# "*Health Informatics - 60 years of changing our environment - and more to come*"

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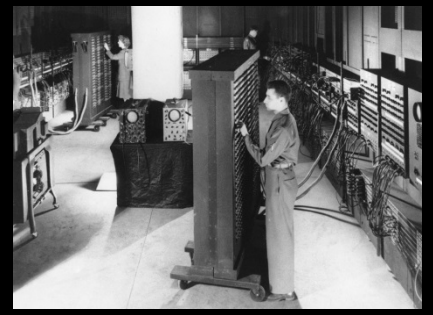
W. Ed Hammond, PhD
Director, Duke Center for Health Informatics

- Technology has far outclassed our ability to use it!
- Healthcare systems and EHR Systems have been a failure.
- Health and healthcare systems of the future will take advantage of technology and artificial Intelligence to create an effective, personalized  Digital Health System.

# Evolution of Computers



- 1959-1970 Large Mainframe Computers
- 1970-1990 Minicomputers
- 1990-20xx Personal computers, laptops
- 2010-20xx IPads, Tablets
- 2014-20xx Nanocomputers, wearable computers

# The Growth of Technology

- In the early years, computers were the weakest part of healthcare IT.
- Moore's Law – the number of transistors on a microchip doubles every 18 months while the cost halves during that period.
- Computers evolved rapidly; not just in size and speed, but in cost and ease in using.
- At the same time, wireless, global communication grew so that instantly the world is connected.
- **Today, technology has far outclassed our ability to use the resources available to us.**

# What technology has added

- Small, mobile devices that are ubiquitous
- More knowledge than we can use
- The ability to aggregate all data about a person from all sources
- The ability to package that data in such a way that humans can more effectively use that data
- A rich mixture of media to enhance our understanding of disease and its cure

# Value of Technology

- Data and outcomes available for the understanding of the effects of treatment and for the extraction of knowledge
- Through measurement, a better understanding of cause and effect
- Identification of all factors involved in impacting disease and quality of life
- Creating models that will better predict the cost of health care
- More rapid identification of candidates for clinical trials
- Quicker determination of global adverse drug events
- Quicker awareness of disease outbreaks

# Technology gives us PERSONAL devices

- Mobile devices – mHealth
- Monitors
- Sensors
- Wearable devices
- Smart Watch
- Thousands of apps
- Real-time measurements

Connecting these devices requires INTEROPERABILITY

# Interoperability requires Enabling standards


- HL7 FHIR ®


- SMART ®

- CDS Hooks


Bulk FHIR

FHIRCast

**REST (REpresentational State Transfer)**


OAuth 2.0

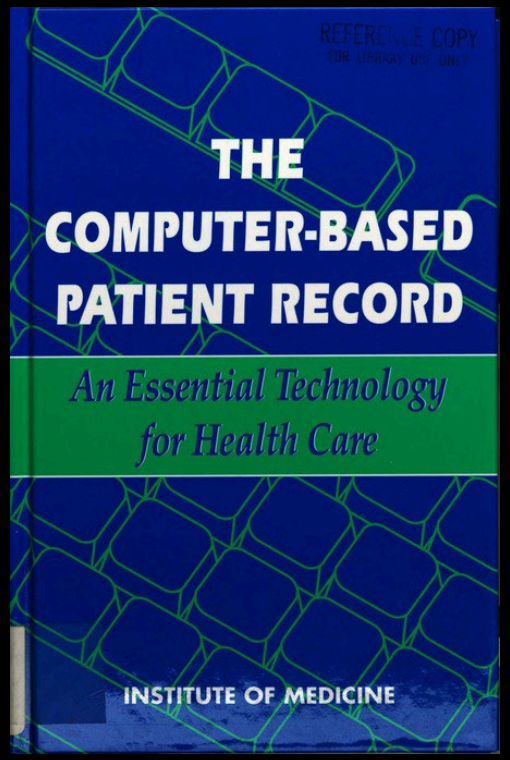
"Give me a place to stand, and a lever long enough, and I will move the world. "
— **Archimedes**

