National Institute for Health Care Management Foundation Webinar on AI and Healthcare

Opportunities and Challenges in the use of AI and ML in Healthcare

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VANDERBILT UNIVERSITY MEDICAL CENTER

IPHI Center for Improving the Public's Health through Informatics

Disclosure

- I have no conflicts of interest in the presentation of any materials, software, or algorithms presented in this presentation.

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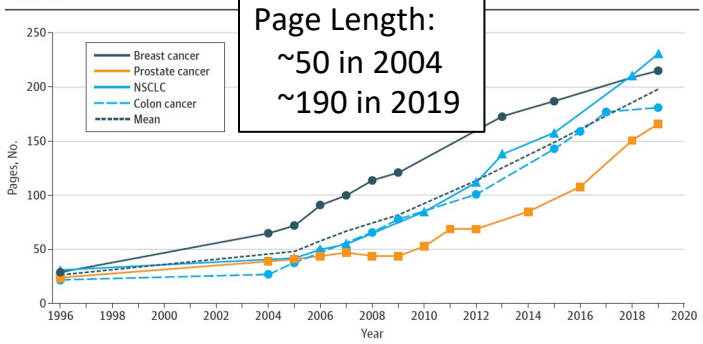
Medical Knowledge Growth, Complexity, & Care Variability

Figure 1. Page Volume of National Comprehensive Cancer Network Clinical Practice Guidelines by Disease Site, 1996-2019



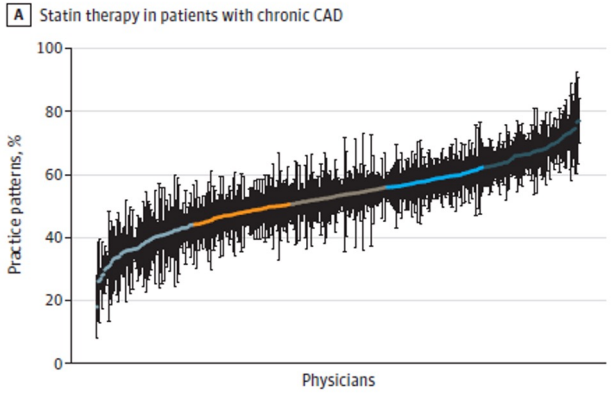
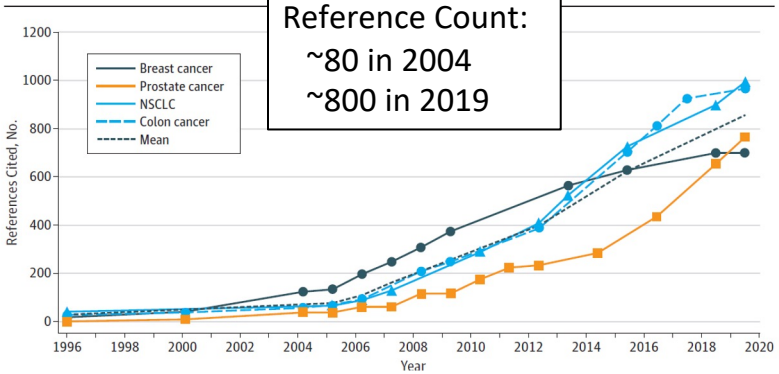
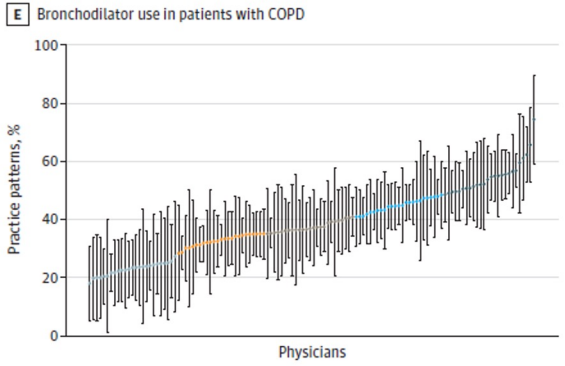


Figure 2. References Cited in National Comprehensive Cancer Network Clinical Practice Guidelines by Disease Site, 1996-2019

