Dental Insights — AI in dentistry: What will the data-driven dental practice be like in the future?

1. The past, present and future of AI in dentistry

AI = automation of intellectual tasks normallly done by humans.

AI has been developed since 1950's, but we lacked good enough data and computers to develop it (AI winter in 1960's-1990's). During that time we had rule-based expert systems until early 2000's. Nature is very complex, and it is difficult to describe with just a prompt! (Nikon quote).

"AI has the same impact as fire and electricity had for human kind" - Sundar Pichai Google CEO.

Thousands of AI authors on the future of AI: full automation of all human labor/jobs in year 2100, with surgeons and dentists as some of the lasts ones to be automated. Many of the forecasts for the future are changing because AI is moving faster than forecasted.

Collingridge dilemma 1980: when it's too late, you can't control AI.

AI: robotics, simulations, expert support, language, neuronal networks.

Fun meme that has been hard for AI to distinguish between: doodle dog or fried chicken.

Sensitivity (false positives) vs Specificity (false negatives)

There's big difference between human beings and how much expertise an individual person have. Medical AI use big data to increase the probability for a correct answer. AI can help us triage patients better, both fx in radiology and pathology images. Many expert fields are a very scarce resource, fx radiologists and pathologists, and we need to have AI help us with this gap.

Explainability is very important, because AI is assistant-systems, that should be usable outside of the training images. Otherwise the AI could mistakenly be trained on a dataset to learn fx that a copywrite is a horse. The AI can easily fail/be challenged in its robustness, where human beings can easily identify images, even if they have been altered somewhat.

AI is maths - not like human brains.
AI will suppport diagnostics and also therapy decisions.
AI is data-driven technologies.

2. What will the data-driven dental practice look like in the future?

Simple models with input data (tooth, caries, root canal material, apical lesion) are manually selected and put into algorithms, and then perform training and testing. Training of the models and testing on the patients.

In 2020 we have 40ZB (zeta byte) of data in the world. Data comes especially from the internet and internet-of-things. And we expect even more data to come. We need data fusion, so we only see the necessary data when we need it.

Digital twin: digitalizing a physical asset.

Creating a digital twin:
Biology (body, organs, tissue, multicellular, subcellular) —>
Data —>
Models —>
Digital twin —>
Predictions (diagnostics, prognosis, therapy optimization)

Psychological language on Twitter predicts county-level heart disease mortality, Eichstaedt et al. 2015. Emotions displayed Twitter (via tweets) could in the study very accurately predict heart disease. Emotions have great meaning for a person's health.

When we assess a patient's anemnestic health details, they often give us the answers they think we want to hear, and the honest answer. Wearables and testing can give us realistic answers.

Microbiomics is valuable for healthcare and dentistry.
Microbiomic data collection can predict disease development.
Early childhood caries (EEC) can be predicted with 77% accuracy from the oral microbiome from 2 months old babies. In 5-10 years the big dental clinics will test the oral microbiome via saliva tests. Oral microbiome testing will become routine care in the future.

Precision medicine (P4 dentistry):
From one-size fits all to —>
Stratified medicine to —>
Precision medicine (personalisation of the individual preferences, clinical features, medication history, environment etc.)

There are not any regenerative technologies based on CRISPR yet. But it will probably happen within the next 10 years.

There are many different data sets in different silos.

AI should only be used if it's better than random guessing in fx predicting future tooth loss! It doesn't matter with 92% accuracy, if the last 8% teeth are lost — then it's useless. We need to understand how AI works and how to interpret the metrics and use it correctly. It's not possible to compare different companies' data sets, unless they share their data with each other.

AI risk based systems should be used to help the patient even better and tailor their care and treatment individually.

Accessibility of data are governed by laws of policy makers.

The New York Times sued Microsoft OpenAI for accessing paywalled articles, but Microsoft can just buy them if they can't find an agreement. Big tech have big power.

Predictive dentistry will come in the future.
AI may help us leveraging big data.
We don't easily access big data, though.

In 5 years we will see AI, scans and e-health in many dental clinics. Some developments will be slower than we thought, and others will be faster.

What will be the unique value of human dentists in the future: our small tactile handcraft, empathy and human interaction.

3. Examples of how AI can be used in the dental practice

ChatGPT-4 have read everything available on the internet!
Human brains have 85 billion neurons, while ChatGPT-4 have 1 trillion parameters.

Remedico.app: fx “cancel all appointments for tomorrow for doctor, send notifications to patients, and schedule new appointments for them.

AI images are getting so good, that you can’t distinguish whether it’s real or a deep fake.

Suno can create a AI-generated song.

101 Soundboards can get AI-generated voice fx like David Attenborough.

AI will help healthcare staff with administrative tasks that can be automated.

AI can also be used as symptom checkers (triaging).

DentalXrai Pro is an x-ray system that can identify radiologic findings and highlight them in different colors, grade them in severity as diagnostic help tools, risk evaluation, patient communication, independent second opinion etc.

Cochrane review: Dentists miss every second caries lesion, especially caries initial lesions in enamel. AI can help us with this. The expert can be a risk factor. Dentists drill more often of they are not supported by AI. AI can reduce overtreatment. AI can guide dentists in the proper treatment. AI can give us suggested treatment options.

Wearables give us huge amounts of health data. Intelligent toothbrushes will be revolutionary. Data is however often silo’ed, and kept in silos in a few big companies. Wearables: headbands, sociometric badges, camera clips, smartwatches, sensors embedded in clothing etc.

Wearables in dentistry: fx orthodontic monitoring with Invisalign and Dental Monitoring.
We could use way more self monitoring to support fx remote areas and prophylactic checkups. A new patent have been given to Apple for their AirPods to measure EEG, EKG etc.

AR/VR glasses can help with surface scans and support live therapy fx navigated implant surgery. It can also assist in endodontics, and show the root canals through AR/VR glasses, and help the clinician to reach the root canal orifices.

Exoskeletons and co-bots can assist healthcare staff with ergonomics.

From cradle to grave, 365 days a year:
Amazon Alexa (symptom check and monitoring) —>
Amazon hospital —>
Amazon online pharmacy —>
Amazon health insurance
Amazon knows everything about that person’s healthcare! But do we really want this?

Good resources

Garcia Cantu et al. J Dent 2020.
Mertens et al. J Dent 2021.
Herbst et al. J Dent. 2022.
Blostein et al. Microbiome, 2022
Pellegrino et al. BMC Oral Health 2019.
Krois et al. J Dent Res 2019.
ImageNet
Ott et al. Nature Comm. 2022
The AI Act

Top 3 Dental Insights — Key Take Aways

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Sources

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That was Dental Insights. Thank you for being here. ❤

Dental love, Anne Mette