FACULTYPERSPECTIVE

VIEWS ON DENTAL TOPICS & TRENDS

AI: The Next Digital Revolution in Oral Healthcare

Digital technologies, especially computer-assisted design and manufacturing (CAD/CAM) have revolutionized clinical dentistry and dental laboratory technology, providing numerous advantages over conventional methods. While these technologies focus more on restoration manufacturing, novel developments, including Artificial Intelligence (AI) are geared toward all stages of patient treatment, starting with diagnostics and treatment planning. AI "combines computer science and robust datasets to enable problem-solving." AI-supported tools are already part of daily life in the form of targeted advertising, face recognition, autonomous driving, voice assistants, virtual reality and simulation systems, and robotics.

In dentistry, areas of interest for AI include image analysis, data synthesis and prediction, evidence-supported treatment planning and delivery, and patient communication.[1]

AI-supported 2-D and 3-D image interpretation software in dental radiology automatically detects common pathologies, such as caries, periapical lesions, and bone loss but also inadequate restoration margins and other abnormalities. Current AI-supported radiograph interpretation tools are as or even more accurate than interpretation by practitioners. In addition, they facilitate generation of comprehensive and systematic reports. These may include information about necessary treatment, progression of pathologies, and quality of care. Large group practices and health insurance providers already employ such for automated quality control and detection of inadequate treatment.

Three-D analyses of intraoral scans, face scans, photos, tomograms, and other images are widely used for digital smile design, surgical, orthodontic, and prosthodontic treatment planning as well as restoration design and fabrication.

Electronic health records and data from diagnostic tests, prior treatment, and insurance claims facilitate better understanding of oral healthcare in general, but also of each individual patient. Consequently, treatment can be more personalized, precise, and preventive based on the patient's condition and needs. Applications on mobile devices recording health and fitness data, dietary habits, and toothbrushing behavior already collect and analyze such data to provide personalized guidance and encourage participation.

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In addition to synthesizing patient data, risk factors, and treatment patterns, AI facilitates integration of external evidence-based information, for example, from clinical guidelines and standards of care, to improve standardization and calibration among providers. AI-supported treatment planning tools can, therefore, support evidence-based patient-centered care, prevent subpar or excessive treatment, and improve cost effectiveness. They can also improve interprofessional communication, for example by automatically triggering referrals to a specialist when needed. AI also supports patient communication, especially in preventive care and post-treatment maintenance. Continuous monitoring allows for regular feedback and patient engagement.

In a broader view, data-driven tools help expand community and public dental health services through closer linkage and data exchange between service centers, improving access to care to the underserved. Standardized oral health indicators and comprehensive reporting of services and outcomes will provide a more detailed view of the public's oral healthcare needs and the effectiveness of the services provided. Comprehensive data-driven analyses will guide future public health efforts and policies in an effective and sustainable manner.

AI functions mentioned above provide a large pool of information for research and targeted data extraction. Such research includes broad-based evaluation and comparison of treatment outcomes and influence of individual factors on clinical success of certain interventions. Challenges to effectively use AI in dental research are related to breaking up dental data silos and pooling of data from multiple sites. Application of AI in healthcare is not without threats, especially related to protection of personal patient information. Governmental agencies and lawmakers have been rushing to identify such threats and develop guidelines and policies for proper and ethical utilization of AI in the medical fields.

Finally, AI-powered technologies are already widely employed in dental education, such as 3-D smile design and simulation software as well virtual simulation tools to practice manual skills. And in clinical dentistry, robotics will soon be employed for tooth preparations and surgical interventions with an accuracy that may challenge or even supersede human capabilities.

Several groups at Penn Dental Medicine are engaged in the application and development of AI tools in clinical dentistry, research, and education as AI is, without a doubt, the next revolution in digital dentistry. In many areas, the revolution has already started.

1. Schwendicke F, Blatz MB, Uribe SE. Artificial intelligence for oral and dental care, public health, dental education and research. FDI Working Group AI in Dentistry Whitepaper, 2022.