Review Article

Benefits and Challenges of Use of Artificial Intelligence in Oral Health Issues of Pediatric Patients

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ABSTRACT

Oral health is often disregarded, especially within pediatric populations, due to caregivers' persistent misconception that primary teeth are transient and will fall out. However, the significance of preserving primary dentition until exfoliation is underestimated, as most individuals remain unaware that primary teeth serve as a critical foundation for the eruption of permanent dentition. Many children do not receive routine oral examinations, leading to inadequate oral hygiene habits and dental caries. Compared to adult patients, gaining the cooperation of young children and their management during dental appointments is challenging. Incorporating artificial intelligence (AI) presents numerous advantages for this patient demographic. AI is progressively becoming a fundamental component of healthcare, wherein machines are programmed to emulate human cognitive functions. Imaging is used as a main resource in AI technology, and it is a cornerstone for dentistry. Visuals from AI can help with diagnosis and treatment, as well as simulate results and predict oral diseases. As every technology may have benefits and challenges to use, AI has its limitations and challenges. Training and education of medical staff may help overcome the challenges and use AI in managing oral issues in pediatric patients. Pediatric dental practices are rapidly integrating the AI movement in oral healthcare. The idea of using AI is to augment the knowledge of clinicians and not to replace them. This article provides an overview of AI technology use, benefits, and challenges in pediatric patients with oral health issues.

Key words: Artificial Intelligence (AI), Dental caries, Dental plaque, Gingivitis, Pediatric Dentistry

Artificial Intelligence (AI) can analyze dental radiographs to help detect early signs of oral health issues and timely intervention and preventive measures. AI can get more accurate diagnoses and reduce the risk of misinterpretation. AI can generate detailed treatment plans based on patient data, including 3D imaging, to optimize treatment strategies and improve outcomes. AI-powered interactive tools like virtual reality can help distract and calm anxious children during dental procedures, improving cooperation. AI can analyze individual oral health data to provide tailored recommendations for preventive care and hygiene practices. AI-enabled tele dentistry can improve access to dental care for children in underserved areas [1].

AI can be used to diagnose and treat various dental conditions, such as deciduous and young permanent tooth detection and ectopic eruption of teeth detection. Some of the children have anxiety about dental exams and dental procedures. AI technology can help with behavior modification. Al can perform fissure sealant categorization and can detect early childhood caries, supernumerary teeth, dental plaque, and dental maxillofacial fracture. Along with its significant benefits, if the challenges and limitations of AI are addressed, it can be a great tool in the management of the oral health of pediatric patients [2]. This article suggests the importance of AI technology in pediatric oral health issues. It highlights the importance of proper education and training of medical staff to use it in the best possible ways.

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Use of AI in different oral health issues in pediatric patients

AI can conduct risk assessments for prospective oral health conditions based on the current state of oral health. AI can be an educational tool for children to enhance their oral hygiene habits. It can improve the efficiency of appointment scheduling and patient data administration, which will optimize administrative functions and enable dental practitioners to focus entirely on the delivery of patient care [3].

AI technology can be adopted by clinicians and parents to keep a check on children's oral hygiene in day-to-day life. AI can never be a replacement for clinicians but can be of assistance in every area of oral health, including prevention, restoration, diagnosis, and management. AI can be a great asset for less experienced dentists in making more accurate diagnoses. These models are of great help at the individual and community levels and are effective in identifying and categorizing children into risk groups, identifying and numbering the tooth, diagnosing early ectopic eruption, and age

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assessment [4].

AI can be used in school oral health programs, thus making the children more aware of their own dental health. It can be used as a complementary aid for clinicians to provide better patient care. The study revealed that implementing virtual reality reduced average anxiety and behavioral scores in patients compared to the control group. Interactive and creative audiovisual representations in virtual reality are particularly appealing to children, contributing to their effectiveness in reducing anxiety [3].

AI algorithms can divide teeth into segments, identify caries, and offer valuable predictions. Image analysis can help to diagnose dental cavities. Anatomical and pathological structures can be found using algorithms. AI models can assist in anticipating the existence of early childhood caries (ECC) in preschool-aged children and can also predict caries risk factors based on genetic and environmental factors [5].

In assessing the child's oral health and management, AI can help to understand how data are collected, organized, and utilized, enhancing the quality of care provided. AI can help well organize the extensive medical records of children, which can ensure quick access to crucial information about a child's dental history, allowing for more personalized and child-centric care plans. AI has applications in orthodontics for treatment planning, locating multiple cephalometric landmarks, and predicting treatment results [6].

