identified key articles were browsed and screened for additional eligible articles.

## **2.3 Article Selection and Data Extraction**

Article selection was undertaken by two reviewers (Q.L. and S.T.) according to the established eligibility criteria, independently and in duplicate. In the first round, we selected the retrieved articles through the assessment of the titles and abstracts. Thereafter, both reviewers examined the full texts of potentially eligible articles. Discrepancies were resolved by discussion with other reviewers (X.Y. and F.H.). The reasons for exclusion of each article, based on the evaluation of full texts, are provided in [Supplementary Table 2](#).

Using specifically developed data extraction forms, two reviewers (Q.L. and S.T.) extracted the following information from included articles, independently and in duplicate: author, publication year, country, objectives, participants, teaching contents, teaching strategies, teaching assessment, and teaching outcomes.

## **2.4 Data Synthesis**

The included articles were classified into two types: research and narrative. Data synthesis was performed on the basis of three domains: teaching contents, teaching strategies and teaching assessment by two reviewers (Q.L. and S.T.), independently and in duplicate. Based on full-text revision, we listed taught EBD-related skills, teaching methods, and assessment strategies described in each included article and then synthesized the pertinent characteristics, perceptions and recommendations on EBD education. The information was organized according to the above three domains to generate implications for research and practice.

# **3. RESULTS**

## **3.1 Article Selection**

A total of 1757 items were identified via electronic searches, from which 97 duplicates were removed. After screening titles and abstracts, 1479 articles were deemed irrelevant and excluded. In the second round, an additional 108 articles were excluded based on their full texts, resulting in 73

eligible articles. Thereafter, hand searches identified another eligible article, leading to the final inclusion of 74 articles in this scoping review (Figure 1).

### 3.2 Characteristics of the Included Articles

More than half of the included articles were conducted in the USA (n=44), followed by the UK (n=7), Canada (n=5), Pakistan (n=4), China (n=3), Australia (n=2), India (n=2), Egypt (n=1), Germany (n=1), Iran (n=1), Ireland (n=1), Jordan (n=1), Netherlands (n=1) and Saudi Arabia (n=1). Forty-two articles described research related to EBD education, while 32 were narratives. In most of the articles (n=55, 74.3%), dental students were the subjects, while the other articles also focused on residents, clinicians, and faculty. A thematic analysis of the included articles identified 15 themes, including four for basic skills taught in EBD education, five for teaching methods of EBD education, and six for assessment strategies of EBD education (Figure 2).

### 3.3 Basic Skills Taught in EBD Education

As presented in Supplementary Table 3, the education of four basic EBD-related skills was discussed in the included articles, namely “problem formulation” (n=30, 40.5%), “literature searching” (n=42, 56.8%), “critical appraisal” (n=47, 63.5%) and “research methodology” (n=17, 23.0%). In 44 articles (59.5%), more than two of the basic skills were taught.

#### 3.3.1 Problem formulation & Literature searching

In the included articles, students were taught how to translate clinical problems into a searchable format,<sup>14-25</sup> how to use MeSH terminology and develop search strategies, and how to access the literature through databases and search engines including PubMed, Cochrane Library, Google, Google Scholar and others.<sup>15, 16, 23, 26-29</sup>

In terms of teaching strategies, the use of web-based electronic methods for literature searching was taught in didactic lectures and debriefing sessions,<sup>30-33</sup> with hands-on practice to utilize websites and databases.<sup>28, 32, 34, 35</sup> Embedded librarians as instructors assisted in the cultivation of evidence-based searching skills and helped form high-quality searches.<sup>17, 26, 33, 36-38</sup> Stone et al.<sup>38</sup> described the faculty-librarian collaboration in an expanded dentistry curriculum, which reinforced information literacy instruction. Likewise, Ispahany et al.<sup>36</sup> developed an online tool (the Library Toolkit) to introduce the appropriate use of library resources in making informed healthcare decisions.

