AI for Health
ITU-WHO Focus Group

The Role of AI in Solving Translational and Implementation Research Challenges in Dentistry

Sergio Uribe, PhD, MSc, DDS
Assoc Prof
Riga Stradiņš University. *Riga*, **Latvia**
Universidad Austral de Chile, *Valdivia*, **Chile**

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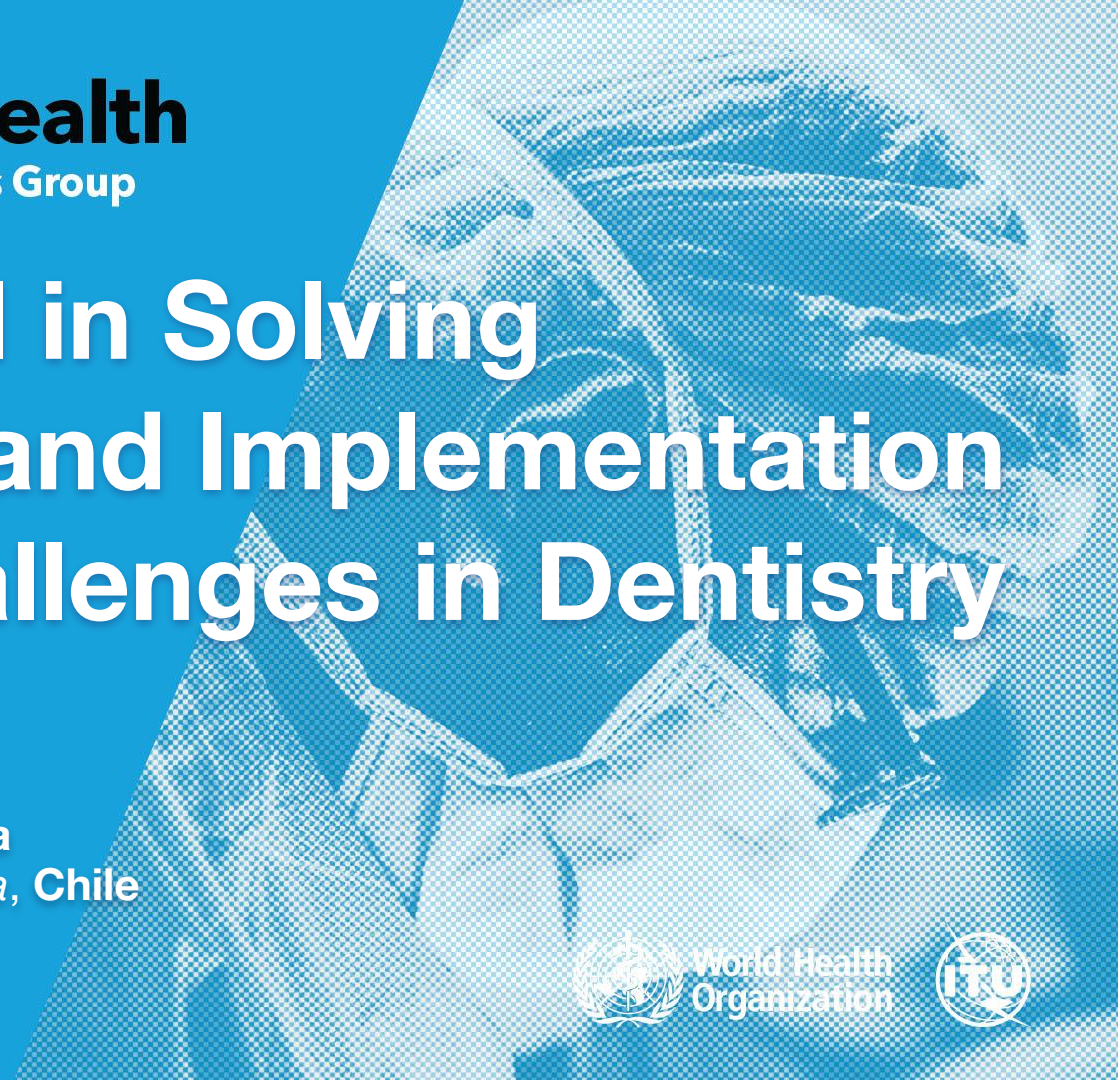


World Health Organization

“There is no function the computer cannot do in radiology”

