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Using AI large language models to assess dental history in systemic conditions

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Abstract

Introduction Technological advancements, particularly in artificial intelligence (AI), are transforming the field of dentistry. AI—including machine learning (ML) and deep learning (DL)—mimics human cognitive processes to enhance diagnostics, treatment planning, and patient care. This study aimed to develop an AI-driven tool for the more effective and efficient evaluation of patients' dental histories and to compare the time required between AI-assisted and conventional methods.

Materials and methods HistorAI analyzes patient anamnesis forms and generates comprehensive reports. A 22-item anamnesis questionnaire, covering both oral and systemic health, guided the structured prompting of AI models (GPT-4 and Gemini). GPT-4 was integrated via an Application Programming Interface (API) to analyze data, provide treatment suggestions, generate prescriptions, and recommend referrals. Evaluation times and outcomes were compared between AI-assisted and conventional methods using descriptive statistics and independent-samples t-tests, with effect sizes calculated using Cohen's d, and significance set at $p < 0.01$.

Results HistorAI successfully evaluated medical and dental histories, identified contraindicated medications and anesthetics, assessed patient complaints, and provided preliminary treatment recommendations. The AI-assisted process significantly reduced the time required to complete dental history assessments compared with conventional methods ($p < 0.01$). A Cohen's d of 2.599 indicates a substantially higher efficiency for the AI-assisted group.

Conclusion The AI-powered tool enhanced efficiency and clinical decision-making in dental practice while maintaining clinician oversight. Further clinical validation and careful consideration of ethical implications are essential to ensure the safe and responsible integration of AI into dental workflows.

Keywords Artificial intelligence, Medical history, Case examples

1 Introduction

Accurate medical and dental histories are essential for safe and effective patient care. Comprehensive histories provide critical information regarding medications, systemic conditions, and potential treatment risks. The proper collection and documentation of

patient history is both a professional skill and a fundamental responsibility for dental practitioners [1].

Previous studies indicate that thorough histories can prevent up to 90% of high-risk situations and reduce medical costs by 15–30%, highlighting not only therapeutic but also economic benefits associated with accurate and complete data collection [1, 2].

Dentistry has historically integrated technological innovations, and artificial intelligence (AI) now represents a significant advancement with the potential to enhance diagnostics, treatment planning, and clinical decision-making [3–5]. AI systems are capable of simulating human cognitive functions and have been employed across various medical domains, including early disease detection, personalized medicine, drug development, and prediction of treatment outcomes [6–8].

In dentistry, AI applications primarily aim to improve diagnostic accuracy, support clinical decision-making, enhance treatment planning, and predict treatment outcomes, with diagnostic performance being the most extensively studied aspect. By streamlining these processes, AI can substantially increase diagnostic efficiency, reduce the workload of dental practitioners, and minimize patient chair time, thereby optimizing overall patient and treatment management within clinical practice. Moreover, as the acquisition of patient histories during initial consultations is often time-consuming and prone to incomplete or inaccurate data, AI-assisted approaches can facilitate more comprehensive and reliable collection of patient information, ultimately supporting more effective clinical decision-making [9–14].

This study aimed to develop a software tool that leverages AI to rapidly and accurately assess dental patients with systemic conditions and to compare the time efficiency of this AI-assisted approach with conventional medical history-taking conducted by dentists.

2 Materials and methods

In this study, we developed an AI-powered tool, **HistorAI**, designed to assist dental practitioners by analyzing patient-submitted anamnesis forms and generating concise, clinician-oriented reports. The subsequent sections outline the systematic development and implementation of this platform [16].

2.1 Dental history form design

The study commenced with the development of a structured dental history form by the research team at Istanbul Kent University. The form consisted of 22 essential items designed to capture comprehensive medical and dental histories while streamlining data collection and minimizing patient burden. The form was subsequently digitized, enabling patients to complete it online and facilitating seamless integration with the AI system. Questions were systematically structured to address both oral and systemic health conditions, including examples such as:

- "What is your primary health concern?"
- "Have you ever been diagnosed with a chronic disease?"

The completed form is administered to patients through both conventional and digital methods. Upon submission, the dentist evaluates the information using the traditional approach, whereas AI-assisted submissions are processed by the system, which

generates concise, clinician-oriented reports and delivers them via email to support clinical decision-making and provide medical guidance.

2.2 Database creation and case utilization

To develop the HistorAI system, a database comprising 77 patient cases was initially established using collected dental and medical history forms [3]. Each case included patient-reported complaints and pertinent background information, which were stored in both Excel and PDF formats for reference.

