AI in Prevention and Oral Care: Promise, Caution, and Responsibility



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Artificial intelligence is moving from research laboratories into everyday healthcare, and oral care is no exception. From earlier detection of disease to more personalised prevention and improved access to care, AI has the potential to transform how risks are identified and managed. But better algorithms do not automatically mean better healthcare. The real challenge is ensuring that AI tools are accurate, fair, transparent, and integrated in ways that strengthen – not replace – clinical judgement.

Artificial intelligence, or AI, is becoming more visible in healthcare. In oral care, this is attracting attention because many important problems depend on noticing risks early, choosing the right preventive action, and supporting professionals who work under growing time and resource pressure.

How AI could support prevention

One of the clearest potential benefits of AI is earlier detection. AI tools have shown promising results in detecting dental caries, with reported pooled sensitivity of 85% and specificity of 90% across imaging methods [1]. This means that such tools may help identify many cases of tooth decay while also avoiding false alarms.

AI may also support prevention by helping to estimate a person's risk. Some tools can analyse protective and risk factors and use this information to suggest more personalised preventive measures. Others, such as AI-powered toothbrushes, may track brushing patterns and support better oral hygiene habits [2]. This matters because prevention is not only about treating disease once it appears. It is also about understanding who may be at risk and what support they need before problems become serious.

What AI may offer in oral care

In gum health, AI models using intraoral photographs have detected gingival inflammation with sensitivity of 92% and specificity of 94%, described as comparable to manual examination by dentists [3]. For periodontitis, AI tools using radiographs have reached accuracies of 81–99% for simpler classifications, although performance is lower when assessing disease stage or severity [4]. This distinction is important; it means that an AI tool may be good at answering a basic yes-or-no question, but less reliable when asked to judge how advanced or complex a condition is.

AI is also being studied for oral cancer and potentially malignant disorders. AI-assisted screening has been reported to distinguish abnormal from normal oral tissue with sensitivity of 89.9% and specificity of 89.2% [5]. Deep learning models have also shown high performance for detecting oral squamous cell carcinoma, with reported AUC values of 0.97–1.00, a performance comparable to or exceeding general practitioners [6,7].

Another possible benefit is access. AI could support remote screening through teledentistry, especially in places where dental professionals are scarce. For example, intraoral photographs could be uploaded by patients or community health workers, with AI flagging areas that may need professional review [7,8]. AI may also support mid-level providers by analysing images and clinical data, or help with store-and-forward consultations, where information is reviewed later rather than during a live appointment [9,10].

Why caution is needed

Despite its promise, AI in oral care should be treated with caution. A major challenge is data. Many AI models are trained on limited datasets, often from a single centre, and may not be tested enough in other real-world settings. In periodontal AI studies, external validation was absent in 90.5% of studies, raising concerns about whether tools will work equally well across different clinics and populations [4].

Bias is another serious concern. Only 2 of 10 dental imaging AI studies reported demographic characteristics, and none performed subgroup analysis across age, sex, ethnicity, or socioeconomic groups [11]. This means that even when an AI tool appears accurate in a study, we may not know whether it works equally well for everyone in a real-world context.

Transparency is also essential. Some AI systems are described as "black boxes," meaning that clinicians cannot easily understand how the system reached its conclusion. This can reduce trust and make it harder to detect or correct errors [12,13]. Clinicians need to understand enough about an AI recom-

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ARTIFICIAL INTELLIGENCE

mendation to decide whether it makes sense for the person in front of them.
There are also practical barriers. AI tools may be difficult to connect with older electronic health record systems or existing clinical software. They may require high initial investment, create uncertainty about return on investment, or face resistance from IT and administrative teams [14,15]. In dentistry, adoption also appears to be uneven; one 2023 survey found that only 35% of experienced dentists reported using AI tools [16].

Who may benefit, and who may be left behind

While AI could help underserved populations, especially in areas with shortages of dental professionals; the same technologies could also deepen inequalities. Algorithmic bias may worsen existing disparities. For example, machine learning models predicting foregone preventive dental care showed bias against Asian, Black, Hispanic, and other racial or ethnic minority groups, as well as low-income individuals and younger adults [17]. Smartphone-based screening may also depend on reliable internet access, smartphone ownership, and digital literacy, which are not equally available to everyone [8].
This is why AI should not be judged only by whether it works in ideal study conditions. It should also be judged by whether it works fairly, safely, and meaningfully for the people and real-world settings where it will actually be used.