Gwilym S. Lodwick, MD

VOL. 81 NO. 2 **Radiology** AUGUST 1963

a monthly journal devoted to clinical radiology and allied sciences

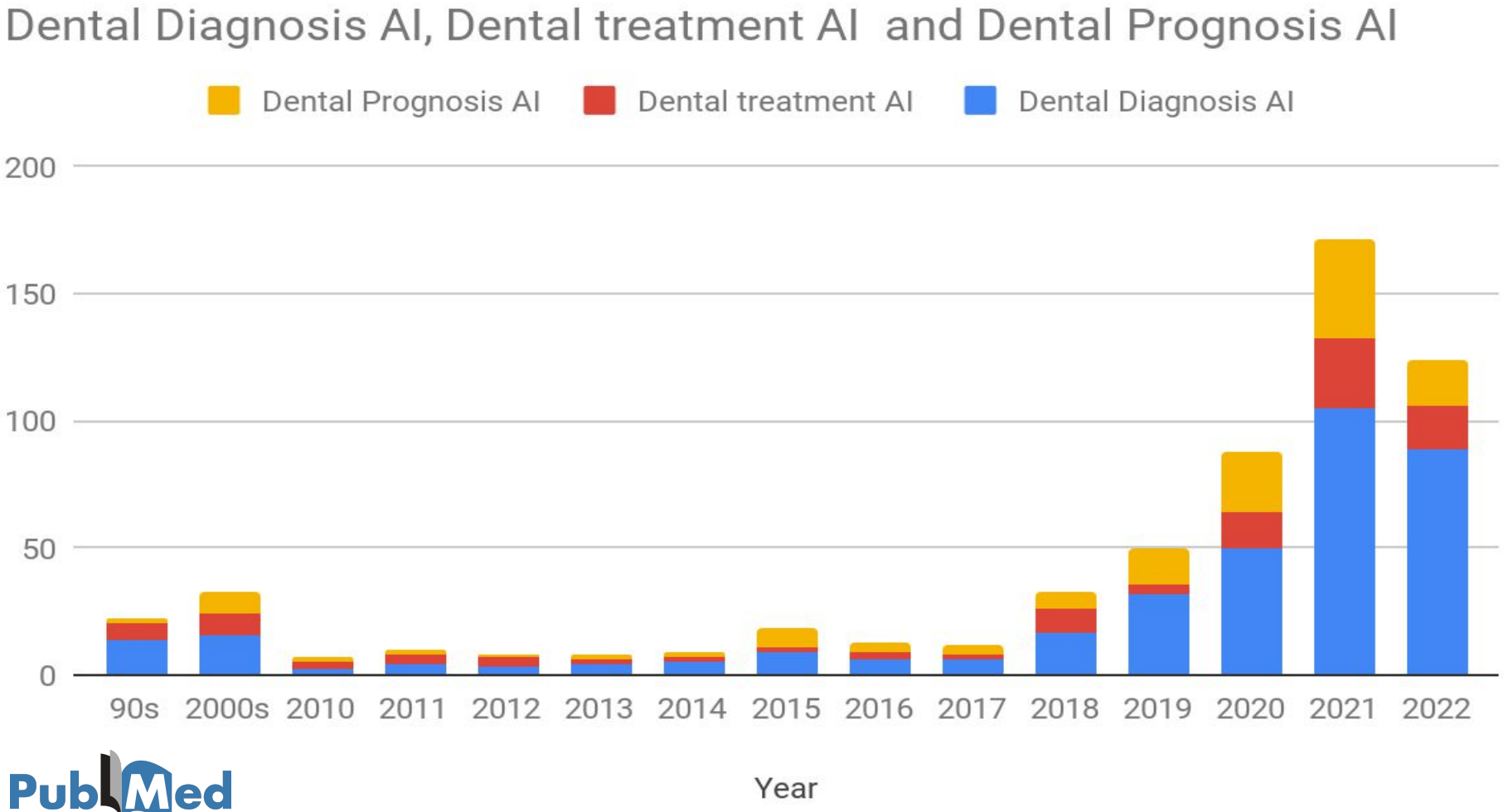
PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA, INC.

The Coding of Roentgen Images for Computer Analysis as Applied to Lung Cancer[1]

GWILYM S. LODWICK, M.D., THEODORE E. KEATS, M.D., and JOHN P. DORST, M.D.

THIS PAPER WILL DESCRIBE a concept of converting the visual images on roentgenograms into numerical sequences that can be manipulated and evaluated by the digital computer and will report the results of employing this system to

cause, against a background of air density, the intimate details of the relationship between tumor and host may be faithfully reproduced roentgenographically. Parenthetically, it may be stated that similar density ranges exist in the relationships


Dental Diagnosis AI, Dental treatment AI and Dental Prognosis AI
Dental Prognosis AI
Dental treatment AI
Dental Diagnosis AI
200
150
100
50
0
90s
2000s
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Year

Use of non-human evaluators in diagnostic healthcare

Pathology	Sensitivity (95% CI)	Specificity (95% CI)	Source
Sars-CoV 2	98% (95-100)	99% (95-100)	Guest et al. *J Travel Med.* 2022;29.
Breast Cancer	99% (97-100)	98% (97-100)	Kure et al. *Biology*. 2021;10.
Colorectal cancer	97%	99%	Sonoda et al *Gut*. 2011;60:814–9.
Cancer biomarkers	discriminate between cancerous and healthy cells and between two cancerous lines, 99% accuracy		Piqueret et al. *iScience*. 2022;25:103959.

(these tools)... achieve equal or better diagnostic performance for the detection of complex pathologies…

…however, the biggest challenge is translating what we see in the research setting into an operational setting

Photopoulos. *Nature*. 2022;606:S10–1.

