Technology to transform pediatric healthcare

Unlimited potential and big obstacles

James A Taylor, MD
Clinical Research Scientist
Google
Professor Emeritus
University of Washington

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Disclaimer

- Which technologic innovations get adopted for use in pediatric healthcare, and the inflection point for adoption are only clear in retrospect
- Truly game changing innovations are rare, sporadic
- Multiple forces will shape the future of pediatrics besides technologic innovation, and impede or accelerate technologic innovations
- Only a true visionary can understand all of these forces and predict the future
- I'm not one of those people

Plan for talk

1. Examples of how currently available technology or technology likely available in near future can transform pediatric healthcare
2. Discuss obstacles to implementation of new technologies and offer some possible solutions

Types of technology

Use of large datasets and “traditional” methods of analysis for use

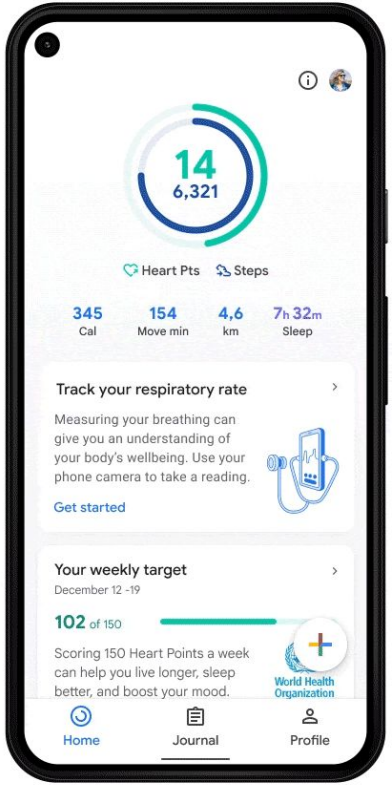
- After informed consent, use of Internet search history to provide health information and collect data for disease prediction
- Machine learning, neural networks to analyze large datasets, e.g. EHR, streamline care, provide data to providers in more usable format, disease prediction

Wearables, i.e. smartwatches

- Opportunity to collect longitudinal health data– activity, HR, sleep, RR, SpO2
- Limited, but growing, penetration in adults, miniscule in children
- Without involvement of healthcare organizations may not promote health equity

Smartphones

- Incredible number of sensors that could be used to provide episodic/longitudinal data on a variety of health indicators
- Cameras- skin lesions, PPG signals (HR, SpO2)
- Microphone– cough count/acoustics, sonar for RR
- Accelerometers,gyroscopes, barometers– activity, movement (falls)
- Radar– RR, HR



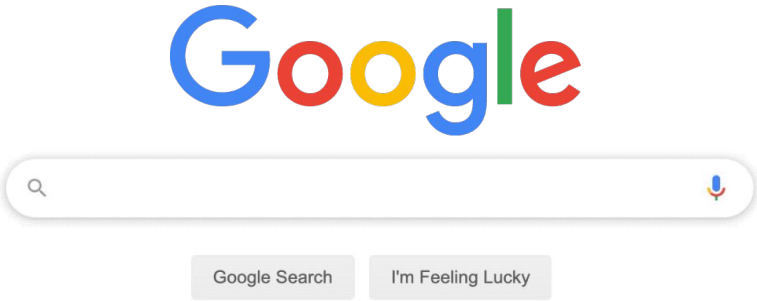
https://blog.google/technology/health/take-pulse-health-and-wellness-your-phone/

Large language models (LLMs)

- Human-like interactive “conversations,” e.g. Bard, ChatGPT, Claude
- Prediction of disease by review of vast amounts of text (in EHR, e.g)
- LLM technology has potential to fundamentally transform medicine
- Currently in infancy, limited utility at present in pediatrics

Technology will provide more parental/youth autonomy for making informed healthcare decisions and make pediatric healthcare more interactive

- High quality health information provided in Google Search
- “Knowledge panels” on numerous pediatric conditions
- Process for labeling Youtube health videos as coming from a “credible source”



Example of possible future uses of sensors on smartphones and wearables

- For child with acute respiratory infection, longitudinal cough count, RR during sleep (or awake), SpO2, HR
- Parent could track trajectory of illness and compare with usual course from data in other children
- Smartphone microphone could be used to “listen” to lungs and with AI to detect wheezing
- Could incorporate sensor data into online validated triage, with LLMs to provide “conversation” and provide triage advice
- Longitudinal data could be sent to providers and/or incorporated into EHR