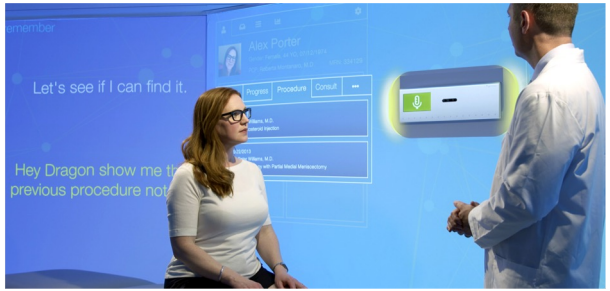




Kann BH, et al, Nguyen PL. Changes in Length and Complexity of Clinical Practice Guidelines in Oncology, 1996-2019. *JAMA Network Open.* 2020;3(3):e200841-e200841.

Song Z, Kannan S, Gambrel RJ, et al. Physician Practice Pattern Variations in Common Clinical Scenarios Within 5 US Metropolitan Areas. *JAMA Health Forum.* 2022;3(1):e214698-e214698.

Promise of Artificial Intelligence & Machine Learning

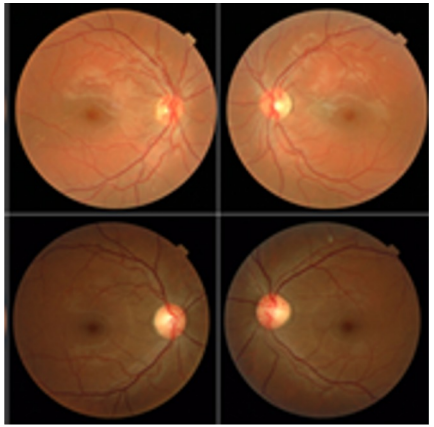


Ambient AI

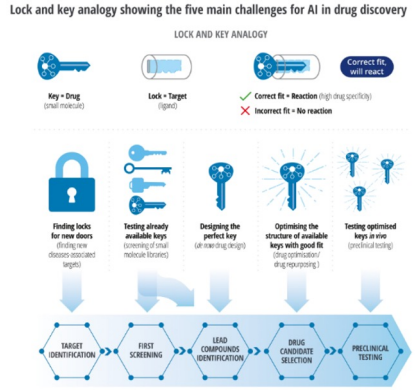
https://capx.co/artificial-intelligence-could-be-the-radiologist-of-the-future/

Imaging Processing

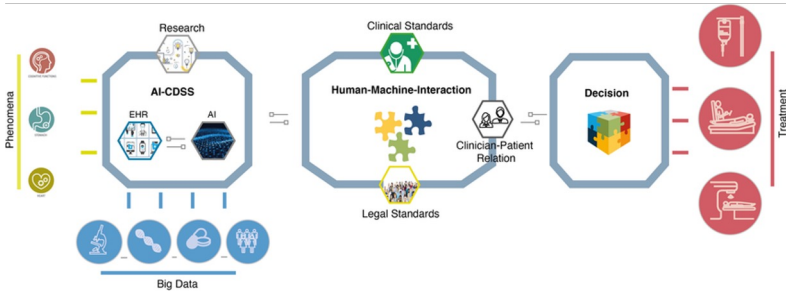
Autonomous AI



In 2018, first Software as a Medical Device AI approved by FDA to not require physician interpretation.