Use of non-human evaluators in diagnostic healthcare

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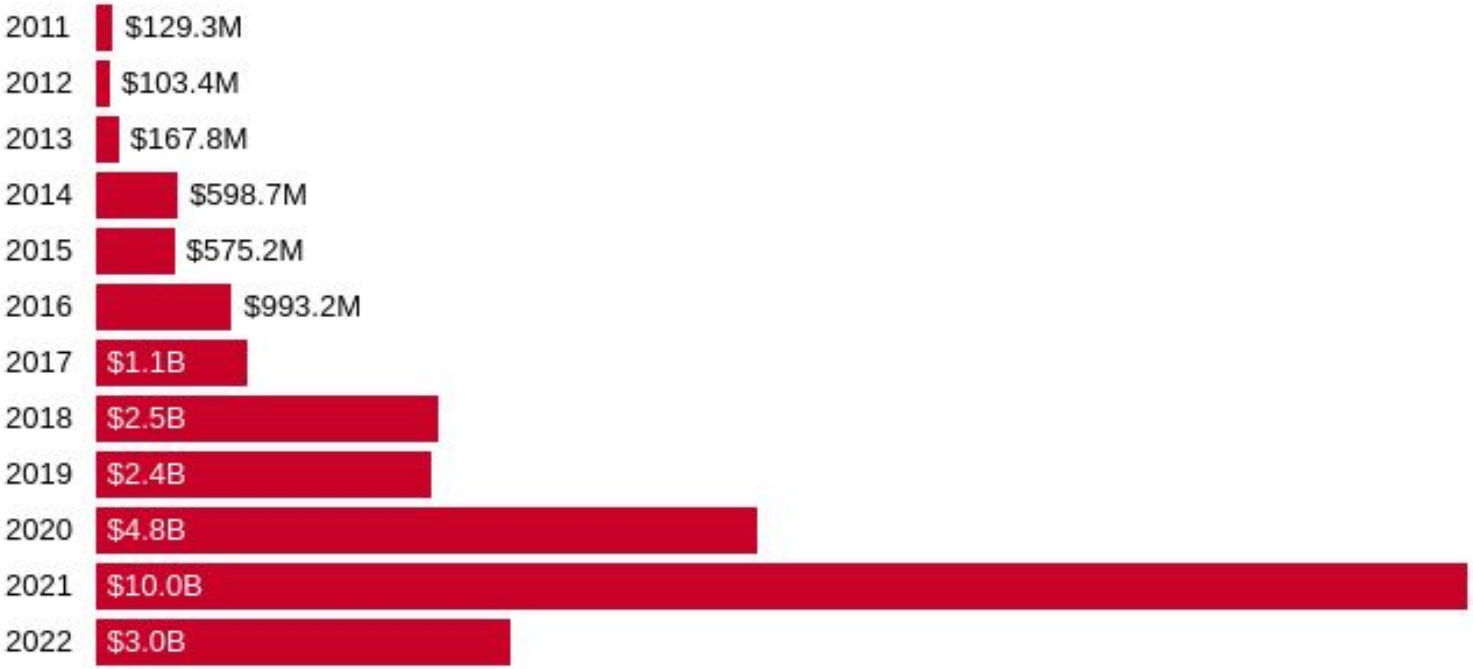
Hinton 2016

"We should stop training radiologists now, it's just completely obvious within five years (**2021**) deep learning is going to do better than radiologists."

AI funding in health care is exploding

Total funding amount for digital health startups using artificial intelligence, by year



(2022 figure through year's first half)
Source: Rock Health analysis for POLITICO
Ben Leonard / POLITICO

Radiology dominates FDA's approved AI-enabled devices

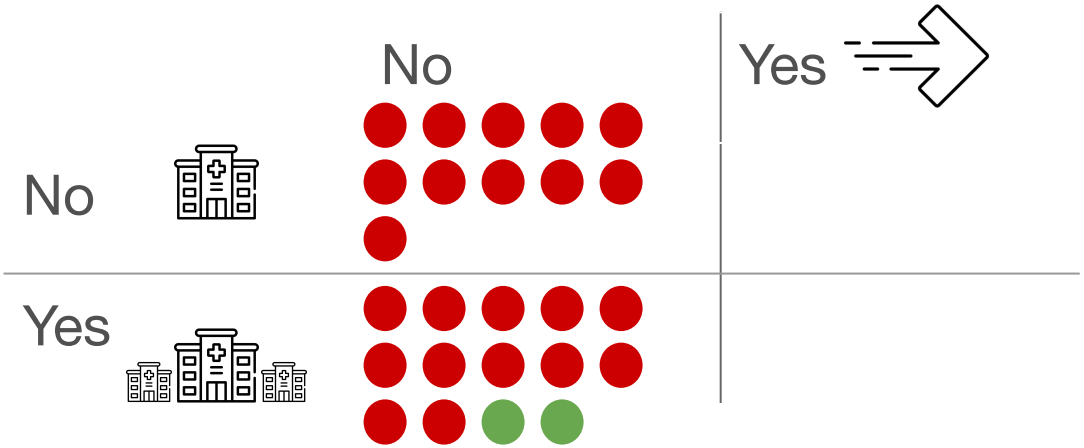
The number of AI/machine learning-enabled devices approved by FDA since 1997

