



FOUNDED BY BRIGHAM AND WOMEN'S HOSPITAL  
AND MASSACHUSETTS GENERAL HOSPITAL



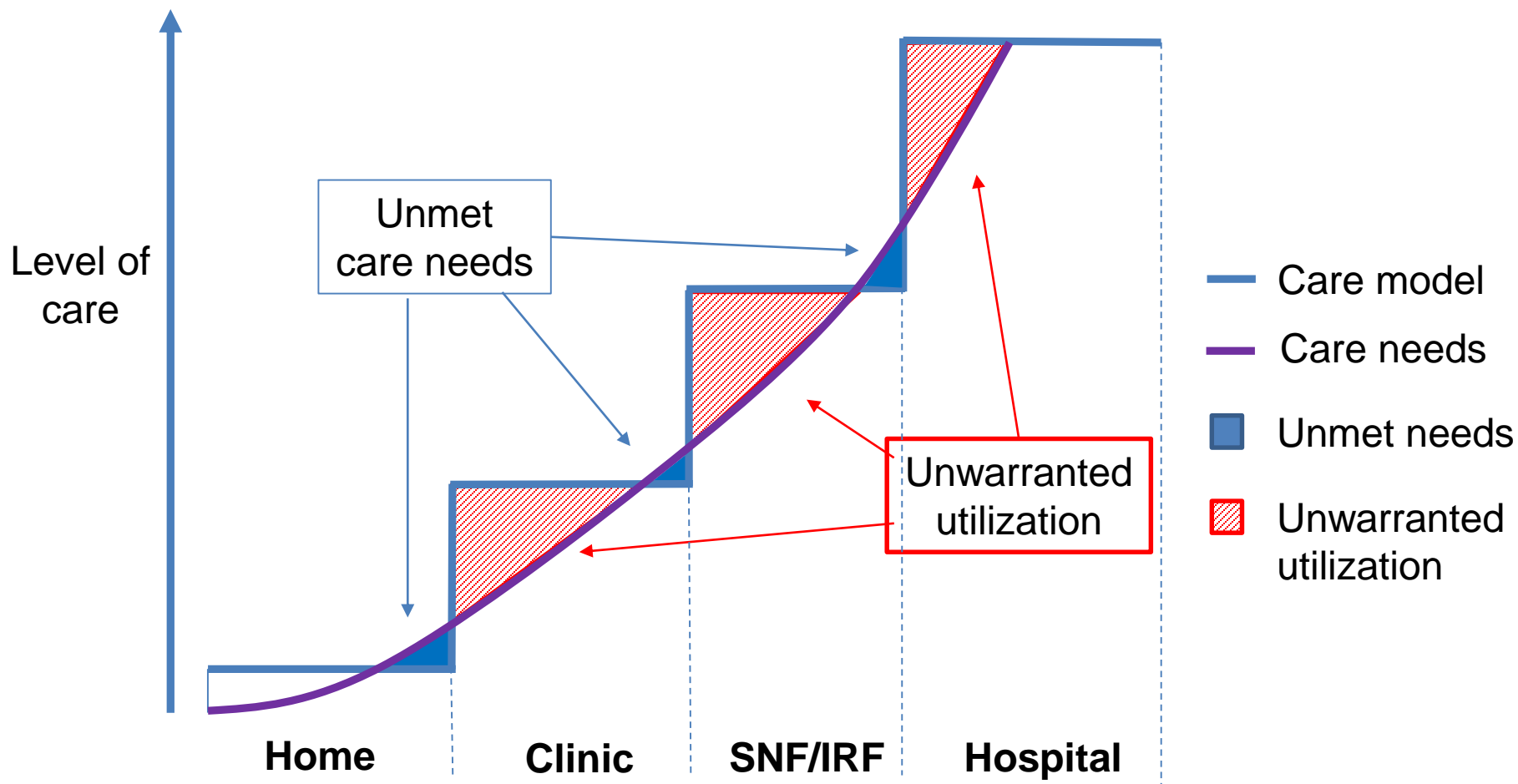