# Mirror, Mirror, 2021  Reflecting Poorly

| | | AUS | CAN | FRA | GER | NETH | NZ | NOR | SWE | SWIZ | UK | US |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Overall | | 3 | 10 | 8 | 5 | 2 | 6 | 1 | 7 | 9 | 4 | 11 |
| Access to care | | 8 | 9 | 7 | 3 | 1 | 5 | 2 | 8 | 10 | 4 | 11 |
| Care process | | 6 | 4 | 10 | 9 | 3 | 1 | 8 | 11 | 7 | 5 | 2 |
| Admin Efficiency | | 2 | 7 | 6 | 9 | 8 | 3 | 1 | 5 | 10 | 4 | 11 |
| Equity | | 1 | 10 | 7 | 2 | 5 | 9 | 8 | 6 | 3 | 4 | 11 |
| Health care outcomes | | 1 | 10 | 6 | 7 | 4 | 8 | 2 | 5 | 3 | 9 | 11 |

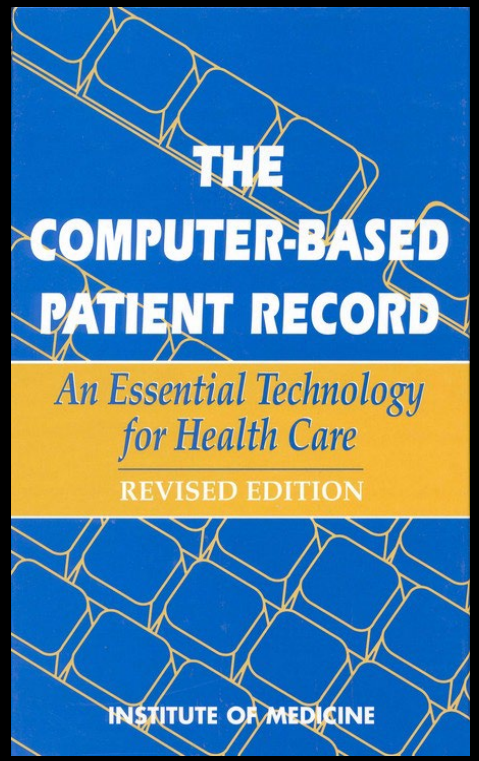
Source: Eric C. Schneider et al., *Mirror, Mirror 2021 — Reflecting Poorly: Health Care in the U.S. Compared to Other High-Income Countries* (Commonwealth Fund, Aug. 2021). https://doi.org/10.26099/01DV-H208

# THE COMPUTER-BASED PATIENT RECORD




1991

Published by the Institute of Medicine – now the National Academies of Medicine




1997

EHR systems are computerized paper systems

# Requirements for Computer-based Patient Record

- Support patient care and improve quality
- Enhance productivity of health practitioners
- Reduce administrative costs
- Support clinical and health services research
- Accommodate future developments in health care technology, policy, management, and finance
- Insure patient data confidentiality

Today's EHR has not met these expectations!

# Solving EHR's suboptimal approaches to data storage

All data about a patient is stored in a single data cell

- Clinical, genomic, behavioral, social, economic, environmental, and family history
- May contain multiple databases, but data is managed by knowing precisely where data is located
- Instantly knowing if a data element exists.