Rather than training a new AI model from scratch, this case database was employed to guide the responses of AI tools, specifically GPT and Google Gemini. Outputs generated by GPT-4 (OpenAI, 2024) and Gemini 1.5 Pro (Google DeepMind, 2024) were compared using identical structured prompts derived from the database. Comparative evaluations focused on diagnostic consistency and medical terminology accuracy, with GPT-4 demonstrating superior precision and contextual reliability. Consequently, all subsequent development and analyses were conducted exclusively with GPT-4.

Upon submission of a new patient form, the system cross-references the input against the existing database to identify analogous cases. These reference cases inform the AI's interpretation of the new patient data, enhancing the accuracy and clinical relevance of its recommendations. This approach allows the AI to contextualize novel information effectively, generating precise and clinically meaningful suggestions without necessitating retraining or reconstruction of the underlying AI architecture.

2.3 AI integration and report generation

HistorAI utilizes GPT-4 via an API to analyze patient-submitted history forms and generate structured, clinician-oriented reports that include medication recommendations, risk assessments, and referral guidance. Custom-designed prompts were developed to guide the AI in producing preliminary reports for dental practitioners. Each report provides:

- Suggested medications, cross-checked against the patient's current prescriptions,
- Alerts regarding potential side effects or treatment-related complications,
- Recommendations for referrals to relevant departments or specialists.

Following report generation, clinicians can interact with the AI through iterative queries to obtain further clarification or detailed guidance, thereby enhancing the clinical applicability of the tool. With each new submission, the system integrates the latest patient data alongside relevant cases from the existing database, ensuring contextually informed outputs, reducing errors, and improving the overall reliability and precision of its recommendations.

2.4 Fine-tuning the AI through prompting

No AI model was trained from scratch. Instead, GPT-4 responses were guided using structured prompts derived from real patient cases, ensuring accurate, clinically relevant recommendations without the need for large-scale model training. This approach, commonly referred to as example-based prompting or prompt-guided reasoning, combines carefully designed instructions with representative case examples from the database to generate reliable and efficient outputs.

This strategy enabled the production of accurate and actionable recommendations without reliance on extensive datasets or complex model retraining. It illustrates how existing AI tools can be effectively leveraged in a cost-efficient and practical manner to support dental practitioners in clinical decision-making.

2.5 Example of the dental history form

1. Are you currently experiencing any dental symptoms? (pain, sensitivity, swelling, or inflammation)
2. Do you experience pain when chewing or applying pressure to your teeth?
3. Do your teeth react to sweet, sour, or temperature changes?
4. Do you have any pain or discomfort in your jaw, joints, or face? (e.g., clicking or popping sounds, difficulty opening your mouth)
5. Do you have any signs of inflammation in your mouth? (redness, swelling, fever)
6. Are you experiencing gum issues such as bleeding, pain, or inflammation?
7. Do you have any old prosthesis or dental restoration problems?
8. Are you currently taking any medications or herbal supplements? If yes, please specify.
9. Have you been diagnosed with any chronic diseases? (e.g., cardiovascular disease, diabetes, kidney or liver disease) If yes, please specify.
10. Do you have any joint or muscle pain? (e.g., neck, shoulders, jaw) If yes, please specify.
11. Do you suffer from any immune-related conditions? (e.g., allergies, autoimmune diseases, HIV/AIDS) If yes, please specify.
12. Have you been diagnosed with any serious conditions such as cancer? If yes, please specify.
13. Have you had any significant health events recently? (e.g., surgeries, accidents, trauma) If yes, please specify.
14. Do you smoke? If yes, how many cigarettes per day?
15. Do you consume alcohol? If yes, how often and what type?
16. Do you have any known allergies? (e.g., medications, foods, anesthesia) If yes, please specify.
17. Do you experience issues related to your cardiovascular system? (e.g., hypertension, tachycardia) If yes, please specify.
18. Do you have any gastrointestinal problems? (e.g., constipation, bulimia) If yes, please specify.
19. Are you pregnant or in menopause?
20. Do you have a history of autoimmune diseases in your family?
21. Do you have any vitamin deficiencies? (e.g., vitamin D deficiency or excess) If yes, please specify.
22. Have you had any oral infections such as oral candidiasis or herpes simplex?

We evaluated 10 sample cases by dividing them into two groups: one assessed by a dentist with five years of clinical experience and the other analyzed using the AI-powered tool. In the conventional group, the dentist reviewed patient information after the history form was completed. In the AI group, digitally submitted forms were processed by the AI system, which then generated and emailed a report to the dentist. The time required for case evaluation in both groups was recorded and compared.