#### 3.3.2 Critical appraisal & Research methodology

Critical appraisal is the most frequently taught skill among skills identified in this review. In a survey conducted by Hong and colleagues,<sup>39</sup> all 12 participating UK dental schools reported that critical appraisal skills were taught and assessed in their institutions.

In the included articles, multiple critical appraisal worksheets and tools were used to optimize the teaching process. The Critical Appraisal Skills Program (CASP) was used as a template for dental students to critically appraise different types of articles.<sup>22, 40</sup> A basic literature analysis instrument, the Literature Analysis Form (LAF), has been in continuous use in the Skills in Assessing the Professional Literature (SAPL) curriculum at New York University,<sup>41, 42</sup> so was a modified version used in Howard University.<sup>20</sup> According to Grant,<sup>15</sup> the worksheet from the *AMA Manual for Evidence-Based Clinical Practice* provided a rapid means of assessing relevant studies

for clinical practice in journal-based learning. Teich et al.<sup>43</sup> presented that through step-by-step lecture teaching and independent appraisal exercises, the Assessment of Multiple Systematic Reviews (AMSTAR) was well adopted by dental students to evaluate the methodological quality of systematic reviews.

### **3.4 Teaching Methods for EBD Education**

As shown in [Supplementary Table 4](#), five teaching methods for EBD education were touched upon in the included articles. Thirty-nine articles (52.7%) were dedicated to “courses”; eleven (14.9%) focused on “journal clubs”; eight (10.8%) were grouped for “workshops”; six (8.1%) were related to “EBD-related teaching projects”; and six (8.1%) used “online learning”.

#### *3.4.1 Courses*

Courses were the most commonly used teaching method in the included articles. In addition to traditional teaching strategies, lectures and classroom instructions included, educators utilized some advanced learning enhancement models: embedded librarians,<sup>17, 31, 33, 34, 37, 38</sup> problem-based learning (PBL)<sup>21, 31, 36, 44</sup> and peer-assisted learning (PAL).<sup>25, 45</sup>

Dental schools have been traversing different paths toward the same goal of engaging students in the curriculum that incorporates the EBD skill set. In 2001, experts from University College London, Oxford University and Forsyth Institute explored evidence-based methods for solving clinical dilemma at dental teaching clinics.<sup>14</sup> In the same year, New York University implemented a four-year curriculum model on SAPL,<sup>41</sup> with a follow-up assessment showing that students acquired the requisite skills at a high success rate.<sup>42</sup> In 2008, Texas A&M Baylor College of Dentistry launched a comprehensive EBD curriculum and a series of faculty development initiatives, which made substantial progress toward creating an EBD culture.<sup>30, 46</sup> In the early 2010s, the progressive EBD curriculum at University of Iowa was designed to model independent learning and emphasize accessible online resources for practicing EBD.<sup>21, 47</sup> Regarding conceptual framework and related procedures for curriculum reform, different dental schools provided transferable experience for other schools.<sup>38, 48-50</sup> Besides, dental educators from 20 dental schools in 15 countries published a co-signed article in 2008 on how to develop a successful EBD curriculum.<sup>51</sup>

#### *3.4.2 Journal clubs*

In the included articles, journal clubs (JCs) were often embedded in the curriculum for dental students,<sup>44, 49</sup> while dental residents, clinicians, and faculty joined in single JC sessions.<sup>52-54</sup> JCs were encouraged to adopt a small group format of about 8 members, one of whom hosted the meeting. In the meantime, one expert was invited to function as a facilitator guiding the learning process.<sup>44, 52, 55</sup> The structure of JCs can be adjusted and formatted according to the defined targets of the organizations and the learning objectives of the participants.<sup>53</sup> Some were based on current articles to enrich the understanding of important literature.<sup>44, 53</sup> Some revolved around a selected clinical topic to fill the gap between research evidence and clinical practice.<sup>49, 52</sup> Other JCs went through the complete process of evidence-based decision-making to give a real-world example of EBP.<sup>15</sup> Overall, journal clubs were a multipurpose approach with a well-defined format to build up EBD-related expertise, particularly the critical appraisal skill.