Use of sensors to monitor chronic disease severity

- Use of under bed sensors for HR, RR. Additional inputs– RR, activity

ORIGINAL ARTICLE

Passive Nocturnal Physiologic Monitoring Enables Early Detection of Exacerbations in Children with Asthma

A Proof-of-Concept Study

Michelle F. Huffaker[1], Michael Carchia[2], Bronwyn U. Harris[2,3], William C. Kethman[4], Todd E. Murphy[2], Charlotte C. D. Sakarovitch[5], FeiFei Qin[5], and David N. Cornfield[6]

[1]Department of Pediatrics–Allergy and Immunology, [3]Department of Pediatrics–Cardiology, [4]Department of Surgery, [5]Quantitative Sciences Unit, and [6]Center for Excellence in Pulmonary Biology, Division of Pulmonary, Asthma, and Sleep Medicine, Department of Pediatrics, Stanford University Medical School, Stanford, California; and [2]Tueo Health, Inc., San Francisco, California

AI and imaging

Point of care ultrasound with AI assist in primary pediatric care

communications medicine

ARTICLE

https://doi.org/10.1038/s43856-022-00194-5 OPEN

Check for updates

A mobile-optimized artificial intelligence system for gestational age and fetal malpresentation assessment

Ryan G. Gomes[1,6✉], Bellington Vwalika[2,3,6], Chace Lee[1,6], Angelica Willis[1,6], Marcin Sieniek[1], Joan T. Price[3,4], Christina Chen[1], Margaret P. Kasaro[2,4], James A. Taylor[1], Elizabeth M. Stringer[3], Scott Mayer McKinney[1], Ntazana Sindano[4], George E. Dahl[5], William Goodnight III[2], Justin Gilmer[5], Benjamin H. Chi[3,4], Charles Lau[1], Terry Spitz[1], T. Saensuksopa[1], Kris Liu[1], Tiya Tiyasirichokchai[1], Jonny Wong[1], Rory Pilgrim[1], Akib Uddin[1✉], Greg Corrado[1], Lily Peng[1], Katherine Chou[1], Daniel Tse[1✉], Jeffrey S. A. Stringer[3,4,7] & Shravya Shetty[1,7✉]

Use cases for POC ultrasound in primary care pediatrics

- Infant with large head but developing normally
- Follow-up of fetal pelviectasis
- Diagnosis of appendicitis
- Monitoring for closure of VSD in young infant
- Diagnosis of distal radius “buckle” fracture
- Diagnosis of pneumonia
- AI to guide collection of image data and help with interpretation
- Could be part of pediatric training

Technology and the “new morbidities”

Primary care pediatrics in the 21st century

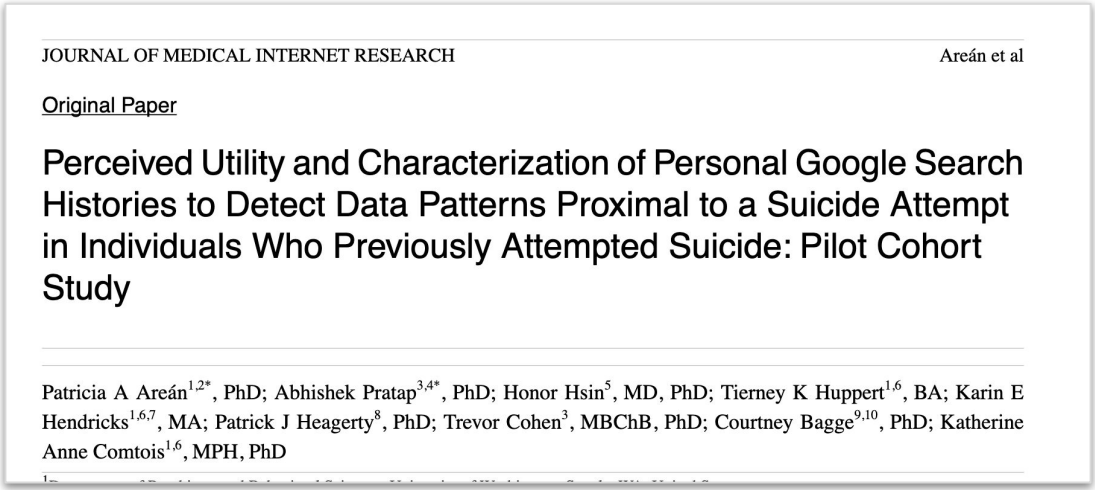
- Focus shifting from acute infectious diseases
- Chronic health management
- Behavioral issues and mental health
- Physical inactivity
- Social determinants of health