Keeping humans in charge

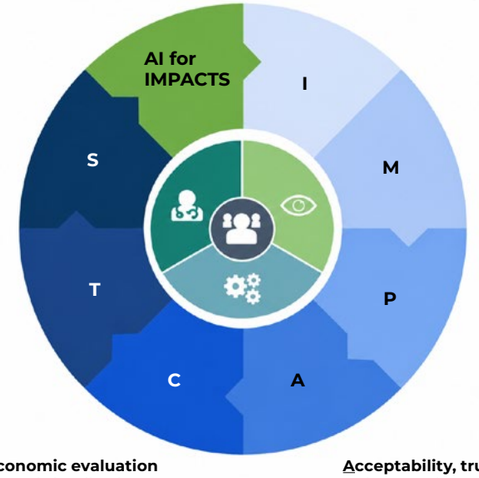
For these reasons, human judgement remains essential. AI systems do not inherently consider the consequences of misdiagnosis or act with the caution expected of a clinician [13]. Clinicians and patients also have concerns about over-reliance on AI and about who is responsible when AI-supported recommendations lead to harm [12,13].
Hence, AI should be seen as a support tool, not a replacement for healthcare professionals. Users should not rely only on AI recommendations, but should combine them with clinical expertise and patient-specific context [18]. This "human-in-the-loop" approach helps maintain accountability while still allowing AI to contribute useful information.

Asking the right questions before adoption

The concerns outlined above point to one central message: adopting AI in prevention and oral care should never be a matter of enthusiasm alone. Before an AI tool is introduced, we need to ask whether it is safe, fair, understandable, useful in everyday practice, and likely to create real value for patients and professionals. This is where assessment guides such as the AI for IMPACTS framework can provide practical guidance [19]. Developed through a collaboration between several Swiss universities and research institutions, including clinicians, AI engineers, UX experts, and implementation science experts, the framework was created to address a key gap: many AI tools are assessed mainly on technical performance, but far less often on whether they can succeed safely and meaningfully in real healthcare settings.
It asks whether an AI tool fits into clinical workflows, can be trusted by professionals and patients, protects privacy, performs fairly across different groups, is economically sustainable, and can be monitored over time. Its seven areas, highlighted in the figure below, cover integration, monitoring and governance, performance and quality, acceptability and training, cost and economic value, technological safety and transparency, and scalability and impact.
For prevention and oral care, this broader view is essential. An AI tool for detecting tooth decay, gum disease, or oral cancer should not only perform well in a study. It should also protect patient data, be understandable to professionals, be tested across diverse populations, remain safe over time, and offer real value for patients and health systems.
While AI may help make prevention and oral care more timely, personalised, and accessible; this promise will only be realised if it is implemented carefully. It is crucial that healthcare teams ask the right questions before adopting a tool, during its use, and after it has entered real-world practice. In doing so, they adopt a more responsible, ethical, evidence-based, and patient-centred approach to AI.

FIGURE 1

AI for IMPACTS



Integration, interoperability, and workflow
How seamlessly does the AI tool integrate into clinical workflows and healthcare systems?

Monitoring, governance, and accountability
How is the tool monitored, addressing model drift, data governance, and compliance with ethical standard?

Performance quality metrics
Is the model accurate, fair, explainable, reliable, and robust?

Acceptability, trust, and training
Is the AI tool accepted, trusted, and supported by adequate user training?

Cost, and economic evaluation
What are the economic implications? Is the tool cost-effective and sustainable long-term?

Technological safety, and transparency
What safeguards exist to ensure safety and ethical operation?

Scalability, and impact
Can the AI tool scale effectively and equitably across different settings, and what is its broader impact?

Source: Jacob et al., AI for IMPACTS Framework for Evaluating the Long-Term Real-World Impacts of AI-Powered Clinician Tools: Systematic Review and Narrative Synthesis. J Med Internet Res 2025;27:e67485. doi: 10.2196/67485

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