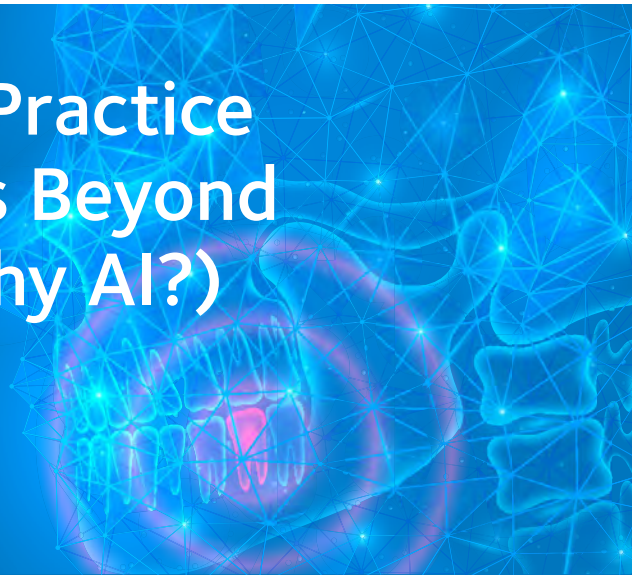
The Future of Dental Practice Management: Insights Beyond Human Cognition. (Why AI?)



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Augmented intelligence (AI) is commonplace in everyday life, with predictive metrics that push content and advertisements to our social media accounts and recommend programs for us to stream on Netflix. They provide facial recognition to enable secure verification and authentication in login systems and allow us to search photos on our phones, so we shouldn't be surprised by AI integration into clinical dental practice. This article aims to inform readers of the transformative power of AI-supported technologies in dentistry to answer the question: Why AI?

AI is machine learning through algorithms that work together to accomplish goals set by humans. These algorithms detect patterns and learn to make predictions by processing data and experiences to go beyond the limitations of explicit programming instructions. These algorithms adapt to new data and experiences to improve efficacy over time.[1, 2]

AI is different from automation because its algorithms learn by processing data. In dentistry, AI streamlines diagnosis and data management, building on reams of charts, patient documents, and radiographic images to recognize patterns and make predictions. It then applies what it learns to improve diagnostic accuracy, predict prognosis, and assist with clinical decision-making.[3]

The two primary forms of AI used in dentistry are artificial neural networks and convolutional neural networks. Artificial neural networks find patterns within data

and then teach the machine to recognize those patterns.[4] Convolutional neural networks, also known as deep learning, collect features from an abstracted layer of filters to process large, complex images.[5]

Through this deep learning, AI brings dynamic radiographic and image review efficiencies with diagnostic accuracy and consistency in rapid time. This revolutionary analysis of digital data allows early identification of oral lesions, bone loss, and caries. It also identifies vertical root fractures, bone, and apical lesions and can classify oral and oropharyngeal cancers. Early detection of these pathologies provides an opportunity for early intervention and conservative treatment options to achieve improved outcomes.[6]

The Clinical Impact of AI in Helping Dentists Manage Patient Data

In 1950, it took an estimated 50 years for available knowledge to double; by 1980, the estimate shrunk to seven years, and in 2010, to 3.5 years. The current projection is that knowledge doubles in just 73 days.7 The dental profession is not exempt from managing a wave of health information.8 The volume of patient information has grown to a point where providers possess the necessary information, yet, it's challenging to find the time and ability to sift through it all to identify what is needed to make the best patient care decisions.

The adoption and expansion of electronic health records dramatically increased the quantity of digitized data available. AI-supported analytics applied to this trove of information leads to insights beyond human capabilities and creates opportunities to predict disease occurrence, reduce inefficiencies, and advance patient care.[9]

Improving the quality of care is a priority throughout Dentistry. AI-assisted diagnostic support facilitates the analysis of patient information to improve disease detection, identify patient conditions and risk factors to assure patient safety, and recommend treatment options that enhance care outcomes.

AI's most transformative clinical power is how it impacts diagnosis and treatment

planning. For example, after processing diagnostic data, including images, charting, and patient records, an integrated AI software program can generate a visual dashboard that presents considerations for care that may include the need to update periodontal charting, obtain radiographs, and schedule a comprehensive examination.