HARVARD  
MEDICAL SCHOOL



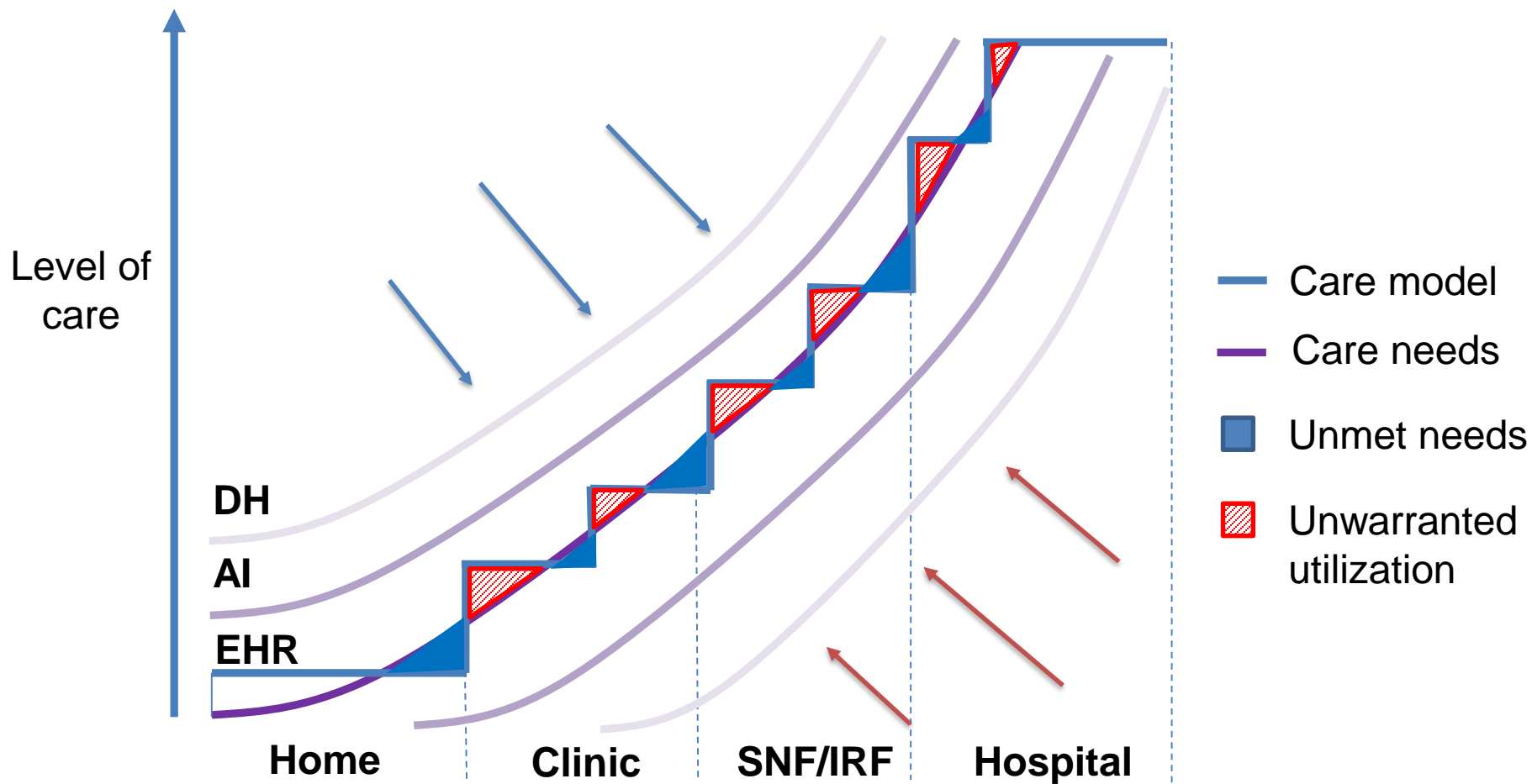
## Digital Health and the Transformation of Care Delivery