To illustrate the process, the responses and recommendations generated for the two most frequently encountered cases are presented below.

2.6 Case 1

2.6.1 Dental history (medical) summary

A 33-year-old male patient with HIV presents with complaints of dental pain, tenderness to pressure, and signs of oral inflammation, including gum issues such as bleeding and pain. The patient is on HIV medications and smokes one box of cigarettes daily but does not consume alcohol [17].

2.6.2 The practitioner's role

Treatment Initiation: Based on the presence of oral inflammation and gum issues, anti-inflammatory and antimicrobial treatment is recommended. Monitoring oral health is crucial, as the patient is on HIV medication that can influence oral health.

2.6.3 Prescription

Metronidazole tablets 500 mg

Directions: PO 500 mg twice a day for 7–10 days. This will address the bacterial component typically associated with gum infections in immunocompromised individuals.

Chlorhexidine gluconate oral rinse 0.12%

Directions: Rinse with 15 ml for 30 s twice daily after brushing to manage oral bacterial load and encourage gum healing.

Artificial saliva as needed

Directions: Use especially if mouth dryness is an issue with HIV medication or smoking.

2.6.4 Dental branch recommendation

Periodontology: Referral to a periodontist for a full periodontal evaluation and treatment to prevent further gum disease progression and manage current gingival inflammation.

Oral Medicine: Given the HIV status and complex oral health, consulting an oral medicine specialist for comprehensive oral care management.

2.6.5 Precautions

Smoking Cessation Advice: The patient is advised to quit smoking as it adversely affects gum health and contributes to periodontal disease progression, especially in the presence of HIV.

Drug interactions: Avoid combining metronidazole with alcohol to prevent an adverse reaction. Since the patient does not consume alcohol, monitor for potential interactions with HIV medications.

Side effects of medications: Metronidazole may cause taste changes and gastrointestinal discomfort; Chlorhexidine may lead to tooth and tongue staining.

Oral hygiene maintenance: Encourage diligent oral hygiene practices including gentle brushing and flossing, particularly given the patient's susceptibility to infections due to their immunocompromised status.

Missed dose instructions: If a dose is missed, take it as soon as remembered but skip it.

if it's almost time for the next scheduled dose to avoid double dosing.

2.7 Case 2

2.7.1 Dental history (medical) summary

A 23 years old female patient with Type 1 Diabetes experiences dental symptoms, notably pain when chewing, sensitivity to sweet, sour, or temperature changes, and issues with existing dental restorations. The patient is currently taking medications but has not specified which ones. They do not have any signs of oral inflammation or gum issues, and they do not smoke or consume alcohol. There is no reported history of recent significant health events or oral infections [17].

2.7.2 The practitioner's role

Observation and Diagnosis: The primary concerns include sensitivity and discomfort related to old dental restorations that may require evaluation for leaks or decay. Treatment Initiation: Consider scheduling an appointment for a thorough dental examination and potential adjustment or replacement of compromised restorations.

2.7.3 Recommendation

Restorative Dentistry: Evaluation to assess the integrity of existing restorations and to determine if replacement or repair is needed.

Desensitizing Treatment: Prescribe a toothpaste for sensitivity that contains potassium nitrate to help manage the discomfort associated with tooth sensitivity.

2.7.4 Dental branch recommendation

Endodontics: If the dental restorations are compromised, referral to an endodontist may be required if any pulpal involvement is suspected.

Prosthodontics: Consultation for potential full coverage restorations if conservative management is insufficient.

2.7.5 Precautions

Diabetes Management: Emphasize the importance of optimal glycemic control to prevent oral complications associated with diabetes.

Monitoring for Infections: Advise the patient to report any signs of oral infections promptly, given the potential for delayed healing in diabetic patients.

Oral Hygiene Maintenance: Regular dental check-ups and meticulous oral hygiene should be encouraged to prevent issues related to diabetes.

Missed Dose Instructions: If routine medication doses are missed, patients should not double up but consult their healthcare provider for guidance.

2.8 Statistical analysis

See Table 1.

Statistical methods

Statistical Methods was conducted using SPSS version 24.0 (IBM Corporation, Armonk, NY, USA). Descriptive statistical methods (mean, standard deviation, median, minimum, maximum) were employed to evaluate the study data. Independent samples t-test was used to compare completion times between the AI group and dentist group. Cohen's d was calculated to assess effect size. Statistical significance was evaluated at $p < 0.01$ levels.

