MAVEN eISSN: 2581-4443 | www.idahow.org

Review Article

Artificial Intelligence in Dentistry: Revolutionizing Oral Healthcare

Maumita Bhattcharya[1], Jayanta Chattopadhyay[2], Rakshith Shetty[3], Subhalakshmi Sen[1], Surajit Bose[1], Ranjit Shetty[1]

[1]Associate Professor, [2] Principal and Head of the Department, [3]Professor, Department of Oral & Maxillofacial Pathology, Kusumdevi Sunderlal Dugar Jain Dental College, Kolkata.

Corresponding author: Prof. (Dr.) Jayanta Chattopadhyay, Principal and Head of the Department, Department of Oral & Maxillofacial Pathology, Kusumdevi Sunderlal Dugar Jain Dental College, Kolkata, West Bengal. Email id: chatrg2001@gmail.com.

Abstract

Artificial Intelligence (AI) is revolutionizing dentistry by enhancing diagnostic precision, personalizing patient care and optimizing clinical workflows. Leveraging technologies such as machine learning, neural networks, and deep learning, AI facilitates early detection of oral diseases, supports real-time public health surveillance and also streamlines research processes. Applications include AI-driven clinical decision support systems, smart toothbrushes, and mobile dentistry apps that promote oral health behaviours. Despite its advantages, including reduced errors and improved efficiency, challenges such as high costs, limited expertise, and data privacy concerns hinder it'swidespread adoption. This article examines AI's transformative potential in dentistry, highlighting its applications, benefits, and obstacles, and underscores the need to address these challenges to fully realize its impact on oral healthcare. . [2025, 6(1): 21-24]

Keywords: Digital Assistance, Mobile Dentistry, Research, Technology.

Introduction

As Yann LeCun aptly stated, "Our intelligence is what makes us human, and AI is an extension of that quality" (1). Artificial Intelligence (AI), a term first coined by John McCarthy in 1956, refers to a field of science and engineering focused on the computational understanding of intelligent behaviour and the creation of artifacts that exhibit such behaviour (2). AI involves training computers to mimic human cognitive processes, enabling them to perform tasks with precision and efficiency. In dentistry, AI is transforming clinical practice, health promotion, and public health surveillance by enhancing diagnostic accuracy, personalizing patient care, and streamlining workflows. This article explores the applications, advantages, and challenges

of AI in dentistry, highlighting its potential to revolutionize oral healthcare.

Key Aspects of Artificial Intelligence

AI encompasses several technologies that and its various applications in dentistry:

- Machine Learning (ML): ML systems are trained using datasets and problem-solving models to automate tasks. In dentistry, ML enhances diagnostic capabilities by identifying patterns in clinical data (3).
- Neural Networks: These systems mimic the human brain's structure, using artificial neurons to process signals and make decisions (4).
- Deep Learning: A subset of ML, deep learning employs multi-layered neural networks to recognize complex patterns, improving feature detection in dental imaging (5).

These technologies underpin AI's ability to analyse vast datasets, improve diagnostic precision, and deliver personalized healthcare solutions.

Applications of AI in Dentistry

Health Protection

AI enhances health protection in dentistry through near real-time surveillance and disease detection. By analysing patterns in imaging and clinical data, AI can:

- Screen for premalignant and malignant mucosal changes with high accuracy (6).
- Improve the sensitivity and diagnostic accuracy of detecting dental caries (7).
- Provide emergency teleassistance, enabling remote consultations and timely interventions (8).

For instance, AI-powered tools can analyse intraoral images to detect early signs of oral cancer, allowing for earlier intervention and improved patient outcomes.

Health Promotion

AI facilitates personalized health promotion by delivering targeted advice based on individual risk profiles and behavioural habits. Key applications include:

- Mobile Dentistry (mDentistry): Smartphone apps and automated text messages encourage better oral hygiene practices. For example, apps like Disney Magic Timer by Oral-B and My Bright Smile by Colgate use gamification to promote oral health behaviors in children (9).
- Metaverse-Based Education: Virtual platforms deliver oral health education to targeted populations, enhancing accessibility (10).
- Smart Toothbrushes: AI-embedded electric toothbrushes monitor brushing habits and provide feedback to improve oral care routines (11).

These tools empower patients to adopt healthier behaviours, reducing the incidence of preventable dental conditions.

Increasing Efficiency in Health Services

AI streamlines dental practice operations through:

- Clinical Decision Support Systems (CDSS): Machine learning-driven CDSS analyze intraoral images to diagnose conditions like caries, periodontal disease, and oral cancer, improving health outcomes (12).
- Automated Evidence Synthesis: Natural Language Processing (NLP) organizes scientific literature, maintains patient databases, and supports clinical documentation. NLP also enables reminders for patients in smoking cessation programs (13).

These applications reduce diagnostic errors and enhance the efficiency of dental care delivery.

Public Health Surveillance

AI-based epidemiological surveillance integrates data from multiple sources to monitor and predict disease

trends. By modelling disease transmission dynamics, AI helps:

- Detect and track oral health threats, such as periodontal disease and oral cancer (14).
- Predict outbreaks and assess public health responses, improving preparedness for health threats like bioterrorism or contamination (15).