Data is stored as data – not as a function of use

All functionality for using the data is external to the data cell

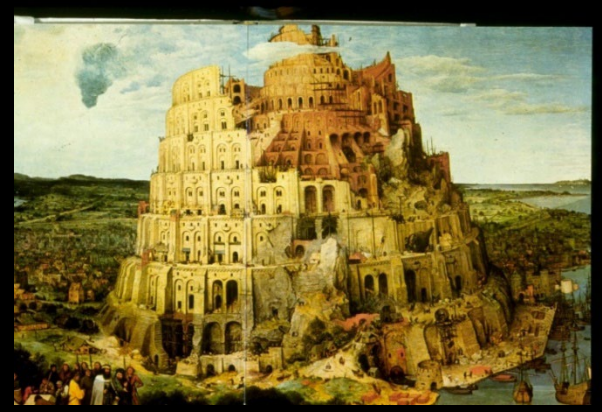
# The New EHR

- Supports multiple use of data rather than secondary use.
- All data related to the patient is stored in a single virtual container labeled data box.
- Data box performs REST services – Create, read, update, delete
- Data storage is independent of data use.
- Use functionality is performed independently by functional apps.
  - Permits keeping up with new technology and new requirements
  - Allows specialization of data presentation and use
  - Enables competitive market
- Supports query based interactions: pull over push

# Data Sharing

- Understanding COVID-19 and effective treatments required aggregating data across multiple sites.
- The National COVID Cohort Collaborative (N3C) **Data Enclave** is a secure platform through which the harmonized clinical data provided by multiple contributing members is stored.
  - 16.9 million patients
  - COVID cases 6,563,324
  - 94 Data Transfer Agreements
- Participants submitted data using multiple data models

# The Problem: Speaking the same language



- National Covid Cohort Collaborative (N3C)
  - (Un)Common Data Models
    - PCORI
    - ACT (i2b2)
    - OMOP
    - TriNetx
- Universities of California Integrated System
- United States Core Data for Interoperability (USCDI)
- Arden Syntax “curly brackets” problem

# The perfect world – the big picture

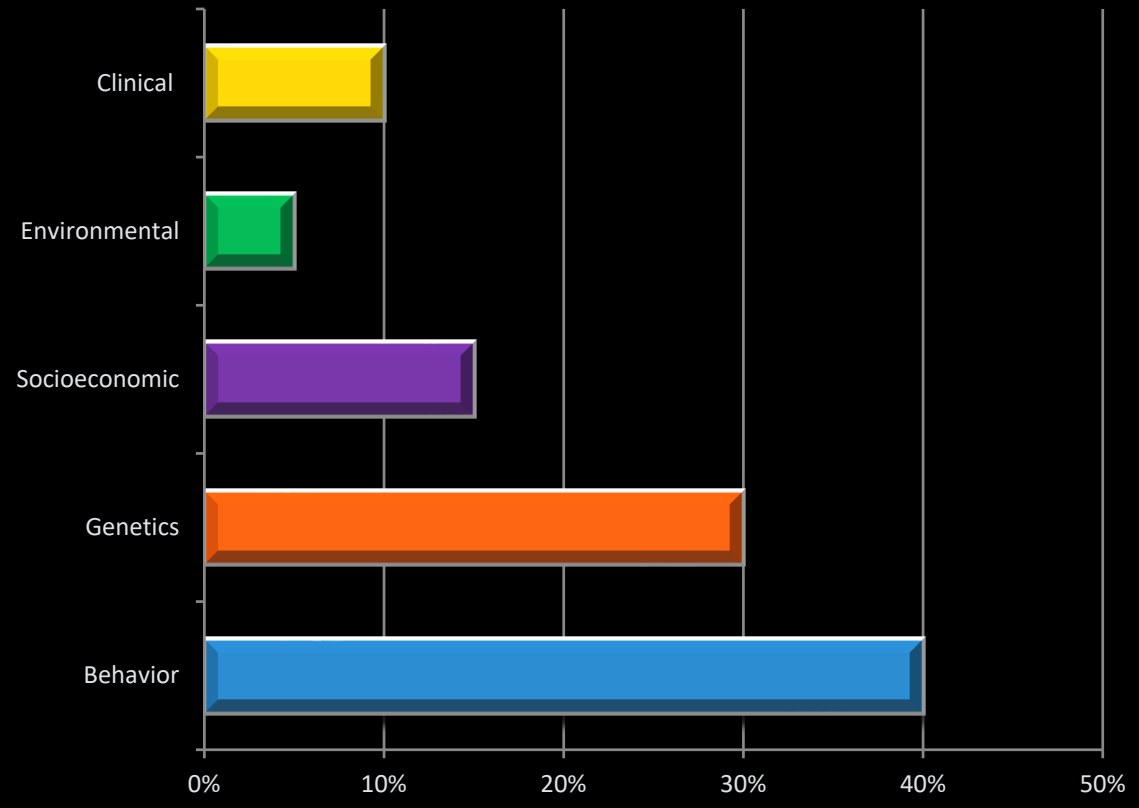
- Common set of data elements with rich attributes
- Data numeric identifier – global
- Integration of all data types – clinical, behavioral, genomic, social, environmental, administrative, reimbursement, and process related.
- Standardize data collection – both methods, data elements, and contents
- Embedded knowledge within data elements
- Establish trust, data quality, consistency
- Full provenance – know how, when and where data collected
- Goal is going from 80 % to 100% of the data required
- Data defined by clinical and domain experts managed through clinical societies and some other groups
  - Tools and processes must be defined
  - Accelerator group of clinical societies