Source: Food and Drug Administration
Ben Leonard / POLITICO

Evaluation

Prospective

Multisite



Low risk Bias

High risk Bias

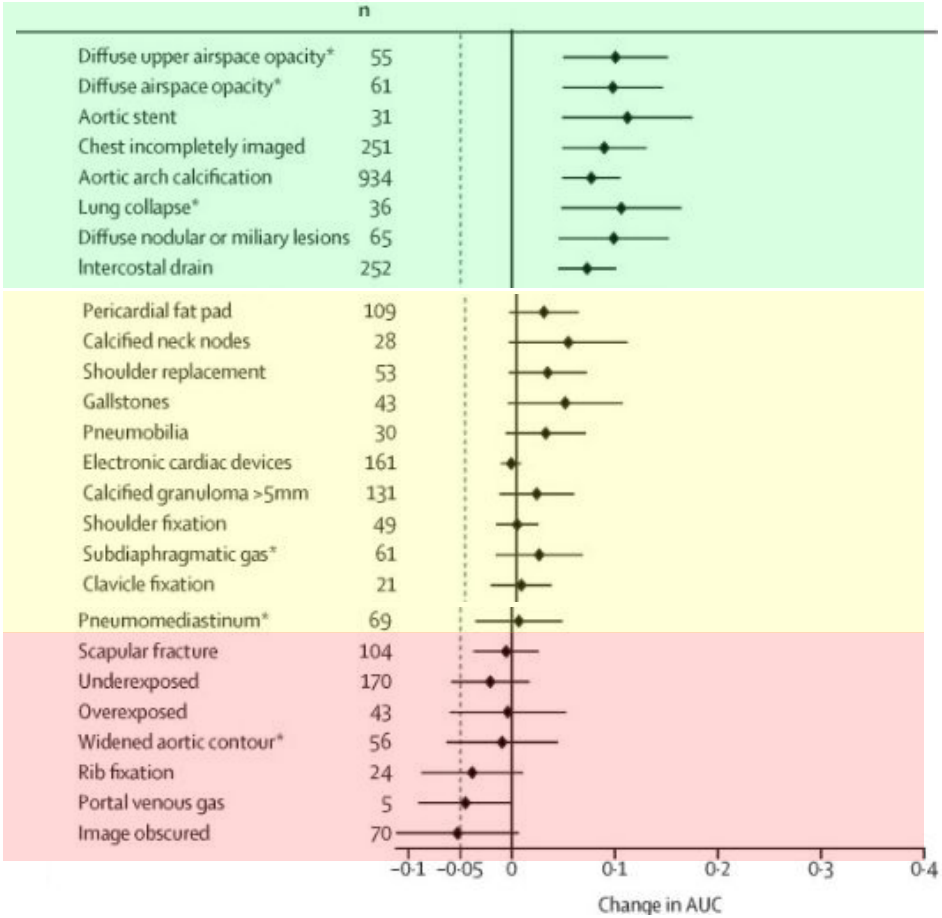
Wu et al. *Nat Med.* 2021;:1–3.

Hinton 2016

> “We should stop training radiologists now, it’s just completely obvious within five years (**2021**) deep learning is going to do better than radiologists.”

Hinton 2022

> “The transition is slightly slower than I hoped but well on track for AI to be better than most radiologists at interpreting many different types of medical images by **2026**”

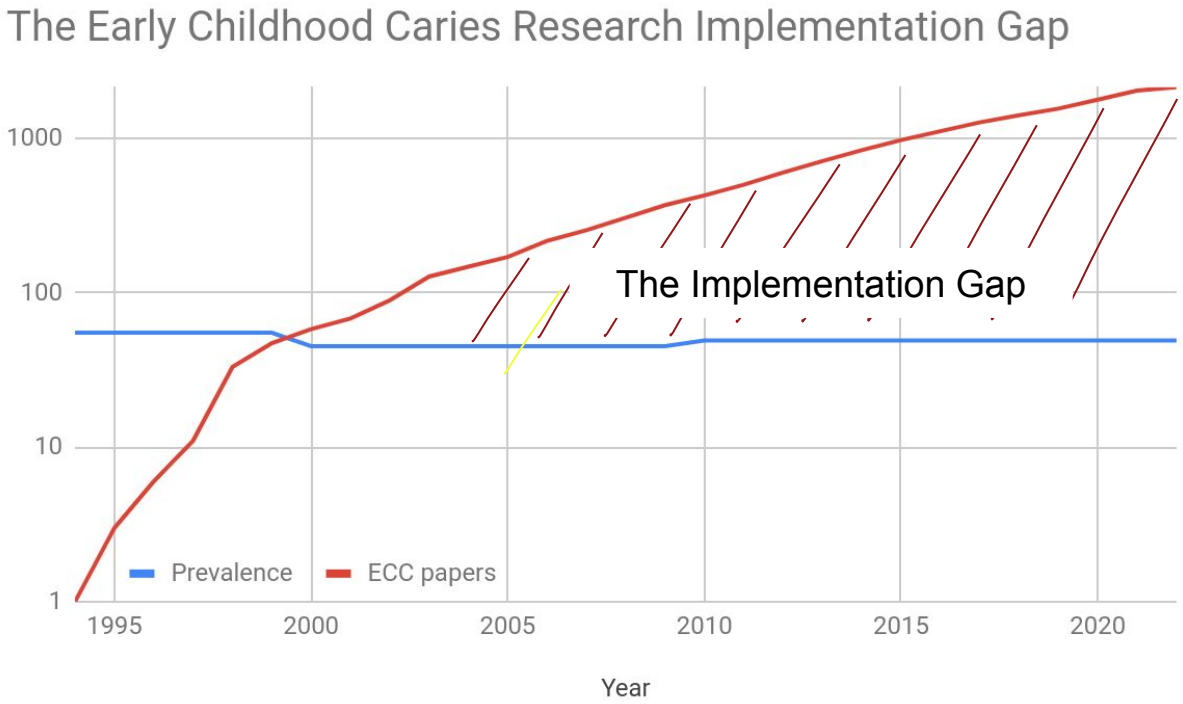


127 clinical findings, 821 681 chest x-rays from 520 014 cases

Seah et al. *Lancet Digit Health.* 2021;3:e496–506.