*Alistair Erskine MD MBA*  
*May 24th, 2019*

# Today: Existing brick & mortar based care models do not match patient care needs



# Future: appropriate use of EHR, data, analytics and AI could help mitigate the patient care need mismatch



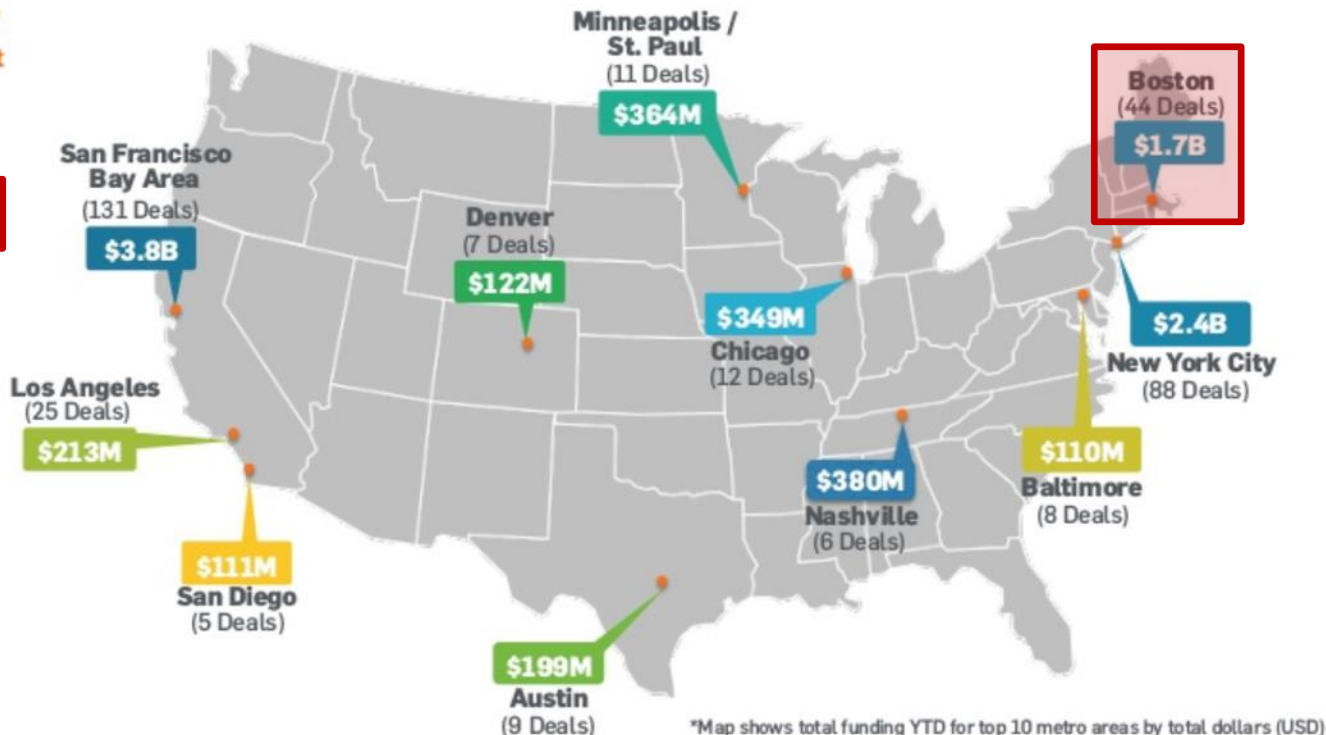
# The impact of technology on digital health has been significant over the past few decades

```
(DR )          PHYSICIAN RETRIEVAL
(TEST RESULTS ) (NURSING )
▶ALL LAB      ▶IV'S  ▶MEDICATIONS
▶CLINICAL CHEM LAB  ▶ALL NURSING DATA
▶COMPARATIVE LABS  (MISC DATA )
▶LAB BY DEPARTMENT ▶ADVANCE DIRECTIVES
▶ALL DIAG RADIOLG ▶ALLERGIES
▶ANCILLARY BY DEPT ▶ANCILLARY NOTES
(CURRENT ORDERS ) ▶CONDITION
▶ALL CURRENT      ▶DEMOGRAPHIC DATA
▶BY TYPE OF ORDER ▶DIAGNOSES, ACUTE
(CALL ORDERS-BY TYPE ) ▶DIAGNOSES, CHRONIC
▶REVERSE CHRON SEQ ▶DISCHARGE INFO
▶CHRONOLOGICAL SEQ ▶FAMILY HISTORY
▶FOR SPECIFIC DATE ▶MED RECORD STATUS
▶TRANSCRIPTIONS    ▶MISC CLINICAL HX
(PREVIOUS VISITS ) ▶PHYSICIANS/SERVICE
▶SELECT A VISIT    ▶PROBLEM LIST
▶SPECIFY SEARCH    ▶PROCEDURES/SURGERY
CRITERIA          ▶PT PROFILE
RETURN           MASTER REVIEW
ERR              TYPE      RETRIEVE
```

TDS 8000 system circa 1980s

# 44 deals (\$1.7B) closed in 2018 alone from Boston's life sciences innovation hubs – an 152% increase from 2017

Region	Total 2018 Deal Count	Total 2017 Deal Count
1 SF Bay Area	131	126
2 New York City	88	63
3 Boston	44	29
4 Los Angeles	25	21
5 Chicago	12	20
6 Minneapolis	11	11
6 Seattle	11	14
7 Austin	9	11
8 Baltimore	8	10
8 Miami	8	6
9 Denver	7	11
9 Philadelphia	7	12



5	23andMe	\$300M	Personalized Health
6	DevotedHealth	\$300M	Patient Empowerment
7	American Well	\$291M	Patient Empowerment
8	BUTTERFLY Network, Inc.	\$250M	Biometric Data Acquisition
9	HeartFlow	\$240M	Clinical Workflow
10	AURIS	\$220M	Biometric Data Acquisition

Source: StartUp Health Insights Global Digital Health Funding Report: 2018 Year End Review

# SMART Apps: Collection of FHIR compatible Apps that visualize clinical data or introduce new workflows

**SMART**® App Gallery

Add New Listing   Your Listings   Search   Login

Sort: Name (A-Z) ▾

**Featured Apps**

- Featured Apps
- All Apps
- Care Coordination
- Clinical Research
- Data Visualization
- Disease Management
- Genomics
- Medication
- Patient Engagement
- Population Health
- Risk Calculation
- FHIR Tools
- AMIA 2018

**1upHealth - Aggregated Patient Data** [View](#)

1upHealth  
Helps providers view patient data aggregated from external health systems. Patients can connect their medical data sources using FHIR.