#### *3.4.3 Workshops*

With a combination of passive and active learning, workshops had similar teaching contents and strategies to courses, but were held for a relatively short period of time and mainly focused on faculty development.<sup>56-60</sup> Having experienced rapid clinical progress, technological advances, and educational reforms, instructors lacking formal training in EBD have significant consequences for students who look to them as models in evidence-based behaviors.<sup>56</sup> Workshops provide a platform to cultivate a critical mass of EBD-competent faculty.

Interprofessional education involving educators and learners from different health professions has been endorsed as a mechanism to improve the overall quality of healthcare.<sup>61</sup> Koffel et al.<sup>57</sup> pointed out that participants were positively impacted by the interprofessional workshop design and preferred such an environment where participants from different professions learned EBP together and shared experience from their respective fields.

#### 3.4.4 Online learning

In the post-pandemic world, dental educators and researchers attached increasing importance to online teaching. Web 2.0 tools, such as Voicethread<sup>62</sup> and Padlet,<sup>63</sup> allow real-time posting. Therefore, students could make comments directly on the slides, and ask and answer questions from peers and instructors. Besides, two interactive online tutorials (*Introduction to EBM* and *Formulating a Clinical Question*) constructed by the librarians have been adopted as key tools in supporting evidence-based instruction.<sup>17</sup> Furthermore, although journal clubs were typically held in academic institutions, online and virtual clubs were flourishing in recent times.<sup>54</sup> As Aulakh et al.<sup>54</sup> stated, there is no shying away from the trend to move our teaching to a virtual medium, and it may be that COVID-19 was the catalyst that has speeded up this digital transformation.

#### 3.4.5 EBD-related teaching projects

Six EBD-related teaching projects were introduced in the included articles. Different from conventional EBD training, they appeared to be novel and distinctive with new teaching concepts, modes, and tools.

Rugh<sup>64, 65</sup> traced the evolution of EBD education at the University of Texas Health Science Center at San Antonio Dental School. The school implemented an academic detailing project in which Faculty, Alumni, Students and Team (FAST) prepared and reviewed Critically Appraised Topics (CATs).<sup>64, 65</sup> With the goals of not only teaching EBD but transferring evidence into practice, the school established an online searchable CAT library to provide students and faculty with cutting-edge, evidence-based answers to clinical questions.<sup>64</sup>

The other four articles reported EBD-related projects as follows:

- A practice-based product evaluation program: Introduce dental hygienists to the principles of research.<sup>35</sup>
- iCARE, modeled after the one-minute preceptor approach: Enhance the interactions between dental preceptors and students in the dental clinic.<sup>66</sup>
- The Wikipedia Collaboration of Dental Schools (WCODS): Publish high-quality scientific, evidence-based contents on the Wikipedia online encyclopedia.<sup>67</sup>
- A new educational method comprised of debates, reply speeches, and policy papers: Combine knowledge delivery with high-level debates.<sup>68</sup>

### 3.5 Assessment of EBD Education



According to the educational objectives, teaching assessment is divided into two categories: formative assessment to provide feedback to trainees during the learning process and summative assessment to document achievements of teaching outcomes.<sup>9</sup> Assessment of EBD education consisted of “WHAT” was measured and “HOW” outcomes were measured, namely assessment strategies.

As presented in [Supplementary Table 5](#), the assessment strategies of EBD education were classified into six domains, “questionnaire survey” (n=32, 43.2%), “assignments” (n=18, 24.3%), “examinations” (n=14, 18.9%), “validated assessment instruments” (n=11, 14.9%), “interviews” (n=4, 5.4%) and “rubrics” (n=4, 5.4%).