2 Key problems in Dentistry

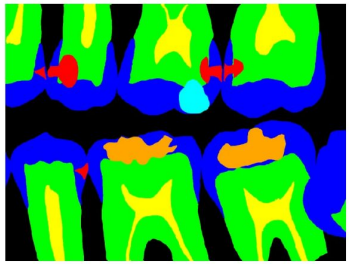
I. How to translate the research findings for practical clinical use



Uribe, Innes, Maldupa. *Int J Paediatr Dent*. 2021;31:817–30.

Better diagnosis

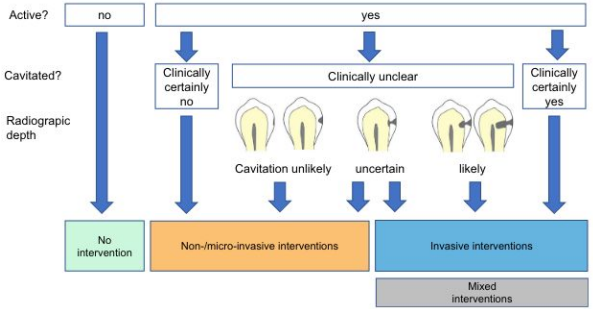
Deep learning model



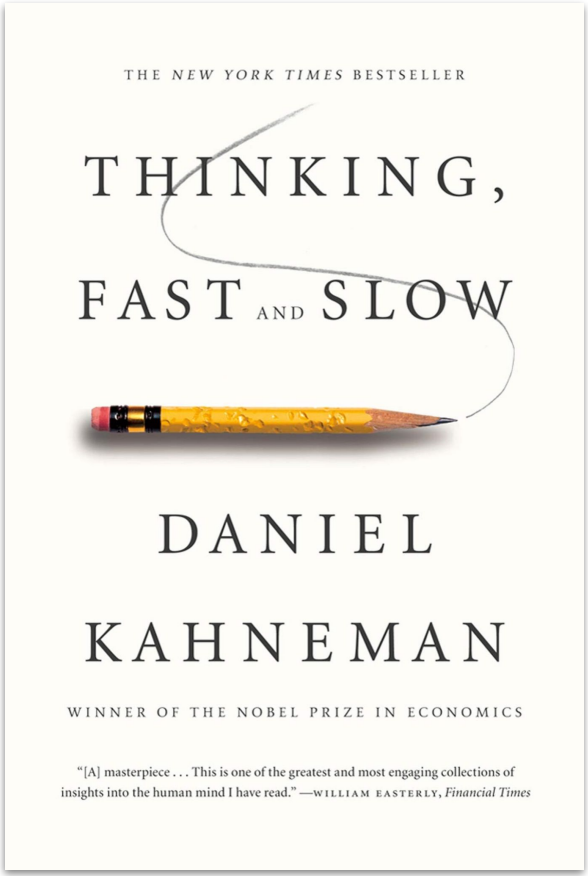
Lee et al. Sci Rep. 2021;11:16807.

plus

Better treatment



Schwendicke et al. Clin Oral Investig. 2019. 23, 3691−3703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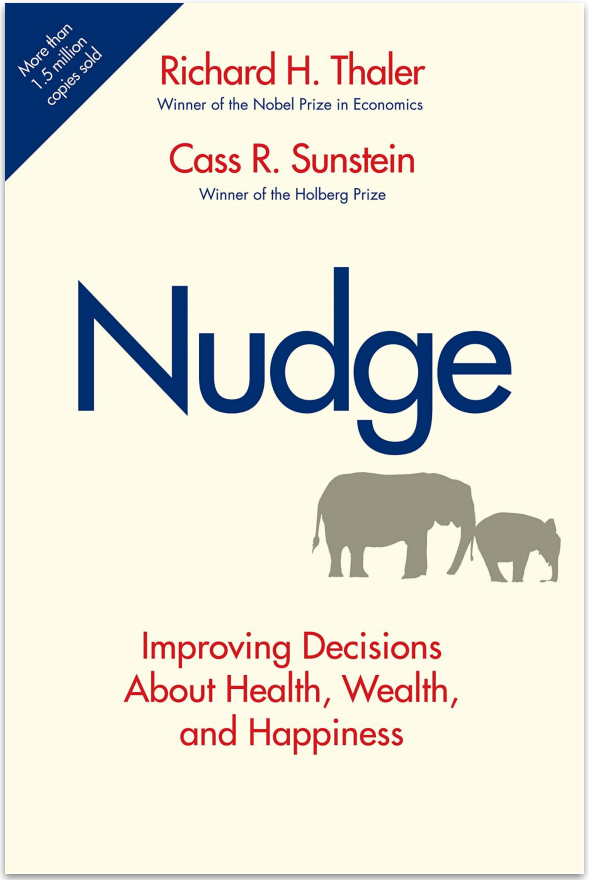
FAST AND SLOW
DANIEL
KAHNEMAN
WINNER OF THE NOBEL PRIZE IN ECONOMICS
"[A] masterpiece . . . This is one of the greatest and most engaging collections of insights into the human mind I have read." —WILLIAM EASTERLY, Financial Times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Winner of the Holberg Prize
Nudge
Improving Decisions About Health, Wealth, and Happiness