AI programs can annotate radiographic images identifying teeth with bone loss that exceed the criteria for periodontal intervention. Carious lesions, overextended restorative margins, and conditions such as a missing cusp are recognized and labeled with treatment options. The dentist can then instantaneously review the findings from a new exam with the patient during the appointment, toggling between annotations on current and older images to demonstrate AI's discoveries and inform the patient of their healthcare needs.[10]

AI aids in informing patients of their needs and promotes acceptance of care recommendations. Having proposed treatment plans confirmed by AI builds patients' confidence in the necessity of care, raising understanding beyond the traditional "tell, show, do" presentation.

> The ability of AI to recognize patterns, make predictions, and learn from experience allows for early identification and intervention to improve health outcomes.

Chart reviews and audits facilitated by AI provide further opportunities to improve care outcomes by alerting the dental team to a patient's needs. Imagine a report generated before the patient arrives that identifies issues and conditions through a rapid AI review of past and current radiographs, health histories, chartings, and treatment records. A summary for each scheduled patient is then easily presented at a morning huddle to efficiently guide workflow for the dental team. Identifying potential medical interactions supports patient safety, and AI's ability to identify treatment indications assures that advancing conditions don't go undetected.

Even well-planned practice schedules experience workflow disruption, and AI can help with those daily frustrations. For example, a patient arrives for a routine preventive visit but is found to have heavy debris and inflammation with bleeding upon probing. The day's charting shows increased periodontal pocketing, and new radiographs show attachment loss with subgingival calculus. These unanticipated findings may change what can be accomplished in the time scheduled. With minimal disruption to workflow, rapid analysis by AI-supported systems can guide care decisions so that the provider can confidently present options to the patient, focus on what can be done that day, and inform the patient of what should be scheduled for a future visit. An essential element in implementing analytics at scale is that it is *actionable*.[9] With minimal disruption to existing workflows, AI solutions identify the patient's needs while making predictions for treatment options, increasing the provider's ability to take action on the proposed treatment at the point of care.

AI in Practice Administration

AI technology improves data-based oversight in the administrative management of the practice.[11] Insights from aggregated data include identifying patients needing particular procedures, so they don't "fall through the cracks." For example, an AI audit of practice data for periodontal indicators in patient records, including radiographic history, will identify patients needing periodontal therapy. This insight can provide an opportunity to establish consistent treatment protocols for all patients in the practice.

Add-on software programs with AI can access data within practice management systems to identify patients with diagnosed treatment needs who do not have scheduled appointments and reactivate patients overdue for their preventive care. This ability was instrumental in addressing delayed care resulting from office closure during the COVID-19 pandemic and the reluctance of some patients to return until the pandemic subsides. Once a list of unscheduled patients is generated, the software sends a text or an email message containing a live link that allows patients to schedule their care remotely without a call to the office. Comparable to online seat selection of air travel, AI software offers an appointment time with a preferred provider based on care needs, patient preferences, experience, and schedule

availability. Integrated remote scheduling software allows for accurate and efficient online scheduling that is convenient for the patient and reduces staff burden.[12]

Intelligent software that mines practice management systems data allows tracking key performance indicators with real-time metrics, such as provider and practice production, collection ratio, practice growth, and patients with unscheduled planned treatment. These insights from the analysis of aggregated practice data aid in making management decisions, such as a need to increase staff capacity. Other dashboard indicators show the case acceptance rates for the practice and each provider, identifying opportunities for improvement in treatment plan presentations and reinforcing the entire team's role in ensuring practice productivity.[13] Measurement metrics modeled on those created by the Dental Quality Alliance can be applied to assess clinical performance with evidence-based protocols, such as those for the timely placement of sealants.[14] Practice measures can be customized to address office protocols and goals helpful in managing team performance.

AI software can further track accounts receivable, automatically sending a text or an email statement to the responsible party. Payments are directly deposited into the office account and posted to the patient ledger through program interoperability, efficiently and effectively reducing accounts receivable.[15]

AI systems in dentistry identify dental disease and can take risk factors into account to determine treatment needs. Risk stratification requires segmenting patients by defined comorbidities that may influence the prevalence and severity of disease progression and response to treatment protocols. Self-reported patient indicators identified through natural language processing models from the practice's electronic health record can identify risk factors such as diabetes, smoking, frequency of maintenance appointments, and current medications.[16, 17] To maximize patient safety, pharmaceutical applications evaluate a patient's medications with those under consideration to identify potential adverse interactions.18 Identifying predefined criteria can allow the clinician to stratify patients into high-, intermediate-, and low-risk groups for dental disease development or progression, which can be a powerful predictor of treatment success. This patient cohort stratification approach to guide the prevention of highly prevalent chronic diseases is meant to improve outcomes and increase the use of cost-effective health care resources.[19]

Population-based strategies to improve outcomes can be extrapolated to clinical settings. Prevention pays.[20, 21] Targeting resources to improve utilization and support evidence-based services requires data analysis and identifying those at risk. Incorporating stratified risk levels proactively in patient care management will enable dentists and hygienists to intervene in real-time, implement early preventive measures, and improve treatment outcomes over time.