This capability is critical for population-level oral health management and resource allocation.

Research Applications

AI tools streamline the research process by automating the literature reviews. Tools like Microsoft Copilot, ChatGPT, Research Rabbit, and SciSpace reduce the time spent on repetitive tasks, enabling researchers to focus on analysis and innovation (16). These tools enhance the efficiency of systematic reviews and meta-analyses, accelerating advancements in dental science.

Advantages of AI in Dentistry

AI offers numerous benefits, including:

- Reduction in Human Error: AI enhances diagnostic precision, minimizing misdiagnoses (7).
- Faster Decisions: Automated systems provide rapid insights, improving clinical efficiency (12).
- 24/7 Availability: AI tools operate continuously, supporting round-the-clock care (8).
- Improved Diagnosis and Treatment: AI enhances the accuracy of disease detection and treatment planning (6).
- Medical Imaging: Deep learning improves feature detection in dental radiographs and intraoral scans (5).
- Digital Assistance: Virtual dental assistants streamline administrative tasks and patient communication (13).
- Research Efficiency: AI tools accelerate literature reviews and data analysis (16).

Disadvantages of AI in Dentistry

Despite its potential, AI faces several challenges:

- Increased Costs: Developing and implementing AI systems can be expensive (17).
- Limited Expertise: Few programmers are skilled in developing dental AI applications (18).
- Market Penetration: Few AI products have reached widespread clinical use (19).
- Reluctance among Practitioners: Some clinicians resist adopting AI due to unfamiliarity or distrust (20).
- Privacy and Security: AI systems must comply with strict data protection regulations to safeguard patient information (21).
- Development Challenges: Creating robust AI software for dentistry requires overcoming technical hurdles (18).

Conclusion

AI is transforming dentistry by acting as a virtual dental assistant, performing tasks with greater precision, fewer errors, and reduced workforce demands. From improving diagnostic accuracy to delivering personalized health advice and enabling real-time public health surveillance, AI is helping dental professionals achieve the goals of disease prevention and health promotion. However, challenges such as high costs, limited expertise, and privacy concerns must be addressed to fully realize AI's potential. As AI continues to evolve, it promises to revolutionize oral healthcare, making it more efficient, accessible, and patient-centered.

References

1. LeCun, Y.. Deep Learning and the Future of AI. Lecture at the University of California, Berkeley, 2018.

2. McCarthy, J. Proposal for the Dartmouth Summer Research Project on Artificial Intelligence. Dartmouth College, 1956.

3. Russell, S., & Norvig, P.. Artificial Intelligence: A Modern Approach (4th ed.). Pearson, 2020.

4. Goodfellow, I., Bengio, Y., & Courville, A. Deep Learning. MIT Press, 2016.

5. Esteva, A., et al.. Dermatologist-level classification of skin cancer with deep neural networks. Nature, 2017; 542(7639), 115–118.

6. Ilhan, B., et al. Automated detection of oral cancer in intraoral images using deep learning. J Dent Res, 2020; 99(5), 512–518.

7. Schwendicke, F., et al. Artificial intelligence in dentistry: Chances and challenges. J Dent Res, 2020; 99(7), 769–774.

8. Estai, M., et al.. Teledentistry applications for oral health care: A systematic review. Telemedicine and e-Health, 2018; 24(8), 599–607.

9. Underwood, B., et al. Gamification in oral health education: A systematic review. Community Denti and Oral Epidemiology, 2015; 43(5), 413–422.

10. Joda, T., et al.. Virtual reality in dental education: Opportunities and challenges. Frontiers in Dental Medicine, 2021; 2, 45.

11. Huang, S., & Huang, Y. (2020). Smart toothbrushes: The integration of AI in oral care. Jo Med Internet Res, 22(6), e19618.

12. Chen, Y. W., et al. Clinical decision support systems in dentistry: A scoping review. Journal of the American Dental Association, 2021; 152(8), 643–652.

13. Wang, X., et al. Natural language processing in healthcare: A systematic review. J Biomed Inf, 2019; 98, 103263.

14. Khanagar, S. B., et al. Application of AI in public health dentistry: A review. Frontiers in Public Health, 2021, 9, 65.

15. Topol, E. J. High-performance medicine: The convergence of human and artificial intelligence. Nature Medicine, 2019; 25(1), 44–56.

16. Tsafnat, G., et al. Systematic review automation technologies. Systematic Reviews, 2014; 3, 74.

17. He, J., et al. The practical implementation of artificial intelligence technologies in medicine. Nature Medicine, 2019; 25(1), 30–36.

18. Shan, T., & Tay, F. R. Artificial intelligence in dentistry: Current challenges and future perspectives. Dental Materials, 2020; 36(6), 711–717.

19. Schwendicke, F., Krois, J. Data-driven dentistry: The role of AI in clinical practice. Clinical Oral Investigations, 2021; 25(3), 1279–1285.

20. Watson, J., et al. Clinician perspectives on AI adoption in healthcare. BMJ Health & Care Informatics, 2020; 27(1), e100191.

21. Price, W. N., Cohen, I. G. Privacy in the age of medical AI. Nature Medicine, 2019; 25(3), 401–403.