**Support:** Web   **Specialties:** Trauma, Pediatrics, Cardiology  
**Designed for:** Clinicians & Patients

**ACT.md** [View](#)

ACT.md  
ACT.md extends EMR's across the community, removing the silos that prevent you from addressing social determinants of health.

**Support:** Web, Android, iOS   **Specialties:** Rheumatology, Pediatrics, Oncology  
**Designed for:** Clinicians & Patients

**Adherence - Surescripts Medication Management Solution** [View](#)

Surescripts, LLC  
Improves patient medication management via patient-specific insights, health plan-generated messages, and streamlined physician feedback.

**Support:** Web   **Designed for:** Clinicians & Patients

App List →

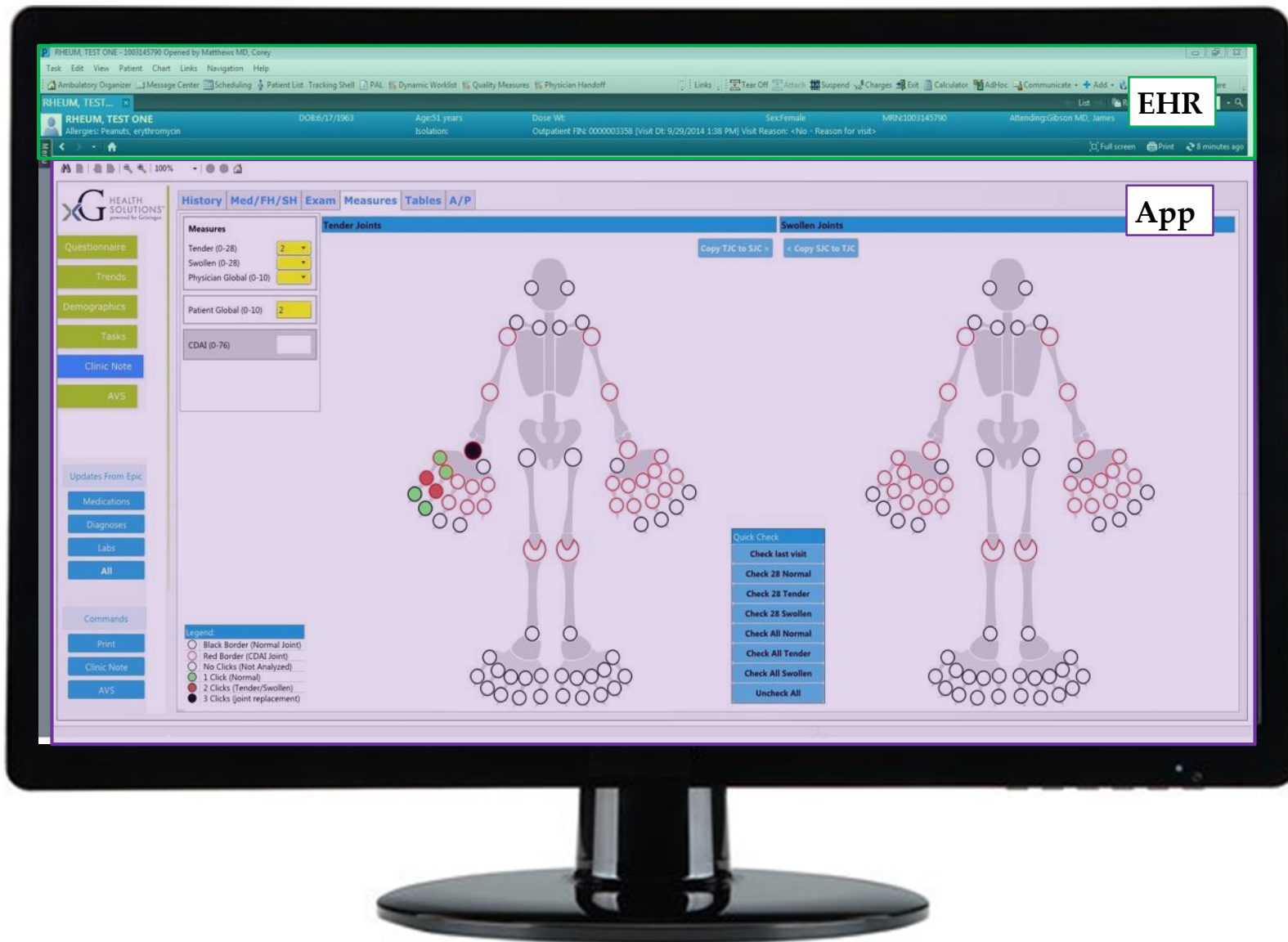
Compatibility →

Contact info →

No business model

# EHR monoliths augmented by Apps

## Rheumatology Example



However, despite heavy investment in digital health, we still have some work to do...