Table 1 Evaluation of completion times by groups

	Dentist group		AI group		[a]*p*
	Mean ± Sd	**Min-Max (Median)**	**Mean ± SD**	**Min-Max (Median)**	
Completion Time	14774.10 ± 3794.41	9391–22,453 (13677.50)	7135.30 ± 1075.08	5800–9500 (6889.50)	**0.001****

[a]Independent Sample T Testi ***p* < *0,01*

Completion times differed significantly between the two groups (*p* < *0.001*). The AI-powered tool achieved substantially shorter evaluation times compared to the conventional method. A Cohen's d value of 2.599 further indicates a large effect size, confirming that the AI-based approach was considerably more efficient than evaluations conducted by the dentist

3 Results

This pilot study aimed to provide information regarding the appropriate clinical discipline for patient referrals while comparing conventional and AI-assisted evaluation methods. A total of 10 patients were assessed in two groups. In the first group, dental history forms completed using the conventional method were evaluated by a dentist. In the second group, forms were completed digitally and analyzed using the AI-powered HistorAI tool. Evaluation durations were compared between the two groups.

Analysis of the results demonstrated that, in each case, the AI-assisted tool processed dental history forms in significantly less time than the conventional approach, with a statistically significant difference observed between the groups.(Table 1).

To illustrate the tool's functionality, two representative cases were selected from the 10 evaluated patients, both with systemic conditions (Type 1 Diabetes and HIV). In these examples, AI-assisted evaluations provided clinicians with automated consultations and treatment recommendations, highlighting systemic considerations, whereas conventional methods required manual assessment and interdisciplinary consultation.

Case 1: A 33-year-old male patient with HIV presented with dental pain, gingival bleeding, and oral inflammation. The patient reported smoking one pack of cigarettes daily and abstaining from alcohol. HIV treatment may affect oral health. The AI-assisted evaluation recommended metronidazole 500 mg twice daily for 7–10 days, chlorhexidine gluconate 0.12% oral rinse twice daily, and artificial saliva as needed. Referral to a periodontist for periodontal evaluation and an oral medicine specialist for complex oral health management was advised. Smoking cessation and avoidance of alcohol during metronidazole therapy were recommended, alongside instructions for proper oral hygiene and adherence to the prescribed regimen.

Case 2: A 23-year-old female patient with Type 1 Diabetes presented with dental sensitivity and discomfort associated with existing restorations. She did not smoke or consume alcohol, and no signs of oral inflammation or gum disease were present. The AI-assisted tool recommended a comprehensive dental examination to assess restorations, potential repairs or replacements, use of potassium nitrate-containing desensitizing toothpaste, and referral to an endodontist or prosthodontist if pulpal involvement or restoration failure was suspected. Emphasis was placed on optimal glycemic control, monitoring for oral infections, and maintaining meticulous oral hygiene practices.

Overall, the AI-assisted tool provided comprehensive evaluations of patient complaints, highlighted potential issues related to systemic conditions, and identified possible drug interactions. In contrast, the conventional approach required the dentist to manually review forms, take notes, identify consultation needs, determine contraindicated medications, and make final clinical decisions.

4 Discussion

In the biomedical domain, artificial intelligence (AI) has evolved from theoretical computational modeling to the development of sophisticated systems capable of processing and interpreting clinical data, with the ultimate aim of enhancing medical and dental decision-making [18]. AI has become an integral component of contemporary dentistry, improving diagnostic precision, predicting treatment outcomes, and supporting clinical decision-making. These systems hold substantial promise for increasing diagnostic efficiency and accuracy, thereby alleviating the workload of dental practitioners [19–21].

AI is also instrumental in predicting and preventing medical conditions through the systematic analysis of patient data. By evaluating variables such as medical history, clinical findings, and lifestyle factors, AI can estimate disease risk, enabling earlier interventions and improved treatment outcomes. Moreover, AI can process extensive clinical datasets—including imaging and electronic health records—more efficiently than humans, facilitating faster and more precise diagnoses while minimizing the risk of human error [22–24].

Dentists must rely on their accumulated clinical expertise to diagnose conditions, determine appropriate treatment strategies, and anticipate patient outcomes. AI applications can serve as decision-support tools, guiding clinicians toward more informed judgments and enhancing both the quality and consistency of care [21, 25, 26].

When evaluating conventional diagnostic approaches versus AI-assisted dental history tools, several considerations are paramount. In traditional practice, dentists manually review results and, when necessary, consult with other specialists, often resulting in additional appointments and extended treatment timelines [27]. In contrast, AI-based anamnesis tools can generate automated consultations and provide treatment recommendations based on accessible patient data. While clinical judgment and interdisciplinary consultation remain indispensable, AI serves as a valuable adjunct, streamlining workflows and improving overall efficiency.