Usual AI performance metrics

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	Detection	Segmentation	Classification	Prediction
Features	-Bounding boxes -Masks	-Lesion patch -Full image at max diameter -Radiomics features -Masks	-Lesion patch -Radiomic features	-Lesion patch -Time to recurrence -Survival time -TRG
Model architectures	-CNN	-U-Net	-Fully connected	-CNN
Performance metrics	-Intersection over union (IOU) -Mean average precision (mAP)	-Dice score -IOU	-Receiver operating characteristic (ROC) -Accuracy	-ROC curve -Accuracy -R^2

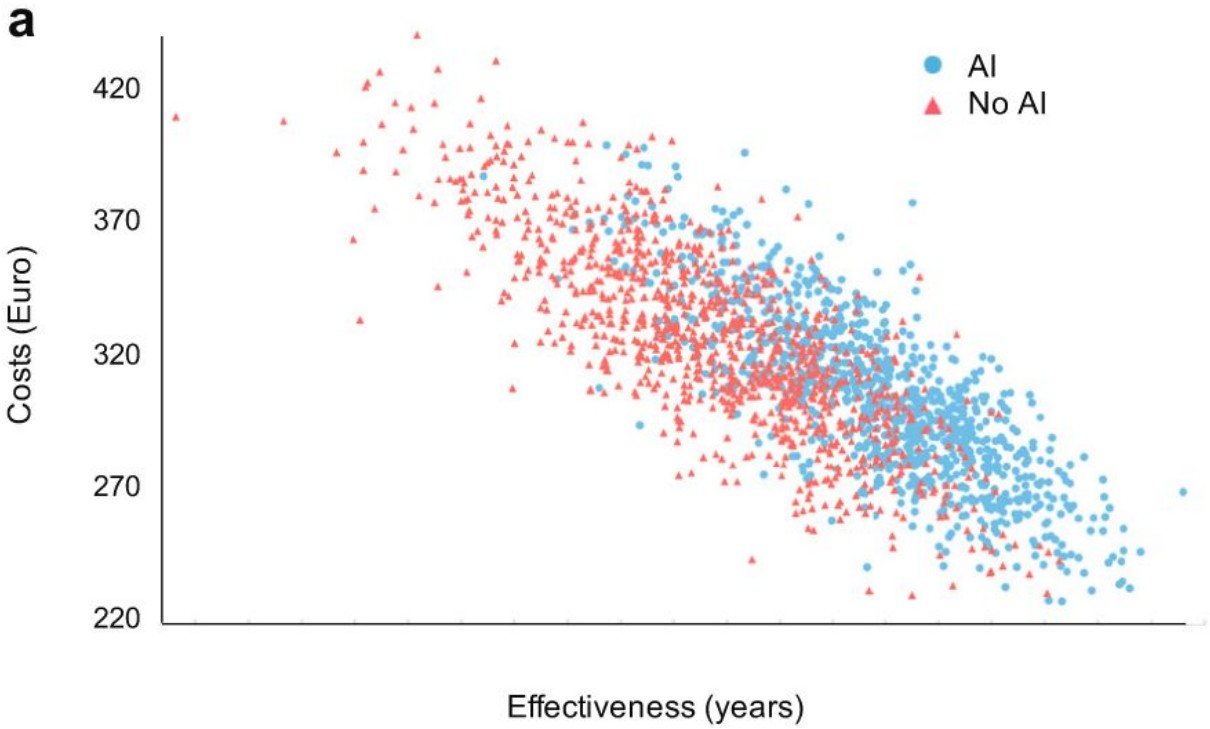
Clinically relevant performance metrics

Therapeutic change

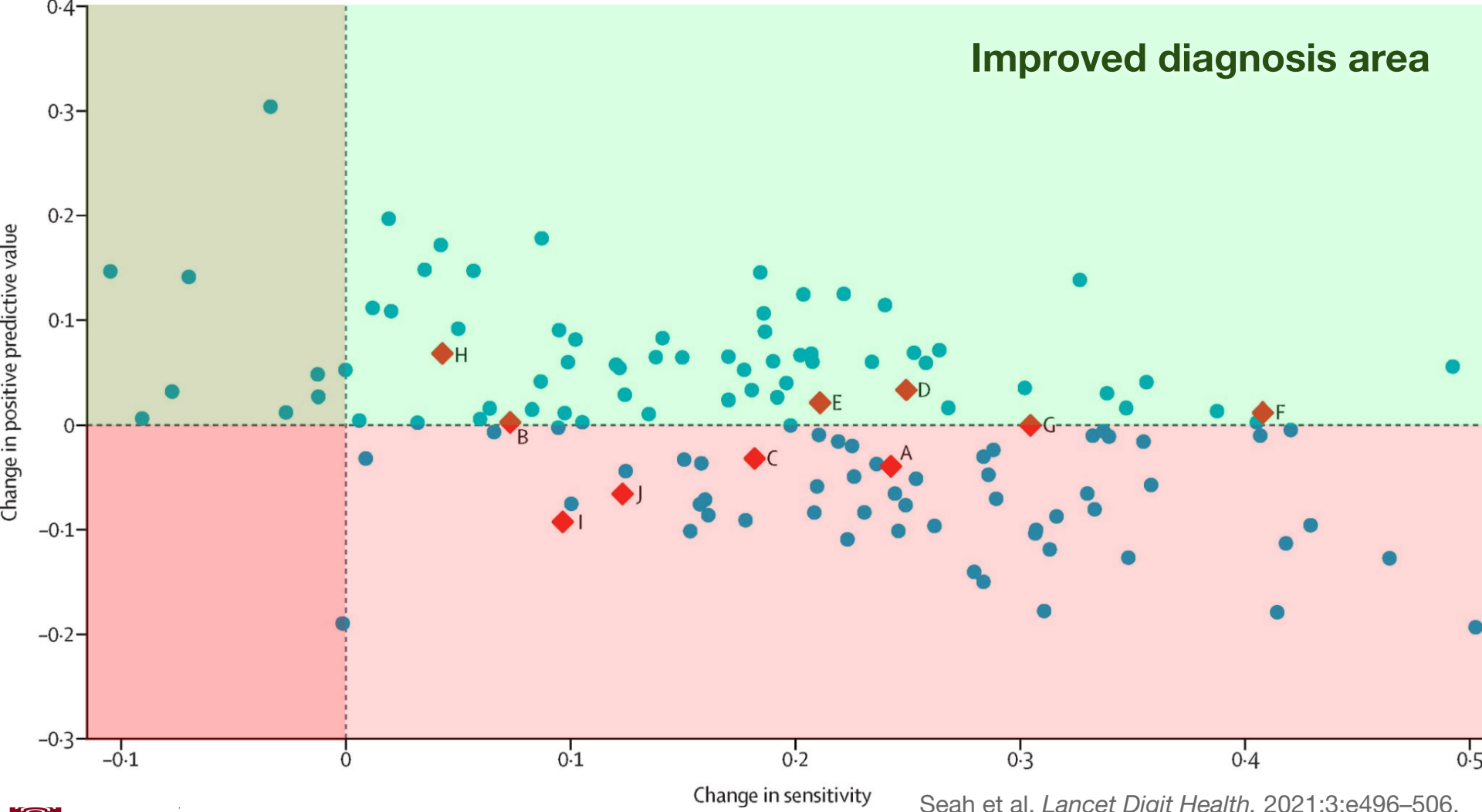
Patient outcomes

Societal outcomes

1. Percentage of times medical procedure **avoided** due to image information.