California Technology Council



**Burnout:** EHRs are the tip of the spear to a healthcare delivery process laden with administrative burden

THE  
NEW YORKER

ANNALS OF MEDICINE NOVEMBER 12, 2018 ISSUE



# WHY DOCTORS HATE THEIR COMPUTERS

*Digitization promises to make medical care easier and more efficient. But are screens coming between doctors and patients?*

**By Atul Gawande**

**Clicks:** despite \$36B government investment in EHRs, considerable room for improvement exists



BOTCHED OPERATION

# Death By 1,000 Clicks: Where Electronic Health Records Went Wrong

The U.S. government claimed that turning American medical charts into electronic records would make health care better, safer, and cheaper. Ten years and \$36 billion later, the system is an unholy mess. Inside a digital revolution that took a bad turn.

By Fred Schulte and Erika Fry, Fortune • MARCH 18, 2019  
(The Voorhes for Fortune)

**Patient harm**  
(glitches)

**Signs of fraud**  
(upcoding, MU)

**Gaps in interoperability**

**Clinician burnout**

**Web of secrets**  
(gag clauses)

Source: Kaiser Health News

# EHR adoption: Plagued by numerous barriers to usability and generators of clicks



**Interoperability  
(Privacy/funding)**



**Data hungry  
(Research/AI)**



# Burnout



**Unintended  
Consequences  
(shift roles)**



**Administrative  
Burden  
(MU/Coding)**



**Cybersecurity**

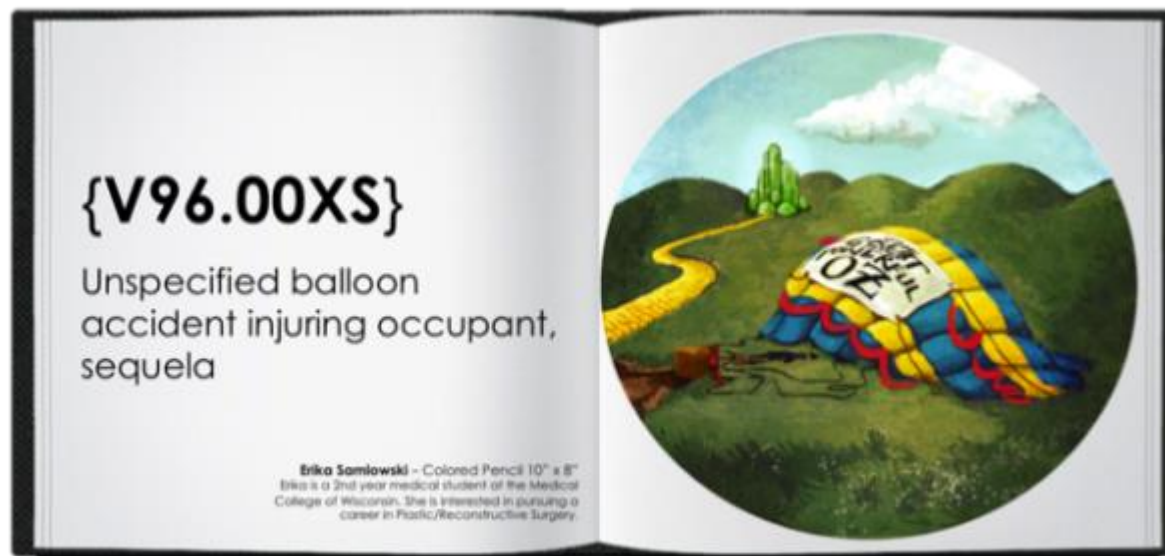




## Administrative Burden (MU/Coding)

# Clinical Nomenclature

- ICD-10 approved by WHO 1990
  - CM version increases number of terms (69k) and procedures (72k)
- **Impact:** Affect mostly Ortho (laterality), Obstetrics/Gyn (stage), Behavioral Health, not so much specialist and PCP