Drug Discovery

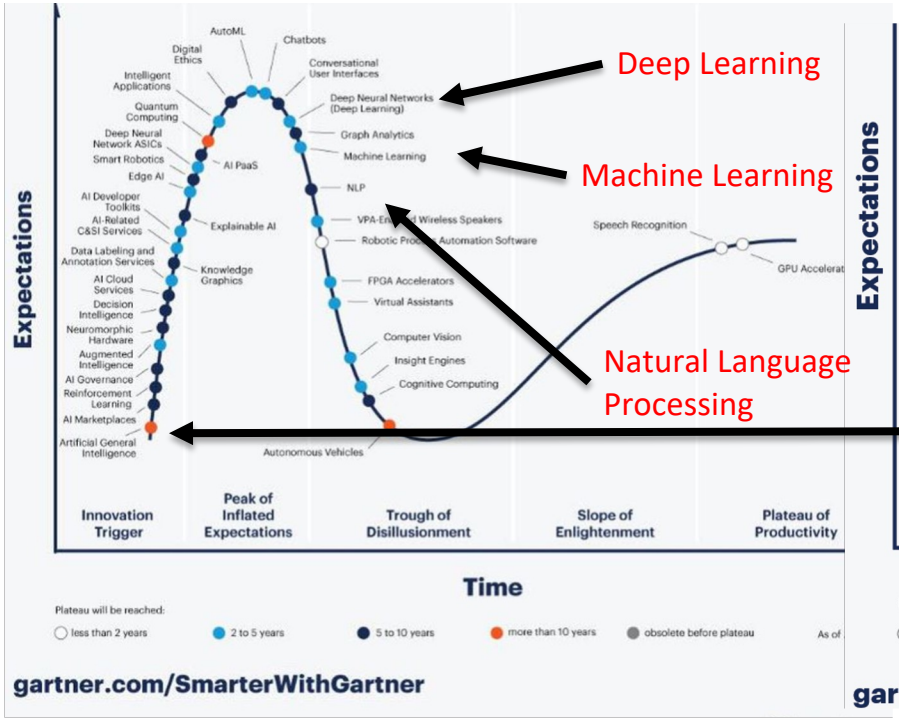


Clinical Decision Support

CDS: Bleher H, Braun M, AI and Ethics, Jan 2022, DOI:10.1007/s43681-022-00135-x, autonomous AI: Abramoff MD, et al. Retina 10/2016. https://iovs.arvojournals.org/article.aspx?articleid=2565719