2. Number of percentage of times clinicians' prospectively stated therapeutic choices **changed** after test information.
3. Percentage of patients **improved** with test compared with/without test.
4. Cost per QALY **saved** with image information.
5. **Cost-benefit** analysis from societal viewpoint.
6. **Cost-effectiveness** analysis from societal viewpoint.

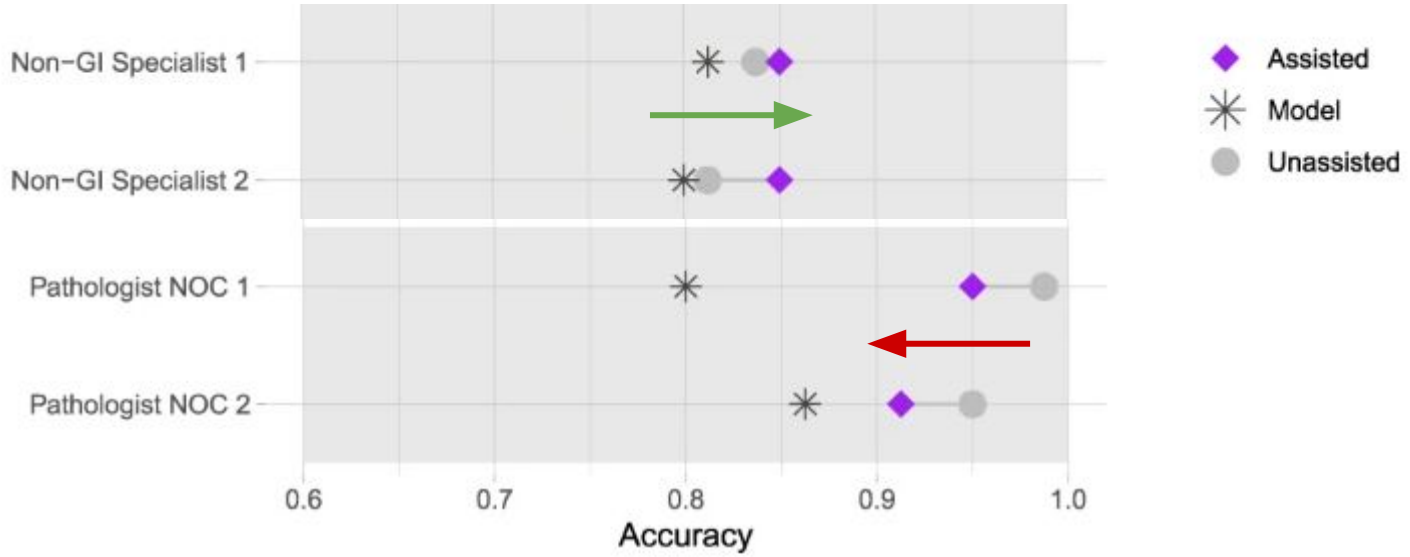


Schwendicke et al. J Dent. 2022;119:104080.



Seah et al. *Lancet Digit Health.* 2021;3:e496–506.

Fig. 4: Impact of assistance on individual pathologist diagnostic performance.

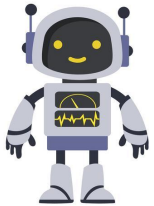


Kiani et al. *NPJ Digit Med.* 2020;3:23.

Current Model
Personalized Medicine

Low Sensitivity

Low Specificity

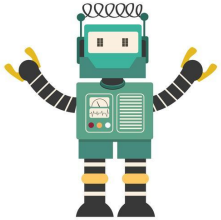


Best treatment?

