

EDITORIAL

Ethical Application of Artificial Intelligence (AI) in Dental Research

Artificial intelligence (AI) is the capacity of machines to carry out human-like cognitive and intellectual tasks.¹⁻⁵ AI has the potential to improve patient outcomes, increase diagnostic precision, and optimize workflows in dentistry. The use of AI in dental research and practice raises a number of important ethical concerns, such as data privacy, algorithmic bias, a lack of transparency, difficulties with accountability, and upholding human oversight.⁶ AI requires a lot of patient data, which raises the possibility of breaches, misuse, and re-identification. As a result, robust encryption, anonymization, and explicit consent are required.⁷

AI delineates^{8,9}.

Artificial intelligence: A technology that aims to create a machine (algorithm-software) that can mimic intelligent human behavior.

Machine learning: A part of AI, which depends on algorithms to predict outcomes based on a dataset.

Neural networks: A set of algorithms that compute signals via artificial neurons, and that function like the human brain.

Deep learning: A component of machine learning that utilizes the network.

AI in Dentistry primarily employs two types of neural networks (NN)^{8,9}.

Convolutional Neural Networks (CNNs):

- CNNs are particularly adept at processing visual imagery.
- They are used extensively in analyzing dental radiographs and scans, where they can identify patterns and anomalies that might escape the human eye.
- Their application in detecting minute changes in tooth structure, bone density, and even soft tissue anomalies is groundbreaking.

Artificial Neural Networks (ANNs):

- ANNs mimic the functioning of the human brain and are utilized in various aspects of dentistry.
- These networks can process numerous data inputs, from patient medical histories to specific dental measurements, aiding in complex decision-making processes like predicting treatment outcomes or assessing the risk of certain dental conditions.

AI plays a crucial role in modern dental practices by providing easy access to electronic health records (EHRs) and assisting in the prompt detection of abnormalities. It enhances efficiency and precision in dental care through AI-driven virtual dental assistants, which streamline administrative tasks and aid in diagnosis and treatment planning. AI also helps shorten chairside time, improve infection control, and ensure high-quality treatment.¹⁰

Research question: how to describe PICO elements in AI in dentistry- PICO (P =Population; I =Intervention; C =Comparison; and O =Outcome)?⁸

Population: Patients diagnostic images related to oral and maxillofacial regions [clinical images, radiographs, CBCT, confocal laser endomicroscopy (CLE) Images, intraoral fluorescence images, cephalometric radiographs, near-infrared-light transillumination (NILT) images].

Intervention: AI based models for diagnosis, treatment planning, clinical decision making, predicting the need for treatment, and predicting the prognosis.

Comparison: Expert opinions, reference standards.

Outcome: Measurable or predictive outcomes such as accuracy, sensitivity, specificity, ROC =receiver operating characteristic curve, AUC =Area Under the Curve, ICC =Intraclass. Correlation Coefficient, Positive/Negative Predictive Values (PPV/NPV).

Patients must be aware of AI's function, how their data is utilized, and any potential hazards or advantages to grant informed consent. Unfair treatment may result from AI trained on non-representative data that may exacerbate current health inequities. To ensure fairness, train AI on a variety of sample datasets by establishing systems that prioritize patient welfare, justice, and privacy, training dentists how to assess and use AI tools critically, encouraging cooperation and openness between patients, practitioners, and developers.¹² Dental research and practice can ethically utilize AI's potential to enhance care by addressing these problems. Providers, patients, researchers, industry, and other stakeholders should take these concepts into account while creating, executing, or accepting AI applications in dentistry.

Diligent and ethical AI use in Dentistry has to consider: i) when to apply AI; ii) How to use AI appropriately and responsibly; and iii) How to avoid unethical behavior?¹¹⁻¹³

When to use AI?

- Does AI-software support the principle of the best outcome for patient with the least intervention?
- Are there published studies to support these claims?
- Is there a legal regulation surrounding its use?
- Is informed consent necessary?

How to use AI?

- The prudent dental practitioner who aims to use AI must resolve the following:
- Is there a legal regulation surrounding its use?
- Who is accountable if unwanted effects occur while using AI?
- How to manage data obtained while using AI.

How to avoid unethical behavior?

- A regulatory body should monitor the ethical use of AI in dentistry.

Regulatory Framework to Implement Ethical Dentistry:^{13,14}

Compliance with health regulations: Applications of AI in dentistry must abide by current healthcare laws, notably those pertaining to patient data protection and medical equipment. In

order to better support AI technologies, regulatory agencies are updating these frameworks.

Quality and safety standards: Regulations are being created to guarantee that AI technologies in dentistry adhere to safety and quality requirements. This involves thoroughly evaluating and validating AI technologies for usage in clinical settings.

Professional guidelines: Professional dental organizations are creating recommendations to assist practitioners in appropriately incorporating AI into their clinics in addition to regulatory laws. These rules address patient communication, continuing education, and the ethical usage of AI.

The “Eleven Ethical Pillars” to be considered when researching, marketing or using an AI tool in dentistry: a) Transparency, b) Diversity, c) Wellness, d) Respect of autonomous decision-making, e) Protection of privacy, d) Accountability and responsibility, e) Equity, f) Prudence, g) Sustainable development, i) Solidarity, and j) Governance.^{11,12}

FUTURE OF AI APPLICATIONS IN DENTISTRY¹²⁻¹⁴

AI in Dental Education and Training:

- Personalized learning platforms for dental students.
- AI for continuous professional development.
- AI-powered simulation tools for practical training.

Emerging AI Trends in Dentistry:

- AI-driven nanotechnology in Oral care.
- AI for regenerative Dentistry.
- The role of AI in personalized medicine for dental treatments.

Forecasts for AI progress in the coming Decade:

- Expansion of AI driven diagnostics and treatment automation.
- AI integration with Augmented reality (AR) and Virtual reality (VR) for advanced dental simulations.
- Future impact on global dental healthcare accessibility.

AI is increasingly incorporated into dentistry to assist advance clinical dentistry. Dentists must be the final decision-makers, utilizing AI as a tool rather than a substitute, and establishing clear guidelines for who is responsible for AI mistakes. Ethical frameworks place a strong emphasis on creating precise rules for data security, openness, and regulatory body validation in order to overcome these difficulties.

Keywords: Dental research, artificial intelligence (AI), ethical application of AI.

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