# Data elements value enhanced

- Create structured sets of data elements into larger groupings
  - Simple cases such as blood pressure, heart murmurs
  - More complex sets such as echocardiogram, cardiopulmonary exercise testing
  - Structures to capture complex phenomena yet are easy to work with
  - Functional sets such as well baby work-up, pediatric growth, kidney function, maternal health
  - Phenotypes – diagnostic, treatment, monitoring
  - Digital Biomarkers
  - Tracking Covid patients (and others) across time and space
  - Registries
  - Computable knowledge built into the data element
  - Any defined purpose for a standardized grouping of data elements

# New kinds of data

## Social Determinants of Health




Impact on quality and length of life

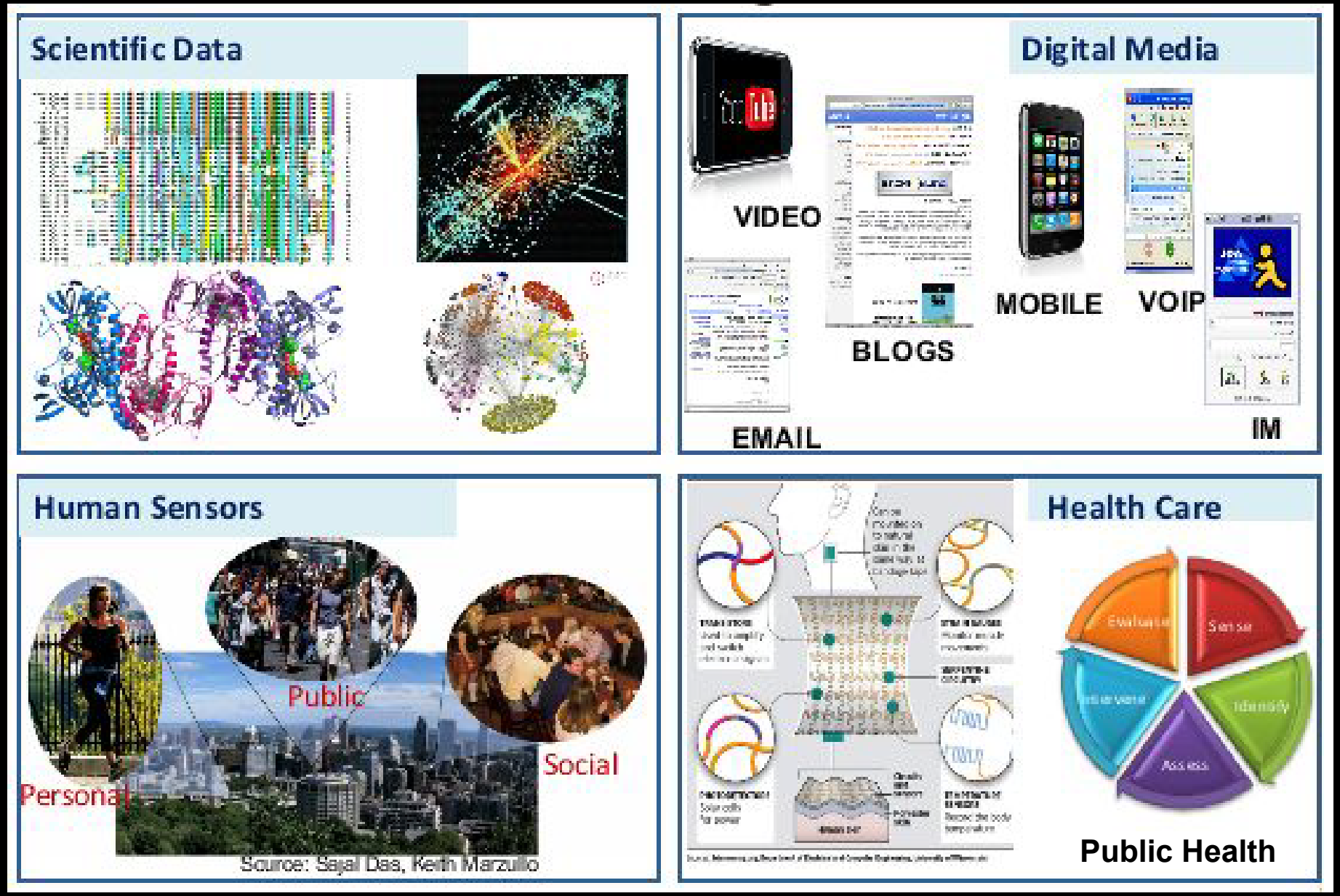
## Types of Wearable Medical Devices based on site of Application