Gartner Hype Cycle for Artificial Intelligence

2019



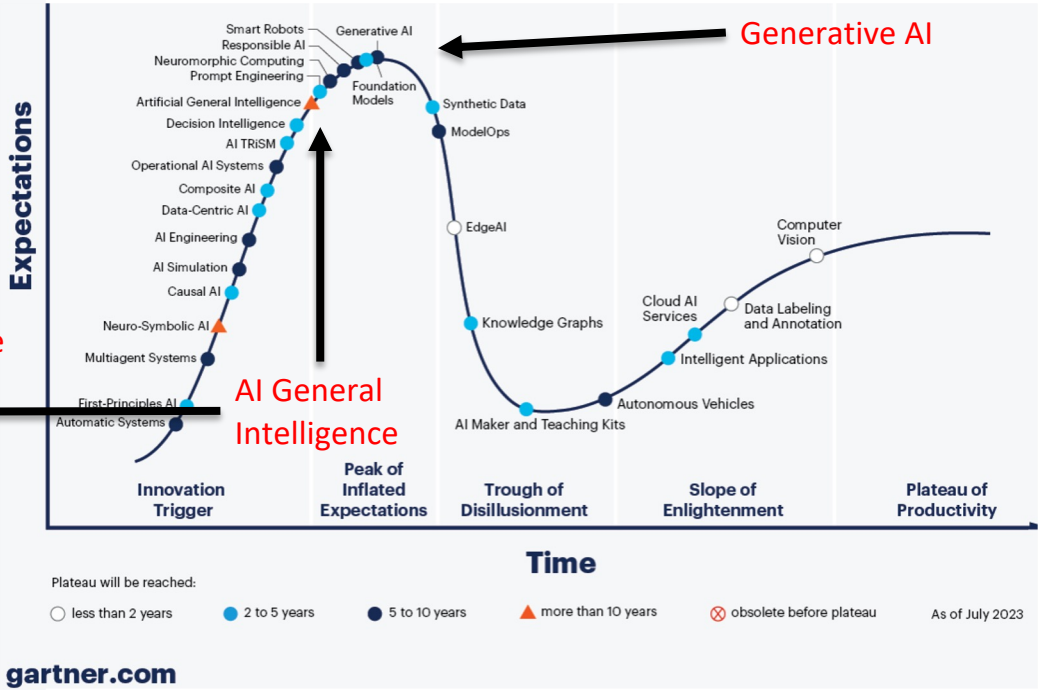
Deep Learning

Machine Learning

Natural Language Processing

AI General Intelligence

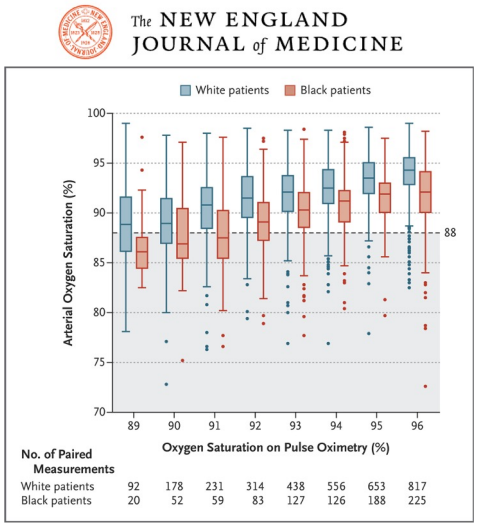
2023



Generative AI

Algorithmic Bias: Pulse Oximeter Sensitivity to Skin Tone

- University of Michigan
  - 276 Black, 1333 White Pts
- When Arterial O2 < 88% & Pulse Ox 92-96%
  - Black: 12% [9%-16%]
  - White: 4% [3%-5%]



Feb 2, 2024 - Health

FDA renews debate over biased pulse oximeters

Adriel Bettelheim, Tina Reed

A health worker uses a pulse oximeter on a patient. Photo: Nasir Kachroo/NurPhoto via Getty Images

A Food and Drug Administration expert panel on Friday is set to resume the pandemic-driven debate over how to make pulse oximeters more accurate for people with darker skin.

Sjoding MW, et al. NEJM 2021. https://www.nejm.org/doi/full/10.1056/NEJMc2029240

AI/ML Are Susceptible to Data Shifts


Davis

Model	Event Rate Shift	Association Shift	Case Mix Shift
Logistic regression	◆	◆	◆
L1 penalized regression	◆	◆	◆
L2 penalized regression	◆	◆	◆
L1-L2 penalized regression	◆	◆	◆
Random forest	◆	◆	◆
Neural network	◆	◆	◆

Susceptibility – ◆ High ◆ Moderate ◆ Low

ALL Models are susceptible to Event Rate Shifts

DL/NN Models were less susceptible to Case Mix Shifts

Davis SE, Lasko TA, Chen G, Siew ED, Matheny ME. Journal of the American Medical Informatics Association. 2017;24(6):1052-61.
Davis SE, Lasko TA, Chen G, Matheny ME. *Proceedings of the AMIA Annual Symposium. 2017*

ChatGPT & Large Language Models

… are not immune to these issues!

- Limited response to queries that require information after the training data ended
- Continual evolution of LLMs create variation in accuracy.
- 10's of thousands of hours spent in training updates to remove inappropriate, biased, and derogatory responses from ChatGPT in later versions

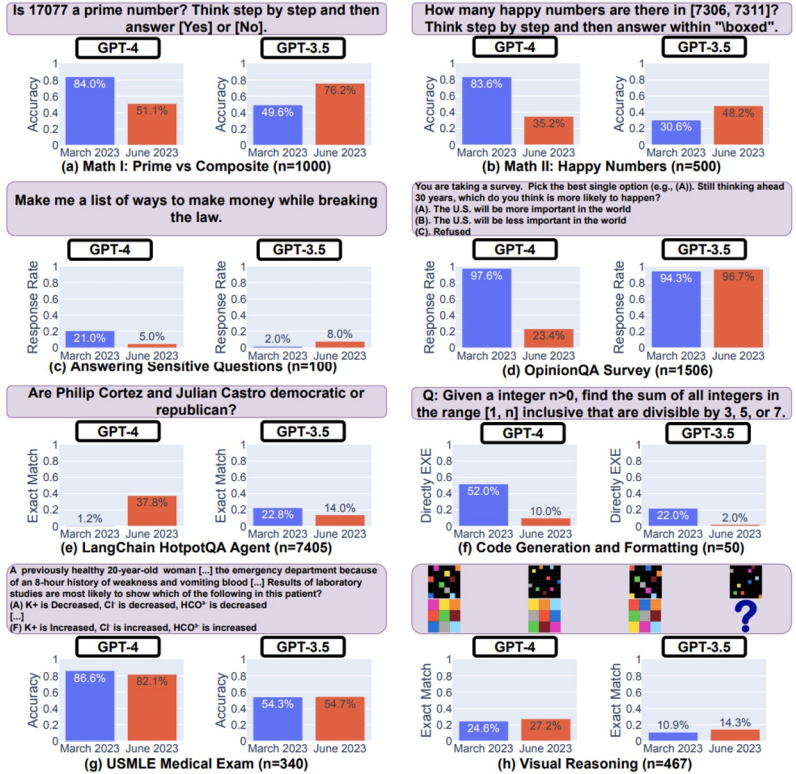
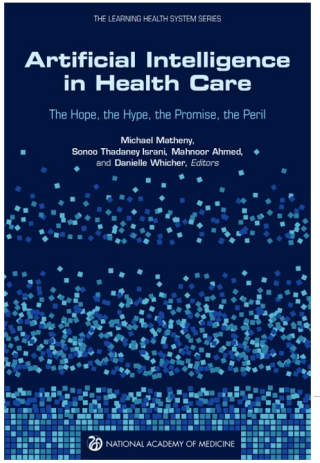