AI can be helpful in endodontics by evaluating the anatomy of the root canal system, identifying working length measures, diagnosing periapical diseases and root fractures, and forecasting the outcome of treatment. AI can help with precise shade matching, and algorithms are useful for automatically identifying cancer and periodontal disease [2].

AI helps in the management of children's oral health in many ways. However, it has some challenges and limitations. Emotions and unique needs of children may require a more personalized and empathetic approach, which AI might not be able to provide effectively. Building trust and rapport is crucial in pediatric patients, and AI might need to address these emotional aspects fully. The behaviors of children may change suddenly during the encounter from curiosity to fear and anxiety. AI may not be able to adapt and respond to sudden changes in behavior. Human touch may be more reliable in creating an overall positive patient experience, especially in patients with nonverbal cues. AI may misinterpret nonverbal communication, which can lead to suboptimal treatment [6].

Ensuring data safety becomes a crucial concern as AI systems can harm children if not programmed and supervised correctly. Overdependence on AI may interfere with the development of essential communication and coping skills in children, which are crucial for their overall emotional and psychological growth and should only be replaced partially by technology [7].

The complexity of pediatric dental procedures may limit the use of AI and require specific procedures with intervention by a dentist. Children are always accompanied by their parents during visits and procedures. AI might inadvertently disrupt the parent-child dynamic during treatments, as parents may feel less engaged or reassured by an AI presence than a human dentist. AI might lack the ability to learn from experiences in the same way that human dentists do, as they solely depend on feeding the data [8].

Children grow and develop through various developmental stages, which may create diverse pediatric age groups. Each group may have specific emotional, behavioral, and oral health needs. AI may not adequately adapt to those individual developmental stages. Any individualized plan with AI may need more data, which may lead to increased privacy and ethical concerns. It may warrant strict measures to safeguard sensitive information [9].

Another consideration while using AI is the possibility of amplification of anxiety due to unfamiliarity or misinterpretation. Pediatric behavioral management using AI applications may require a thoughtful approach to understanding each child's unique emotional journey and ensures that technology enhances rather than diminishes the human-centered care integral to successful pediatric dental practices overall. It's very essential to consider AI limitations and ethical implications before fully integrating it into everyday practice [10].

Collecting and storing sensitive patient data raises privacy issues that must be addressed. The accuracy of AI models depends on the data, which may be challenging to obtain in pediatric dentistry due to the diverse nature of children's dental needs. Misinterpretation of algorithms may require careful interpretation by dentists, which may increase work. Dental professionals may often be customized to use established protocols, and it may be difficult to integrate new technology into their practice. Future research may help to integrate the use of AI tools as a continuous learning activity for healthcare professionals. It may help to adapt the new technology as a daily work flow for the healthcare practice.

Disparities may arise due to limitations such as the cost and availability of AI. The involvement of policymakers and community engagement in designing and deploying AI solutions to ensure they are relevant and accessible and infrastructure development may help ensure equitable access to AI technology in underserved areas. AI algorithm biases may raise ethical concerns. Active monitoring for the use of transparent algorithms, use of data sets, obtaining informed patient consent, establishing clear accountability mechanisms, multidisciplinary collaboration, and regularly reviewing and updating AI models can help to address these issues [3]. The summary of the benefits and challenges of AI in pediatric dentistry is shown in table 1.

Table 1: Benefits and Challenges of AI in Pediatric Dentistry

Benefits	Challenges
Early detection of oral issues and extent of caries	Protection of patient data
Accurate diagnosis	Improper training can lead to misdiagnosis
Optimization of treatment planning	Needs data collection
Improved outcomes	Challenges to integrate with existing workflow
Help distract children during procedure to enhance cooperation	Costly
Recommend preventive care	Not available everywhere
Help to increase access to telehealth in underserved areas	Possibility of algorithm bias
Continuous monitoring of patients to track the long-term effects of drugs	Results depend on image accuracy
Benefit for professionals to save time	Misinterpretation of complex conditions due to improper training in AI may increase the work of professionals
Patients can get specific customized care	Lack of personalized interaction

CONCLUSION

AI is becoming an essential tool of healthcare management that assists clinicians. Assistance with AI may be beneficial, but complete dependence on AI could be harmful. More research is needed to educate and train clinicians, especially those taking care of pediatric patients, as children have unique needs. Proper use of benefits and considering limitations and challenges beforehand may help to use AI in the best possible way to help in the prevention, diagnosis, and management of oral conditions in pediatric patients.

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