Nevertheless, the reliability of AI-generated recommendations is inherently dependent on data quality. Inaccurate or incomplete data can yield erroneous conclusions. Ensuring data integrity and restricting AI systems to secure, closed environments—as implemented in our AI-powered dental history platform—enhances both reliability and clinical utility [28, 29].

Accountability is a critical concern in clinical AI integration, involving multiple stakeholders such as healthcare institutions, practitioners, developers, and regulatory authorities. Determining liability is complex, encompassing both legal and ethical dimensions. In the absence of comprehensive legal frameworks, responsibility may primarily rest with dental practitioners. However, insufficient institutional support or inadequate user training may extend liability to healthcare organizations or governmental entities. Additionally, developers may be held accountable for adverse outcomes resulting from design flaws, algorithmic bias, or insufficient quality assurance [27, 28].

Ethical obligations similarly extend to patient information management. Dental professionals must ensure that patient data are used solely to advance treatment and never to the patient's detriment. Patients retain the right to access their personal data, understand its use, and request restrictions or deletion as appropriate. Given the central role of data in AI and deep learning systems, robust security measures—including anonymization and encryption—are essential to safeguard privacy. Balancing transparency

and data security is critical: transparency fosters trust and accountability in AI systems but must be carefully managed to prevent potential privacy breaches [30, 31].

HistorAI demonstrates substantial potential as a supportive AI system within clinical settings. However, further research is necessary to rigorously evaluate its diagnostic accuracy, safety, and overall clinical performance. This study establishes a methodological framework for AI-assisted anamnesis analysis but does not comprehensively assess the model's clinical validity or regulatory compliance. Consequently, HistorAI should currently be regarded as a proof-of-concept prototype intended for research and educational purposes, rather than a fully validated clinical tool. Future investigations should prioritize clinical validation studies, model interpretability, and the establishment of standardized safety benchmarks to ensure responsible, evidence-based integration of such AI technologies into professional healthcare practice.

5 Conclusion

Artificial intelligence (AI) holds considerable promise in enhancing dental practice by supporting diagnostics, guiding clinical decision-making, and improving overall patient care efficiency. Nevertheless, clinicians retain ultimate responsibility for patient outcomes.

At present, no clear legal or regulatory frameworks govern AI in dentistry, and questions of liability for AI-generated errors remain unresolved. As AI technology advances, the establishment of comprehensive guidelines to ensure its safe and ethical application is essential.

Our findings indicate that AI can assist in evaluating patient data and guiding referral decisions; however, further validation is required. While the current system performs reliably with familiar data patterns, broader and more diverse datasets, overseen by clinicians and supported by advanced machine learning techniques, are necessary to enhance both accuracy and robustness.

Integrating AI into dental education is equally critical. Curricula should incorporate AI training to prepare future practitioners for a technology-driven profession, with academic institutions playing a central role in fostering AI literacy and innovation.

Despite its potential, challenges such as data bias, privacy, and ethical considerations—particularly in the context of the doctor-patient relationship—must be addressed meticulously. Human interaction remains essential, and AI should augment, rather than replace, this interaction.

Future work will focus on expanding the dataset to over 500,000 cases and developing specialized AI models to further improve accuracy and reliability. With appropriate validation, interdisciplinary collaboration, and rigorous ethical oversight, AI has the potential to transform dental practice, enabling more efficient, effective, and patient-centered care.

HistorAI, specifically, demonstrates promise as a supportive clinical AI tool; however, additional validation is required before it can be reliably implemented in routine practice.

Author contributions

Osman Bilal Kandaz and Yegane Guven wrote the manuscript. Tibet Teksoz and Can Sarpkaya created the anamnesis form via artificial intelligence and prepared the video.Cagdas Avlayici evaluated the results of anamnesis forms.

Data availability

All data supporting the findings of this study are available within the paper and its Supplementary Information.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the principles of the Declaration of Helsinki and received ethical approval from the the Istanbul Kent University Health Sciences and Scientific Research Ethics Committee under the document number: 2025/8. All procedures involving human participants were performed in accordance with institutional guidelines. All participants provided informed consent prior to their inclusion in the study. They were fully informed about the purpose of the research, procedures, potential risks, and benefits, and confirmed their voluntary participation.

Consent for publication

All participants consented to the publication of anonymized data derived from their participation. Any identifying information has been removed to ensure confidentiality.

Competing interests

The authors declare no competing interests.

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