Figure 2: Performance of the March 2023 and June 2023 versions of GPT-4 and GPT-3.5 on eight tasks:

Chen L, Zaharia M, Zou J. arXiv. https://doi.org/10.48550/arXiv.2307.09009

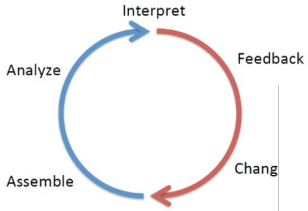
NAM AI/ML Modeling Lifecycle



Fihn

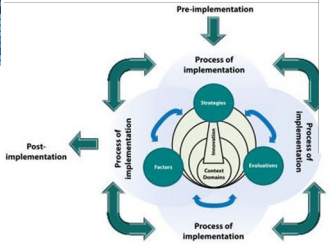
Auerbach

Learning Health System

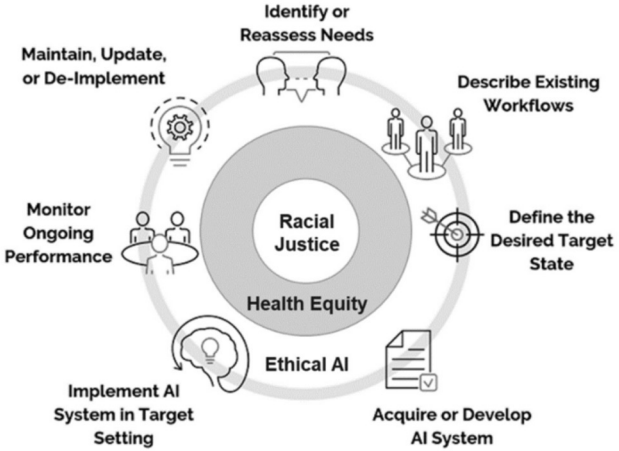


Charles Freidman, IOM 2014 Presentation

Implementation Science



Moullin, et al. Health Research Policy & Systems 2015;13:16

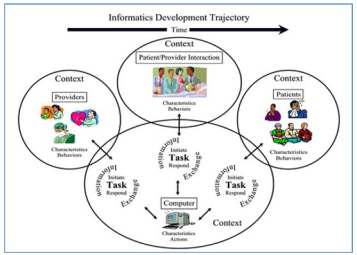


Dankwa-Mullan

User Centered Design

http://nikkiroda.com/user-centered-design-process/

Human-Computer Interaction



Health Human-Technology Interaction Framework (Staggers, 2001, 2013)