Among the included articles, the Likert scale,<sup>25-27, 31, 33, 34, 40, 49, 53, 54, 57, 59, 68, 69</sup> multiple-choice questions<sup>40, 54, 70</sup> and open-ended questions<sup>26, 66</sup> were the most often used formats in questionnaire surveys. Various forms of assignments and examinations (written tasks, oral presentations, simulation exercises, portfolios, and pre-post knowledge tests) were used to accomplish the learning goals.<sup>45, 70-72</sup> Validated assessment instruments were utilized by a few included articles. Imorde and colleagues<sup>73</sup> adapted the Berlin Questionnaire for use in a dentistry setting to assess competency in EBD. The “Practices, Experience, Attitudes, and Knowledge” (PEAK) tool uniquely measures respondents’ EBD knowledge in literature interpretation,<sup>46, 74</sup> whilst the “Knowledge, Attitudes, Access, and Confidence Evaluation” (KACE) instrument has been extensively applied to detect the effects of EBD training.<sup>22, 24, 29, 55, 75</sup> Interviews contained debriefing luncheons and focus group discussions.<sup>40, 65</sup> The rubrics, made up of pre-established criteria, formally specified scoring guidelines to assess students’ performance.<sup>9, 47, 74, 76</sup> For rubrics, assessment activities were designed in conformity with the evolving teaching contents. Generally, the development of assessment strategies did not occur in isolation, but rather was an interactive process between the curricula and desired outcomes.<sup>9</sup>

In terms of “WHAT” was measured, we summarized five dimensions from the included articles -- attitudes, confidence, knowledge, skills, and clinical behaviors: 1) attitudes about EBD; 2) confidence in evidence-based dental practice<sup>31, 46</sup>; 3) understanding of EBD concepts; 4) skill acquisition in the four steps of EBD implementation process (ask, acquire, appraisal and apply)<sup>44, 47</sup>; and 5) clinical behaviors of integrating EBD concepts into clinical decision-making.<sup>33, 45</sup> However, most of the assessments merely reported the short-term progression of EBD education, without further follow-up research. Additionally, among the identified assessments we failed to find any incorporation of dental patient-reported outcomes,<sup>77</sup> which represent a crucial component of evidence-based, shared decision-making.<sup>78, 79</sup>

#### 4. DISCUSSION

This scoping review examined EBD-related education over the past thirty years. As evidenced by the included articles, several teaching concepts made for the successful dissemination of EBD into dental education: teach it early, teach it repeatedly, teach it comprehensively, and teach it with clinical application. In the study of Teich et al., EBD knowledge provided to first-year dental students was not efficiently applied when they reached the third year due to a lack of repeated training.<sup>19</sup> Katz and colleagues<sup>41</sup> implemented a curriculum mode following the “didactic, pre-clinical, and clinical” stepwise progression and achieved desired outcomes. Hence, dental educators underscored repeated reinforcement of EBD principles over the entire educational pathway.<sup>19, 23, 39, 41, 51</sup>

Moreover, it is recommended that EBD teaching modules comprehensively incorporate EBD-related basic skills, and expose learners to the whole process of evidence-based decision-making.<sup>16, 21, 49</sup> The limited effects of didactic teaching have been mentioned in the included articles.<sup>33, 46, 48, 80</sup> This is consistent with the findings of a systematic review that the standalone educational model may improve knowledge of EBP but have difficulties in changing attitudes and behaviors.<sup>81</sup> In a clinical setting, students can practice the combination of research findings, clinical expertise and patient preferences, discuss the relative risks and benefits of each treatment option, and give evidence-based recommendations to patients to arrive at rational decisions.<sup>25, 30, 66</sup> The translation of abstract EBD concepts into concrete cases in clinical scenarios allows learners to see EBD for what it is: a practical tool for clinical practice, rather than a sterile academic exercise.<sup>48</sup>