Technology for management of behavioral/ mental health issues

- Hugely important area in pediatrics, care is sub-optimal for many reasons
  - Pediatric trainees historically felt inadequately trained
  - Too few qualified providers, not distributed equally across US
  - Heighted inequities
- Regionally organized telemedicine visits with pediatric mental health/behavioral providers would improve care, reduce health disparities

“Electronic” and other biomarkers for mental health conditions

- Emerging type of research
- Study participants, after informed consent, can donate their internet search history data to researchers directly (without companies’ involvement)
- Study at right is an example of this kind of study – done by researchers at University of Washington, participants donated their Google Search histories (via Google Takeout) to researchers



JOURNAL OF MEDICAL INTERNET RESEARCH Areán et al

Original Paper

Perceived Utility and Characterization of Personal Google Search Histories to Detect Data Patterns Proximal to a Suicide Attempt in Individuals Who Previously Attempted Suicide: Pilot Cohort Study

Patricia A Areán[1,2*], PhD; Abhishek Pratap[3,4*], PhD; Honor Hsin[5], MD, PhD; Tierney K Huppert[1,6], BA; Karin E Hendricks[1,6,7], MA; Patrick J Heagerty[8], PhD; Trevor Cohen[3], MBChB, PhD; Courtney Bagge[9,10], PhD; Katherine Anne Comtois[1,6], MPH, PhD

MVPA, sedentary time and impact on health

Estimating causal effects of physical activity and sedentary behaviours on the development of type 2 diabetes in at-risk children from childhood to late adolescence: an analysis of the QUALITY cohort

Soren Harnois-Leblanc, Marie-Pierre Sylvestre, Andraea Van Hulst, Tracie A Barnett, Marie-Ève Mathieu, Miceline Mesidor, Jennifer J McGrath, Angelo Tremblay, Vicky Drapeau, Gilles Paradis, Mélanie Henderson

- Provide wearables to youth at risk for type 2 diabetes, measure MVPA, sedentary time for use in monitoring and changing behavior
- Activity data, internet search data, other information to develop multiple “motivation phenotypes” for optimizing behavioral interventions

Effective screening for social determinants of health and accessing programs to mitigate effects

MEDICAL LEGAL PARTNERSHIP AND HEALTH INFORMATICS IMPACTING CHILD HEALTH: INTERPROFESSIONAL INNOVATIONS

Amy Lewis Gilbert, JD, MPH and Stephen M. Downs, MD, MS

Impediments to implementing new technologies into pediatric healthcare

Obstacles for developers

- Availability of large datasets of pediatric healthcare records and biometric signals is limited, compared to adults
- Perception of increased risk of research in children and product deployment for pediatric use cases
- Tension between models for predicting health outcomes and patient privacy
- Technical debt, increased costs, use of resources to retrofit products initially developed for adults for use in children rather than designing for all populations from the start
- Although the QALYS gained through improving child health dwarf the QALYS gained with products for adults, the potential revenue for many important pediatric use cases is relatively limited due to reimbursement models in the US

Obstacles for pediatrics

- Insufficient focus in pediatric training on “new morbidities” and use of technology outside of the hospital, perhaps in part because of how training is financed
- Disconnect between the amount of new technologies that could be used for improving care and interest by pediatric academic researchers in delineating their clinical utility
- Clinical studies on new technologies that could benefit children’s health typically not published in journals read by pediatric healthcare professionals

Overall issues for implementing AI into medicine

- Developing technologies with enough accuracy for use in pediatric healthcare is really hard (see Kelly et al, BMC Medicine 2019;17:195)
- Risk of increasing rather than decreasing health inequities
- So far, haven't found the visionary genius in the right position with the will to take the risks to transform pediatric healthcare (or all of healthcare) through the use of technology

Overcoming the barriers

A few modest suggestions

- Working group of academic pediatric trialists, research scientists from industry, NIH, AHRQ, and FDA to generate ideas for possible uses of technologies in pediatrics and spur interest in clinical studies to delineate clinical utility
- Pediatric training should evolve so that education about newer technologies is fully incorporated
- Multi-sector collaboration for use of innovative technologies that will have significant impact in improving child health, but have limited revenue potential
- Stakeholder collaboration to develop best practices for incorporation of patient data (e.g. wearable) into EHR
- As a society need to determine guidelines for sharing data from devices and use of internet for health application