# Health Information Exchange

*On-going challenge*



**Interoperability  
(Privacy/funding)**



Painting: Pieter Bruegel the Elder c. 1563

**CHIN: Community Health  
Information Network**

**1990s**

**RHIO: Regional Health  
Information Exchange**

**2000s**

**HIE: Health Information  
Exchange**

**2010s**

**Apps: Distribute workflow  
and functionality**

**next**

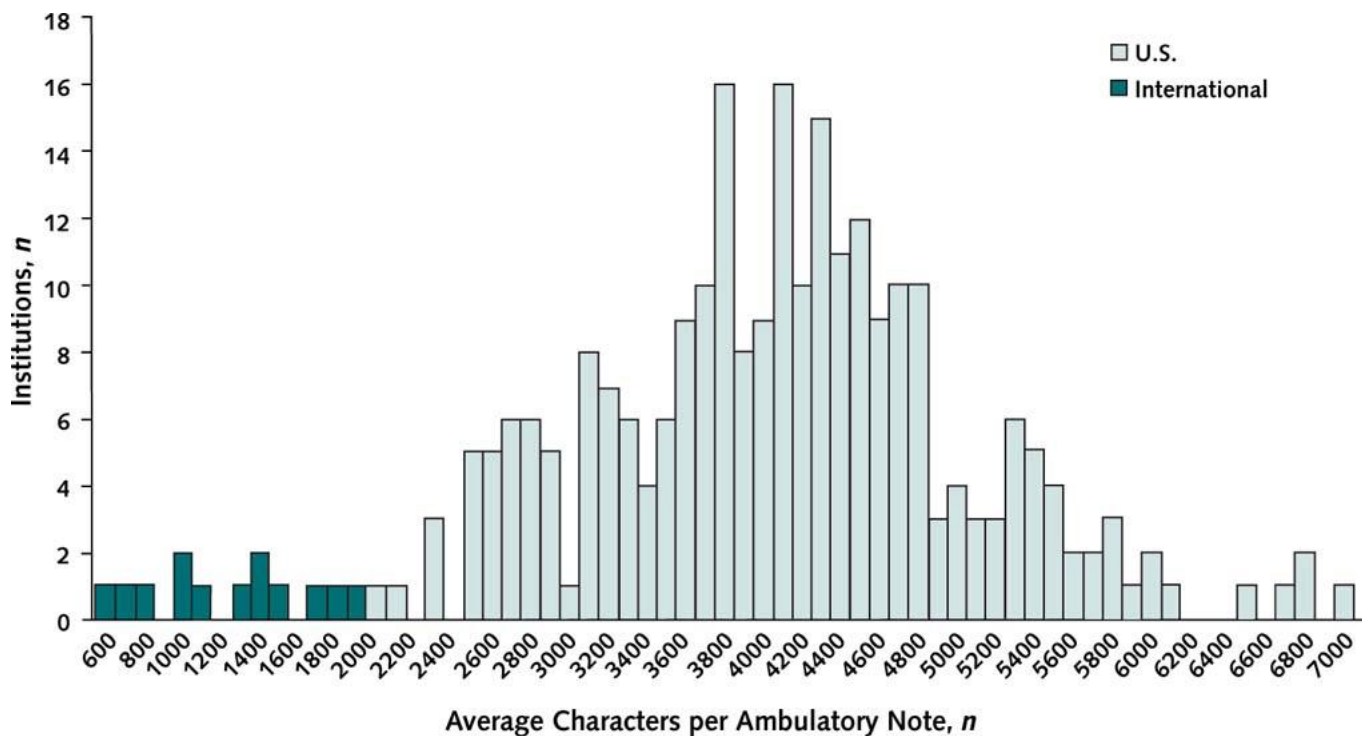
# E/M based documentation causes 'note bloat'

*Other developed countries enjoy less documentation burden*



**Administrative  
Burden  
(MU/Coding)**

## Annals of Internal Medicine®



Downing NL, Bates DW, Longhurst CA. *Physician Burnout in the Electronic Health Record Era: Are We Ignoring the Real Cause?* Ann Intern Med. ;169:50–51. doi: 10.7326/M18-0139

# Incumbents: vexing inability to upgrade/replace legacy technologies despite readily available alternatives



Fax machine  
(interoperability)



Phone  
(Online)



Pager  
(Smartphone)



CD-ROM  
(Cloud)



# CVS Health Hub: \$350M investment in Digital Health in 2019 alone

## HealthHUB. services

### Ongoing care

-  Diabetes & other conditions
-  Preventative care & wellness
-  Dietitian services
-  Health insurance navigation

### Everyday care

-  12+ immunizations
-  Sleep assessments
-  Primary acute care
-  School & sports physicals

Ask our care concierge for more info!

# New entrants: vertical integration of healthcare value chain is opening new 'front doors' to patients

**Humana.**



**Humana in talks to acquire Kindred Healthcare (largest home health care provider and hospice operator)**

**Amazon, Berkshire Hathaway and JPMorgan announce partnership** to launch company to address “The ballooning costs of healthcare act[ing] as a hungry tapeworm on the American economy.”