In the domain of EBD teaching strategies, it is highlighted to use passive and active learning in a balanced manner and tailor instructions to match the learning preferences of different learners.<sup>24, 48, 51, 60</sup> Concretely, educators are recommended to use alternative methods to lectures such as workshops, journal clubs, and computer laboratory sessions.<sup>40, 71, 80</sup> In recent years, some studies have explored the feasibility and effectiveness of new teaching models in EBD-related education, including process-oriented guided inquiry learning (POGIL),<sup>72</sup> experiential and self-learning<sup>24</sup> and PAL,<sup>25</sup> which were proved to enhance students' abilities in communication, information-seeking, and clinical problem-solving. EBD curriculum also requires interaction with extracurricular stakeholders to further enrich the learning environment. For example, cooperation with outreach dental clinics could facilitate the transfer of evidence-based knowledge from dental schools to hospitals and clinics.<sup>65</sup> Learning about practice-based research networks (PBRNs) would invigorate students to future clinical research involvement.<sup>46</sup>

In terms of the assessment of EBD education, a wide variety of strategies were used in the included articles, but validated assessment instruments accounted for a relatively small portion. Dental researchers are encouraged to adopt and/or modify existing, validated instruments to ensure that EBD teaching outcomes are assessed precisely and efficiently.<sup>73</sup> When it comes to the contents of assessment, scholars found that knowledge and attitudes could be easily tested, but behavioral performance was more difficult to evaluate due to its complexity and subjectivity.<sup>39, 74</sup> However, an approach reported by Marshall et al.<sup>74</sup> identified EBD-related behavioral expectations, and evaluated student skill acquisition in each step of the EBD process.<sup>47</sup> Whilst most of the included articles evaluated EBD training in the short term, little empirical work exists indicating educational impacts in shaping sustainable EBP behaviors throughout career span or improving patient care. Future studies need to document the long-term effects of EBD-related education including those on EBP behaviors and dental patient-reported outcomes, and explore those factors related to the retention of EBD principles and skills in clinical practice.

With the development of EBD education, the American Dental Education Association (ADEA) 2022 Survey of U.S. Dental School Seniors illustrated that 97% of respondents expressed confidence in the application of evidence-based information to dental practice.<sup>82</sup> Likewise, the 2016 survey for U.S. PBRN dentists revealed the EBP training during dental school increased the use of peer-reviewed journals in subsequent clinical practice.<sup>83</sup> Arguably, the effectiveness of EBD-related education was gradually demonstrated. As dental educators are making great strides in EBD curriculum improvement, it might be useful to update the previous expert consensus<sup>51</sup> on how to facilitate successful EBD curricula and evidence-based dental practice. To improve the availability of evidence-based oral health information, more efforts need to be put into establishing searchable

libraries and updating high-quality evidence on clinical issues.<sup>64, 67</sup> Access to these pre-searched and pre-appraised EBD resources provides informed and timely answers to clinical problems, and therefore will give critical support in lessening the global burden of oral diseases.

Our scoping review has a few limitations. Firstly, even though we conducted an extensive search to incorporate more articles into this review, some relevant articles that were reported in languages other than English and Chinese, or were not indexed in PubMed or Embase may have been overlooked. Second, due to a relatively wide scope and the word limit, some relevant areas could not be covered in great detail and need to be explored in future research that focuses on a specific aspect of EBD education. Third, in this review articles not directly related to EBD education were excluded as pre-determined. Among these articles there may be other teaching methods or contents that could be applied to EBD education. However, such information is beyond the scope of this review and could be obtained from publications in relevant fields.<sup>84-86</sup>

## **5. CONCLUSIONS**

During the past three decades, the contents, methods and assessment of EBD education have been widely studied and discussed. However, the current literature focuses mainly on teaching of critical appraisal skills, traditional teaching methods, and short-term outcome assessments. Future research in this area can be aimed at integrating all EBD-related skills into educational models, studying multifaceted teaching approaches, and developing comprehensive teaching outcome assessment methods based on validated tools and dental patient-reported outcomes.

**Figure Captions:**

**Figure 1.** PRISMA flow diagram for article selection.

**Figure 2.** The taught skills, teaching methods and assessment strategies in evidence-based dentistry education.

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