Artificial Intelligence in Paediatric Dentistry: Promise, Pitfalls, and the Path Forward

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ABSTRACT

Artificial Intelligence (AI) is revolutionising paediatric dentistry by addressing unique diagnostic and behavioural challenges. This review evaluates its clinical applications, ethical pitfalls, and the path toward responsible integration.

AI-driven tools—such as deep learning for radiographic caries detection and virtual reality for behaviour management—are enhancing diagnostic accuracy and patient cooperation. Additionally, predictive analytics support a shift toward proactive, personalised preventive care by identifying high-risk patients through behavioural and clinical data. Challenges: Barriers to adoption include high costs, algorithmic bias, and the critical need for long-term data protection for minors. Notably, AI cannot replicate the empathy essential to the paediatric dentist-patient relationship. In conclusion AI serves as a powerful assistive technology that enhances clinical expertise. Future success depends on robust regulatory frameworks and clinician-led governance to ensure safety, equity, and professional responsibility.

Key words: Artificial Intelligence, Paediatric dentistry, challenges.

INTRODUCTION

Artificial intelligence (AI) is an emerging field rapidly reshaping life in general and healthcare in particular, and dentistry is not an exception. AI systems are designed to trigger human intelligence through learning, reasoning, and decision-making and are increasingly influencing diagnostic accuracy, treatment planning, patient engagement, and clinical efficiency across dental disciplines.[1,2] Practice of paediatric dentistry represents a particularly compelling domain for AI integration, given the diagnostic complexity, behavioural challenges, and preventive focus required when treating children.

The application of AI in paediatric dentistry raises important clinical, ethical, and regulatory questions, warranting thoughtful discussion beyond technical performance alone.[2,3]

AI and the Unique Landscape of Paediatric Dentistry

Paediatric dentistry differs fundamentally from adult dental care due to distinct anatomical, developmental, and psychological considerations, including heightened dental anxiety and limited cooperation, which can negatively influence treatment outcomes.[4] Studies suggest that dental fear remains a significant barrier to effective paediatric oral healthcare, underscoring the need for innovative engagement strategies.[4]

AI offers tools that may help address these challenges. By analysing large datasets, AI systems can assist in the early detection of caries, developmental anomalies, and orthodontic risks—often before they become clinically evident.[5,6] However, the use of AI in paediatric dentistry raises concerns about

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consent, trust, and long-term data protection, thereby requiring heightened ethical scrutiny.[3,7]

Current Applications: Beyond Automation

AI in paediatric dentistry has progressed beyond administrative automation toward clinical decision support. AI-assisted radiographic interpretation, particularly using deep learning and convolutional neural networks, has shown high accuracy in detecting caries and periodontal changes, reducing diagnostic variability and supporting earlier intervention.[5,6]

In treatment planning, AI-driven simulations enable clinicians to visualise orthodontic outcomes and predict tooth movement, supporting personalised care while remaining under clinician oversight.[8] Behaviour management applications, including gamified oral hygiene tools and AI-enhanced virtual reality experiences, are increasingly being used to reduce dental fear and improve cooperation in children.[9]

Preventive Dentistry and Predictive Potential

The use of AI in preventive dental care shows considerable promise. By analysing behavioural, dietary, and clinical information, predictive analytics can help identify children at higher risk of dental caries or malocclusion.[10] When combined with mobile apps and wearable technologies, AI has the potential to support ongoing monitoring of oral hygiene practices and offer personalised guidance to parents and caregivers.[11]

If applied thoughtfully, these technologies could move paediatric dentistry towards a more proactive and prevention-focused approach. However, the accuracy of AI-driven predictions relies strongly on the quality and diversity of the data used. For this reason, clinical judgement remains essential, as algorithmic recommendations must be interpreted carefully to avoid unnecessary intervention or unequal care.[12]

Ethical, Practical, and Professional Challenges

Despite its potential, the use of AI in

paediatric dentistry remains limited by several practical and ethical challenges. The cost of implementation and the need for appropriate digital infrastructure can make these technologies difficult to access, especially for smaller or under-resourced dental practices.[9] In addition, adopting AI tools often requires specialised training, placing extra demands on dental professionals and dental education programmes.[13]

Ethical considerations are vital in paediatric care. When AI systems are developed with limited or unrepresentative data, there is a risk of algorithmic bias that could unintentionally reinforce existing inequalities in oral healthcare.[12] Protecting patient data is another major concern, as children's health information is highly sensitive and any misuse could have long-term consequences.[14,7]

Most importantly, AI cannot replicate the empathy, reassurance, and personal connection that are central to caring for children in a dental setting. While AI can assist clinicians in decision-making, it cannot replace the human interaction that builds trust among the dentist, the child, and their caregiver.

Future Directions and Editorial Perspective

In the future, AI is expected to become increasingly integrated with teledentistry, robotics, augmented reality, and wearable technologies. In particular, AI-supported teledentistry has the potential to improve

access to paediatric dental care in underserved or remote areas by enabling remote screening, monitoring, and follow-up care.[11]

However, the success of these developments will depend on the presence of strong regulatory frameworks, transparent algorithms, and governance led by dental professionals. International guidance, including recommendations from the World Health Organisation, highlights the need for ethical oversight, accountability, and patient-centred design when implementing AI in healthcare systems.[7]

From our standpoint, the central issue is not whether AI will shape the future of paediatric dentistry, but how it will be used. Its implementation must prioritise equity, safety, and professional responsibility. AI should be viewed as a supportive tool—one that enhances clinical judgement and expertise, rather than replacing the human role at the heart of paediatric dental care.[2,14]

CONCLUSION

Artificial intelligence has great potential for paediatric dentistry, offering advances in diagnosis, prevention, patient engagement, and clinical efficiency. Nevertheless, its long-term value will depend on responsible adoption, ethical safeguards, and sustained clinician involvement. By addressing challenges related to cost, bias, training, and regulation, AI can be considered as a powerful tool that supports high-quality, patient-centred paediatric dental care.

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