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Artificial Intelligence: Coming to a Dental Practice Near You

L. Eric Pulver, DDS

Advancements in computer processing, data analysis, and cloud computing have driven the convergence of innovation and technology. This has paved the way for development and implementation of artificial intelligence (AI) and the opportunity for transformative change in the dental profession.[1] Dentistry now needs champion clinicians, academicians, industry leaders, and adaptive leadership to safely guide the profession through this most exciting time.

Intelligent algorithms are used everyday in interactions with Facebook, Apple, Amazon, Netflix, Google, Microsoft, and other digital entities. In dentistry, AI is presently being used for scatter reduction on STL images, voice monitoring, and data analysis for practice intelligence.[2-4] Dental-based AI "game-changing" companies are beginning to emerge, and dentists will no doubt be hearing more about them soon. Some have aligned with insurers, some with providers, and some with both in an effort to bring efficiencies to the marketplace. Perhaps what is most exciting for providers in this time of COVID-19 is the use of AI for automated charting that is integrated directly into dental practice management systems.[5] Recent research showed that AI was able to identify incipient and moderate caries with more sensitivity (twice as likely) than readers.[6]

AI can lead to significant efficiencies, such as earlier findings and less expensive care. Other potential benefits could include the ability to redefine reimbursement by tracking outcomes, enhanced outcomes with timely provider payments, and lower patient premiums through home monitoring and improved oral health maintenance. This all may be realized in the future through value-based care, precision dentistry, and the assistance of sophisticated deep learning models.

Rigid standards must be maintained when creating ground truths and training algorithms. Academic validation of algorithms by leading accredited institutions with leaders in dentistry is essential. Together, dental professionals must ensure the path forward is beneficial for patients, providers, the profession itself, and overall population health and wellness.

The Quest for Intelligence

Computer vision is more sensitive than the human eye. In dentistry, radiographic interpretation has been shown to miss early incipient lesions up to 30% of the time.[7] Providers' findings are often conflicting. However, this can now become calibrated and standardized.

Computer vision combined with machine learning has allowed for assisted and automated feature identification (caries, periapical infection, bone loss, etc), automated charting, intelligent practice analytic dashboards, voice monitoring (telephone), 3D scans and radiology, lab processing and impression platforms, quality assurance, and treatment planning. There are many new and innovative companies at various stages of their journey, and an abundance of opportunity lies ahead.

Mankind's quest for intelligence has carried the progress of AI from its humble beginnings in 1956 to the advancements achieved today. John McCarthy, a mathematician teaching at Dartmouth College, is credited with coining the term "artificial intelligence," although he claimed no one liked the name-after all, the goal was "genuine," not "artificial" intelligence.[8]

"You don't know what you don't know." This statement is the basis for an evidence-based interdisciplinary treatment planning course taught to the graduating students at Indiana University School of Dentistry. The genesis of the course was faculty team members sharing what they had learned from mistakes they made when first entering into practice. This is more relevant today than ever, as we are living in an age of exponential change. Consider that in 1950 medical knowledge doubled every 50 years; in 2020 doubling of knowledge is estimated to be 60 days, and now post COVID-19, perhaps even faster.[9] In these times of rapid-moving information, being aware of "unknown unknowns"[10] reinforces mankind's need to adopt and implement new innovation and technology. This aligns with a movement toward precision healthcare. The amount of relevant data that must be *input - weighted - optimized - reassessed/analyzed* to obtain an accurate *output diagnosis* far exceeds the capacity of one individual mind. (Words in italics represent the AI process [machine and deep learning] in its attempt to mimic the human mind.)

Humans (ie, dental providers) can benefit from the assistance of AI components, such as data mining, statistical learning support, and machine learning,[11] to help process evidence-based decisions. Do humans really *make mistakes*, and can we *trust a machine*?Daniel Kahneman, author and Nobel Prize winner, shared the following example in his book, *Thinking, Fast and Slow*: If a bat and ball cost $1.10, and the bat costs $1.00 more than the ball, how much is the bat?

Before the invention of the traffic light, a person stood in the middle of an intersection with a sign, controlling horses and carriages, pedestrians, bicycles, and the first automobiles. In 1914 the municipal traffic control system, or traffic light, invented by James Hoge, was installed in Cleveland, Ohio. It was controlled by a flip of a switch by a police officer sitting in a booth on the sidewalk. Intersections became safer, trust in the system was developed, and people were able to be more productive. Eventually, a human wasn't necessary for traffic light safety and efficiency.[12]

The answer to the aforementioned bat-and-ball question, by the way, is $1.05. Although you may have answered correctly, this example shows how easily mistakes can be made with fast thinking. Imagine how AI can assist with even simple tasks. Thetraffic light example illustrates man's ability to trust technology while moving toward safety and efficiency.

COVID-19 has allowed a look at the future, revealing "nontraditional competition,"[10] (eg, exposure protocols, digital workflow for efficiency and safety, rapid testing). AI and the virtual workflow is an opportunity presenting itself today. Will dentists reboot and embrace change with a reset or choose to relapse to previous ways?

AI: The Dentist's Teammate

The World Economic Forum has described this time period as the Fourth Industrial Revolution.[13] Dentistry has experienced its digital transformation-x-rays, practice management systems, analytic dashboards, digital impressions, 3D printing, dynamic navigation, virtual/teledentistry-leaving the profession well prepared for the challenge ahead. Today AI can provide an unbiased, calibrated, and standardized set of findings to assist dental providers with an instant second opinion. As AI becomes further integrated into the dental workflow its role can be expected to evolve from assistant to monitor to coach to, finally, teammate.[14] It will offer the dental profession the opportunity to be at the forefront of closing the oral-systemic health gaps and improving overall health and wellness. Data analytics and machine learning can help automate the process of understanding how patient systemic health influences treatment outcomes.

In the future cognitive computational computing may lead to the provision of precision dentistry and treatment that is specific and customized to a patient's phenotype. Having a window into the patient's biologic response and ability to tolerate the proposed care could greatly impact outcomes and elevate value-based care. The ability to track data through IoT (internet of things),[15] wearables (extra- and intraoral), evaluation of oral and gut biome, monitoring, and instant testing of salivaomics and proteomics[16] is an exponential opportunity for oral healthcare providers to create significant change moving forward.

As dentists, this is an opportune time to collectively join together with clinician and academic champions to advance AI and machine learning in a safe, controlled fashion. Once this is achieved, will it be long before the dental profession embraces quantum computing/artificial general intelligence? Be part of the change and help dentistry lead healthcare into the future.

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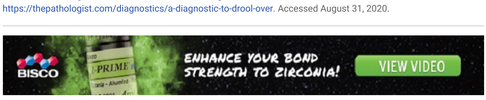

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