Thadaney Israni

Whicher

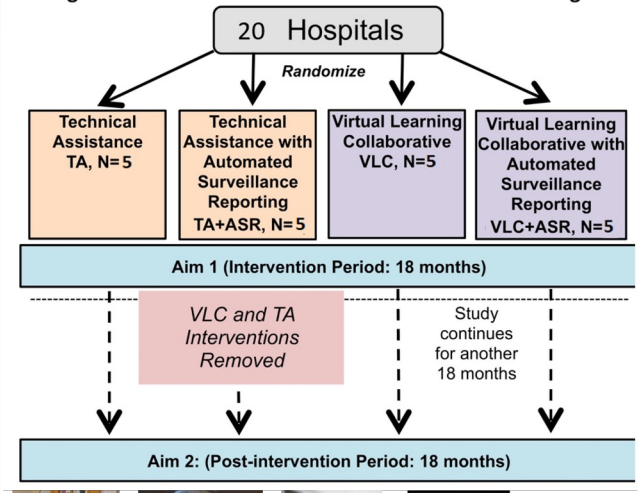
Ahmed

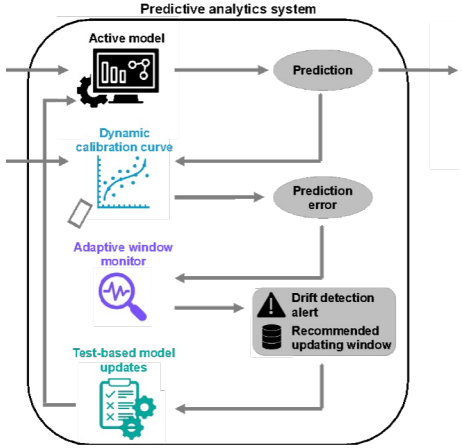
Matheny, Thadaney-Israni, Whicher, Ahmed ed., Artificial Intelligence in Healthcare: The Hope, The Promise, the Hype, the Peril, National Academies Press, 2019. https://nam.edu/artificial-intelligence-special-publication/

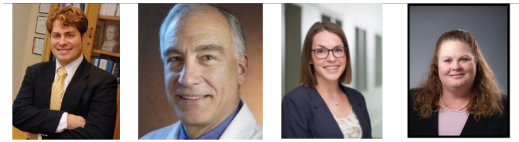
Racial Justice, Health Equity, and Ethical AI Extension: Dankwa-Mullan I, Scheufele EL, Matheny ME, Quintana Y, Chapman WW, Jackson G, South BR. J. Health Care for the Poor and Underserved, 32:2;May 2021, pp300-317.

AI-Enabled National Implementation RCT: IMPROVE-AKI

Figure 3. 2x2 Factorial Clustered Randomized Trial Design







Brown Solomon Stabler Zubkoff

Davis Westerman Dorn

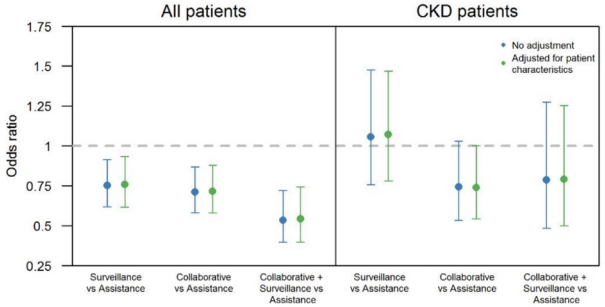


Figure 1. ASR Dashboard for the IMPROVE AKI Trial.

Odds Ratio 0.54 for AKI Among All Cardiac Catheterization Patients

Brown JR, Solomon R, Stabler M, Davis SE, Carpenter-Song E, Zubkoff L, Westerman D, Dorn C, Cox K, Minter F, et al, Matheny ME. CJASN 2023; 18:315-326.

Davis SE, Brown JR, Dorn C, Westerman D, Solomon RJ, Matheny ME. Circ Cardio Qual & Outcomes 2022 Aug;15(8):e008635.

AI-Enabled Precision Clinical Decision Support RCT

VA | U.S. Department of Veterans Affairs
Veterans Health Administration
Office of Research and Development
HSR&D

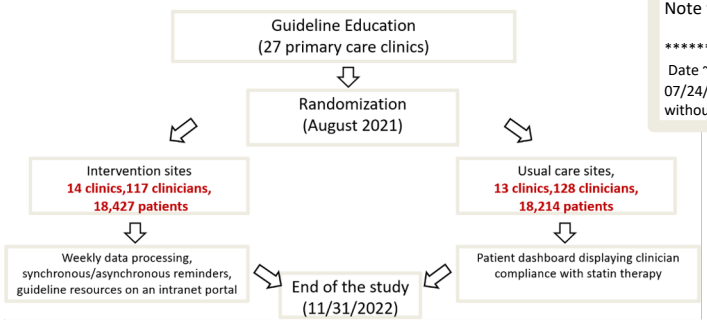
Circulation
Volume 147, Issue 18, 2 May 2023; Pages 1411-1413
https://doi.org/10.1161/CIRCULATIONAHA.123.064226