**Measure your blood oxygen level with a revolutionary sensor and app. Take an ECG anytime, anywhere. Check your heart rate. Along with other innovations like mindfulness and sleep tracking to keep you healthy from head to toe. Series 7 puts more health insights in sight.**

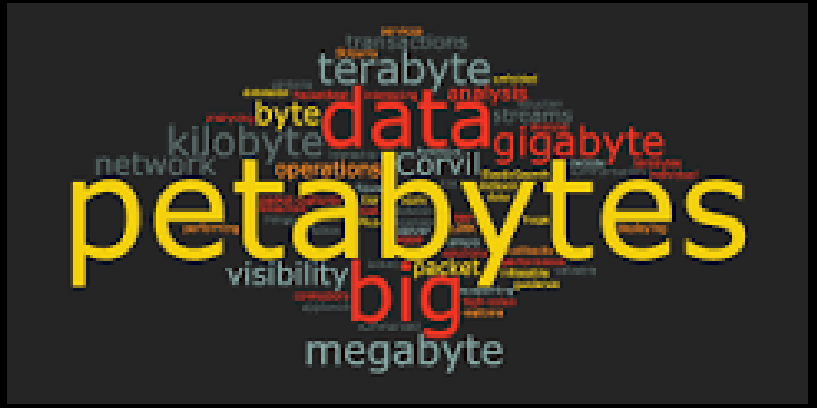
# Today everything is a source of data



# Big Data and Its Impact

COVID requires tracking patients and aggregation of data across multiple sites.

- Big Data is a consequence of more things that create data and more initiatives to merge data.
- For a single patient, we are talking about petabytes of data; for a aggregated database of multiple patients, we are talking about exabytes or more.
- Computable knowledge is an award of Big Data.
- Requires new and innovative methods of analyses to create new knowledge
- NoSQL databases making their appearances to provide higher speed necessary for analyses.




In 2020, we create 463 exabytes of new data daily.