The process of assessing risk for dental diseases, such as periodontal disease and caries, has been less quantitative and more qualitative in current provider-payer systems. The ability of AI to analyze and quantify patient risk factors from dental imaging and qualitative social determinants of oral health factors derived from patient behavioral surveys and assessment tools such as caries management by risk assessment will make this process more quantitative in real time for chairside use and for documenting benefit claims submissions.[22]

AI solutions do not merely identify disease patterns. Applying a patient's risk status to predict prognosis will allow patient-centered AI guidance on treatment recommendations. For example, suppose a patient who has diabetes and smokes has (evidence of bone loss and/or radiographic root calculus. The clinician may offer the patient modified treatment options, including increased maintenance intervals, periodontal intervention, or smoking cessation strategies.[10]

AI and Benefit Claims

Many health care insurers have implemented AI into their operations.[23] AI-assisted auto-adjudication ensures that a submitted claim is complete and addresses the plan's payment policies. AI can further reduce the need for a human consultant and improve payment accuracy for the plan administrator, resulting in plan savings through administrative efficiencies.[24]

Within the practice, AI systems ensure that the documentation supports the diagnosis and recommended care. Guidance from AI supports accurate coding of the care provided and calibrates diagnosis within multiple provider practices to ensure consistency.

Recall the example of the overdue patient who came for a preventive visit with heavy debris, inflammation, bleeding on probing, and increased periodontal pocketing. AI support systems can guide the dental team in determining if scaling and root planing (D4346) is appropriate or if debridement (D4355) or scaling in the presence of inflammation (D4346) is indicated based on documentation and radiographic evidence of bone loss and calculus.[11, 12, 27]

Identification of patients by their benefit carrier allows guidance for treatment in coordination with payer policies so that the patient can anticipate benefit coverage. AI builds knowledge from benefit claim rejection notifications, plan payment performance, and dental treatment coding profiles to verify a specific plan's processing guidelines. Analysis of claims by AI before submission will reduce errors and support favorable adjudication based on real-time insights from dental office payment experience data.

Conclusion

AI processes diagnostic information at a rate and reliability beyond human cognition. Its use as an adjunct to managing patient care can create consistency in diagnosis and treatment planning across the dental team and reduce inefficiencies in reviewing radiographs and patient records.

Practice success is enhanced by AI's ability to build on practice management metrics and trends to facilitate patient access to needed treatment.

The ability of AI to recognize patterns, make predictions, and learn from experience allows for early identification and intervention to improve health outcomes.

Detection and diagnosis of dental decay and periodontal disease can be subjective. AI can help guide treatment recommendations that calibrate providers and promote appropriate coding and documentation of provided services, reducing denial of benefits or delays in payment from requests for further documentation.

Health care organizations that use analytic systems have focused on identifying the algorithm that can best stratify data in near real-time, allowing actionable use

of patient care.[28] By facilitating risk stratification, a predicted prognosis allows for modification of treatment recommendations and implementation of evidence-based preventive strategies that promote health and safety.

A caveat is that algorithms offer the illusion of being unbiased, yet their creators have unintended bias, as do the data sets they build on. Thus, they can encode and amplify human biases. For example, historical data sets for AI used in college admissions decisions have unintentionally favored a specific candidate profile, thereby reinforcing existing inequalities. Bad inputs can mean biased outputs.[29] A dental professional must be the "human-in-the-loop" who critically appraises AI-generated treatment recommendations to guarantee accuracy and patient safety.

About the Author

Christopher J. Smiley, D.D.S., is editor-in-chief of the Journal of the *Michigan Dental Association* and the 2020 recipient of the ADA/AADR Evidence-Based Dentistry Practice Award. He is a past chairman of the Dental Quality Alliance and the ADA Council on Dental Benefit Programs. He was the lead author of the 2015 ADA systematic review titled "Evidence-based Clinical Practice Guideline on the Nonsurgical Treatment of Chronic Periodontitis by Means of Scaling and Root Planing With or Without Adjuncts" (JADA. 2015;146[7]:525-535). He practices general dentistry in Grand Rapids, MI.

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