Current Model
Personalized Medicine

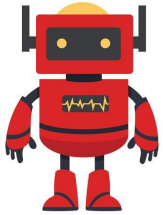
Personalized AI
Precision AI

Low Sensitivity



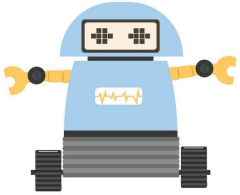
+ Sens

Low Specificity



+ Spec

Best treatment?

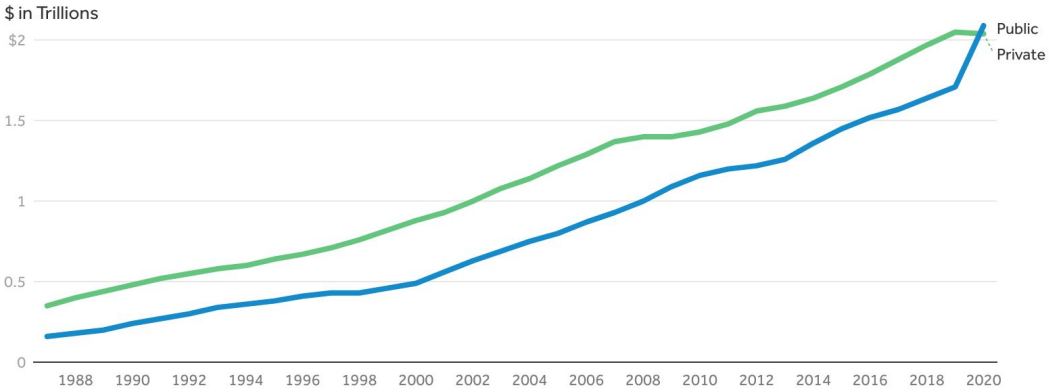


+ Decision Making

2 Key problems in Dentistry

I. How to translate the research findings for practical clinical use
II. How to decrease the costs to increase the coverage

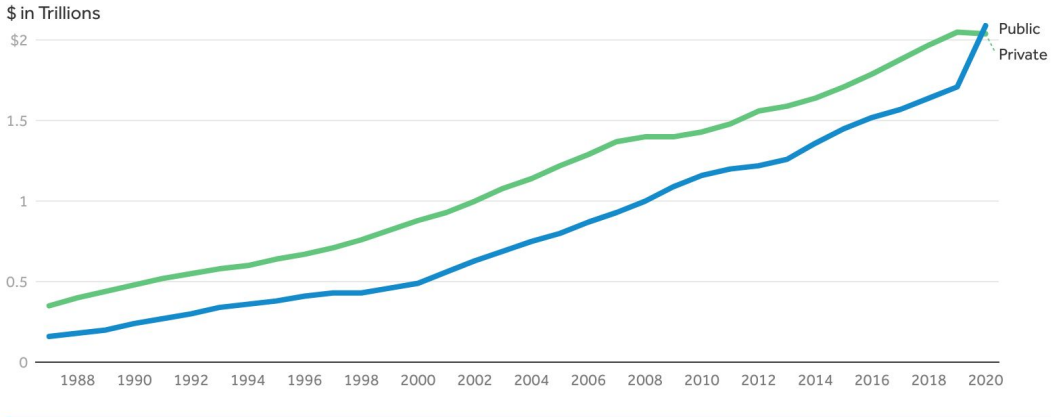
Total national health expenditures, US $ Trillions, 1987-2020



Source: KFF analysis of National Health Expenditure (NHE) data

Peterson-KFF
Health System Tracker

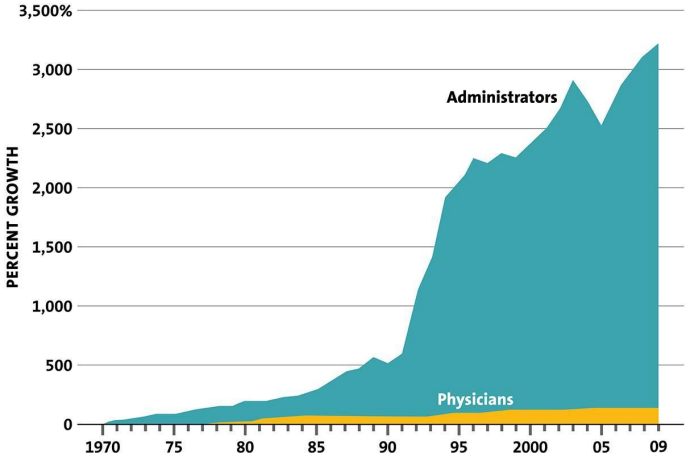
Total national health expenditures, US $ Trillions, 1987-2020



Source: KFF analysis of National Health Expenditure (NHE) data

Peterson-KFF
Health System Tracker

GROWTH IN PHYSICIANS AND ADMINISTRATORS



SOURCE: Bureau of Labor Statistics; NCHS; Himmelstein/Woolhandler analysis of CPS

2 key metrics to keep in mind when developing an AI model in Dentistry

WHO Global Oral Health Action Plan goals

1. Universal Health Coverage 75%
2. Disease reduction 10%

My new AI model/app/algorithm

increases dental UHC by (insert here)%

and

decreases (insert pathology here) prevalence by (insert here)%

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sergio.uribe@gmail.com

@sergiouribe

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LIBERTAS CAPITUR

UNIVERSIDAD AUSTRAL DE CHILE

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