HL7® FHIR®

# Digital Health

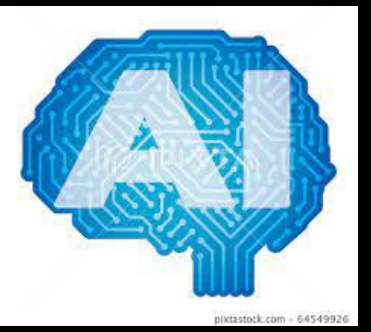
- Convergence of digital technologies with health, healthcare, research, living, and society and make treatments more personalized and precise
- Includes technologies, platforms, and systems that engage consumers for lifestyle, wellness, and health-related purposes
- Captures high-quality relevant data with consistency
- Makes that data available to the right person at the right time for the right purpose  at the right place
- Use of data can be appropriately localized and personalized
- Can and should act as a force multiplier of the innovations to combat challenges for individuals and for population health
- Can ensure that equitable care is available to all

# Mobile Devices

- The ubiquity of smart phones has changed communications between and among groups.  A virtual visit will replace an office visit.
- Wearable sensors will give real time data about the person resulting in early interventions.
- Smart phone apps can be used for data collection by text, check boxes, and photographs with sufficient resolution to make clinical diagnoses in many areas such as dermatology.
- Smart phones can be used for education,  behavior modification, and more.


Brick and mortar institutions will be replaced by virtual healthcare systems.

# Artificial Intelligence




- Knowledge exceeds the ability of humans to use available facts to make decisions
- Computers are becoming able to learn from data and knowledge that is available on the internet and other sources.  Computers are becoming self-aware. Create new knowledge.
- Driver for new groups entering the HIT marketplace: Google, Apple, Microsoft, Amazon, others
- When will computers become smarter than humans?
- What will be the role of computers vs humans?

# What drives the adoption of Artificial Intelligence in health care?

- Ability to bring together many types of data
  - Proliferation of imaging modalities, digitization of health records, next generation sequencing, wearables, IOT …
  - Pull data together, make sense of it, use AI to clean
- Computation at scale – we now work in the cloud with platforms that co-locate diverse large data sets and with compute power that you can dial up from one processor to hundreds if needed.

# Surviving the tsunami of data

- Humans are only capable of using 5-7 facts in making a decision.  We now have thousands of data points relevant to making a decision.
- New evidence for diagnosing and treating human conditions doubles every 12 hours and it is increasing ever faster.
- When you graduate from medical school, half of what you know is wrong, but you don’t know which half. David Sackett, father of evidenced-based medicine.
- It is clear that the future of health and health care depends on the use of Artificial Intelligence (AI)

# The art of the future possible

- The volume of data, the variety of data types, the increasing wealth of knowledge, and the ability to track disease and co-morbidities from start to finish will overpower the ability of humans to make informed decisions about health and health care.
- Computers will not only become the decision makers but will carry out the decisions directly.
- The role of the human clinician will change to being an interface between computers and patients, and that may only be a temporary step.
- Most humans will be replaced in healthcare systems.
- To resist is futile.

# So, what can we expect?

- "Soon, it will be hard to imagine a doctor's visit, or a hospital stay that doesn't incorporate AI in numerous ways. With healthy clinical evidence, we'll see AI become more mainstream in various clinical settings, creating a positive feedback loop of more evidence-based research and use in the field. In addition, AI and ambient sensing technology will help re-humanize medicine by allowing doctors to focus less on paperwork and administrative functions, and more on patient care.

Pete Durlach, senior vice president for healthcare strategy and new business development at Nuance.

# Vision of future state and what will it take to get there

- A perfect health system that starts with the person
  - Remove barriers to access and understanding
  - Integration of use of multiple types and sources of data
  - Community engagement
  - Virtual health
  - Effective use of AI and machine learning
  - Decision support and embedded knowledge – digital biomarkers
  - Interpretation of functionality – single solution for multiple problems
  - Support behavior changes to better health
  - One language, globally

- Leadership – be bold
- Design for the future, not the present.

# DISCUSSION

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