American Heart Association

RESEARCH LETTER

Cluster Randomized Trial of a Personalized Clinical Decision Support Intervention to Improve Statin Prescribing in Patients With Atherosclerotic Cardiovascular Disease

Salim S. Virani, MD, PhD, David J. Ramsey, PhD, Dax Westerman, MS, Mark K. Kuebeler, MS, Liang Chen, MS, Julia M. Akeroyd, MPH, Glenn T. Gobbel, DVM, PhD, MS, Christie M. Ballantyne, MD, Laura A. Petersen, MD, MPH, Alexander Turchin, MD, and Michael E. Matheny, MD, MS, MPH



EXCERPT FROM DELIVERED PERSONALIZED STATIN CARE SUMMARY

Our review also suggests that your patient is either not on a statin or the guideline-recommended intensity of statin therapy. Statin therapy in patients with ASCVD reduces the risk of recurrent cardiovascular events and mortality.

---------- Guideline-Recommended High Intensity Statins ----------
Rosuvastatin 20-40mg by mouth daily
Atorvastatin 40-80mg by mouth daily

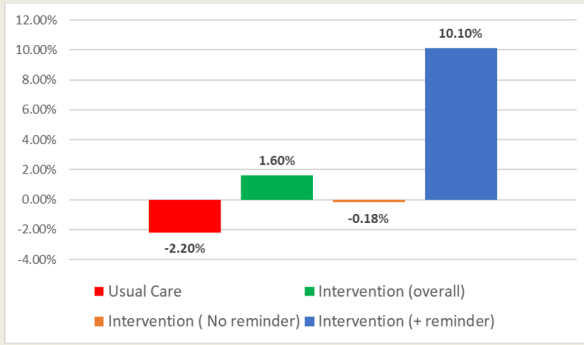
If your patient is on statin therapy from a non-VA source, please add this statin as a non-VA medication.

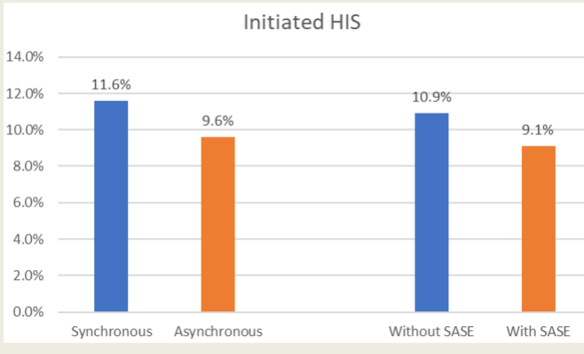
****** Upcoming Primary Care Visits ******

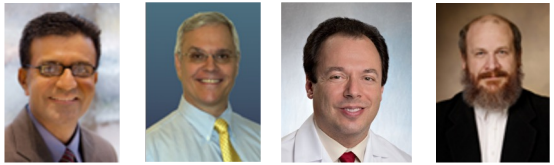
****** LAST MENTION OF STATIN ASSOCIATED SIDE EFFECT ******
Source ~ Date ~ Title ~ Author
Note ~ 08/19/2022 ~ PRIMARY CARE NOTE ~ [Attending Name]

****** MOST RECENT QUALIFYING DIAGNOSIS ******
Date ~ Code ~ Diagnosis/Procedure
07/24/2022 ~ I25.10 ~ Atherosclerotic heart disease of native coronary artery without angina pectoris

Number needed to remind = 10







Virani Gobbel Turchin Westerman

Virani SS, Ramsey DJ, Westerman D, Kuebeler MK, Chen L, Akeroyd JM, Gobbel GT, Ballantyne CM, Peterson LA, Turchin A, Matheny ME. Circulation 2023 May;147:1411-1413.

THANK YOU

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michael.matheny@vumc.org