**J.P.Morgan**

**BERKSHIRE HATHAWAY INC.**



**CVS Health purchased Aetna for \$69 billion** “...to position the combined company as America's front door to quality health care...”

**UnitedHealth's Optum unit acquires DaVita Medical Group for \$4.9 billion**



**Cigna agrees to purchase pharmacy benefits manager Express Scripts for \$67B in cash and stocks**

**Walmart engaging in preliminary talks to acquire insurer Humana, adding an incremental \$37B of market value to Walmart**

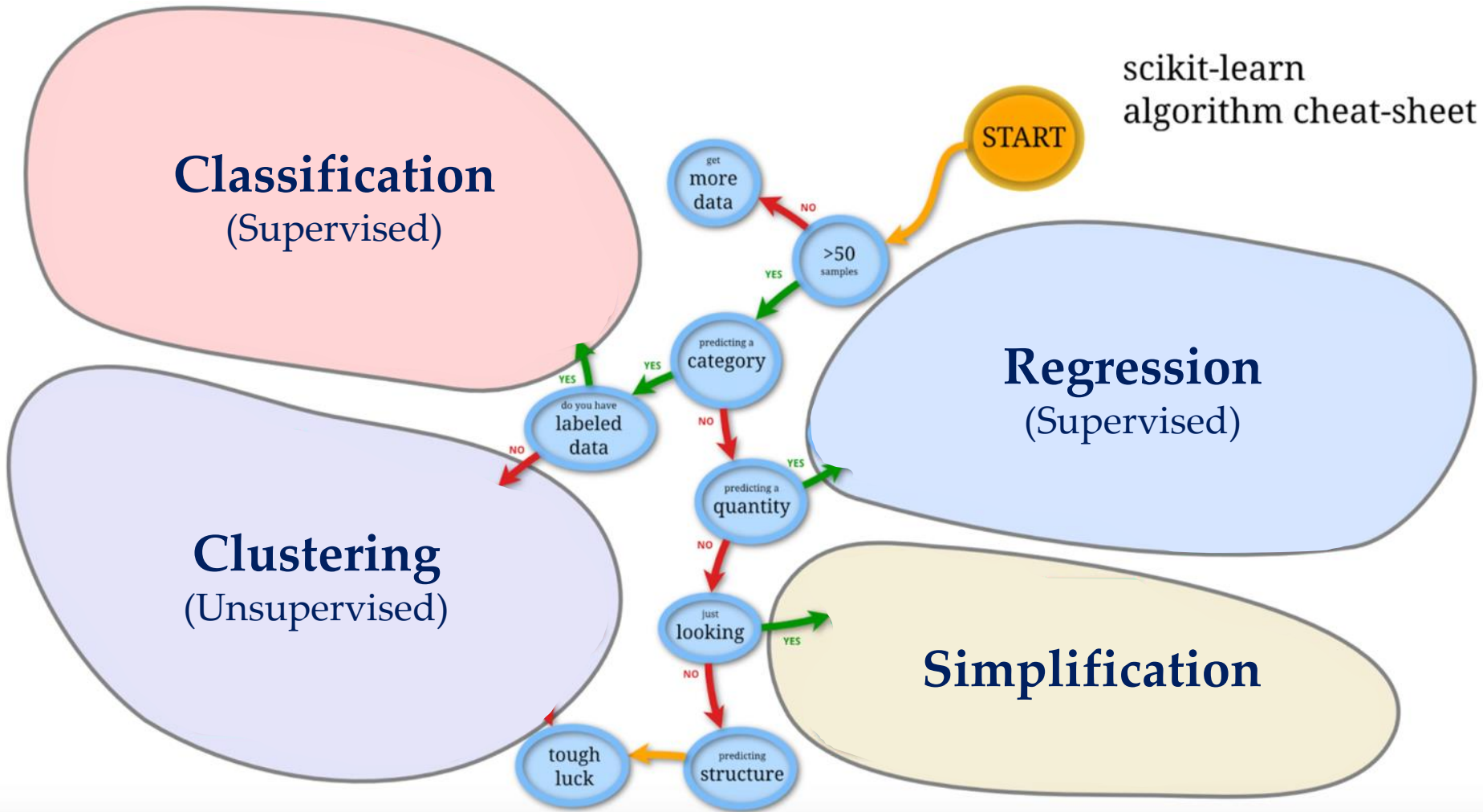


# Artificial Intelligence

# Today: Common and practical applications of AI with software that helps automation care processes

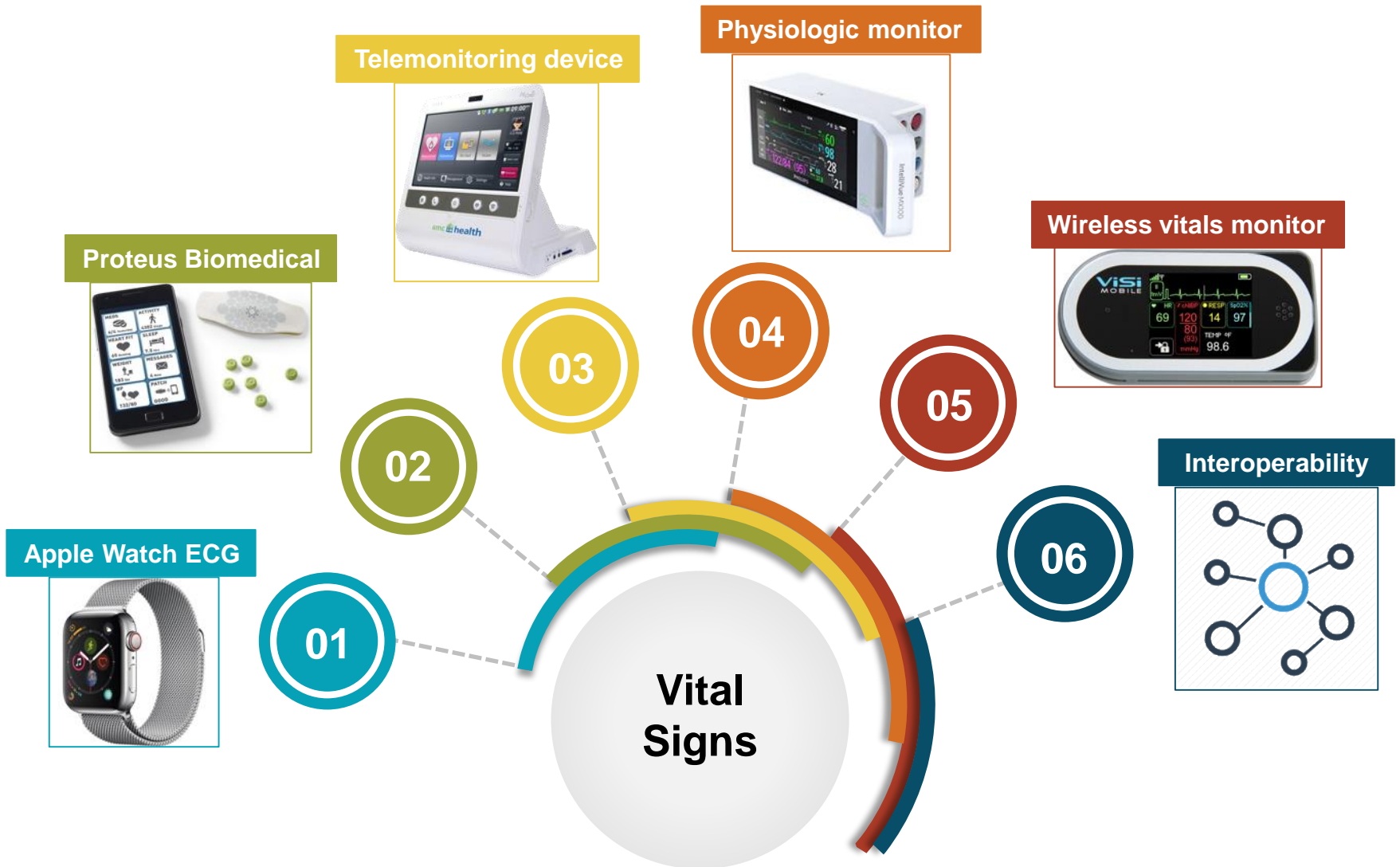
- **Robotic Process Automation (RPA)** helps remove remedial work and redirect the healthcare workforce towards more value-added work
- **Centralized monitoring:** remote monitoring of 300+ patient specific inpatient data elements on a minute-to-minute basis helps identify and escalate care at scale (e.g. Sepsis, Rapid Response Teams)
- **Chatbots:** Patients begin care interaction with chatbots, help address their questions especially during off hours and tease out answers to topics that might be uncomfortable during face-to-face encounters and reduce dependency on call centers
- **Algorithms:** Models derived from clinical data sources now exist that can reduce non-ICU codes by 44%
- **Decision Support:** Appropriate selection of chemotherapy agents has been augmented by AI
- **Throughput:** AI helps hospital capacity and throughput by identifying when patients with flu-like symptoms have not been tested and notifying providers with the results
- **Prioritization:** alternative to default 'first in, first out' order of care delivery by identifying and resorting the order of priority care needs

# Interpretive vs Black-box: Not all Artificial Intelligence is created equal

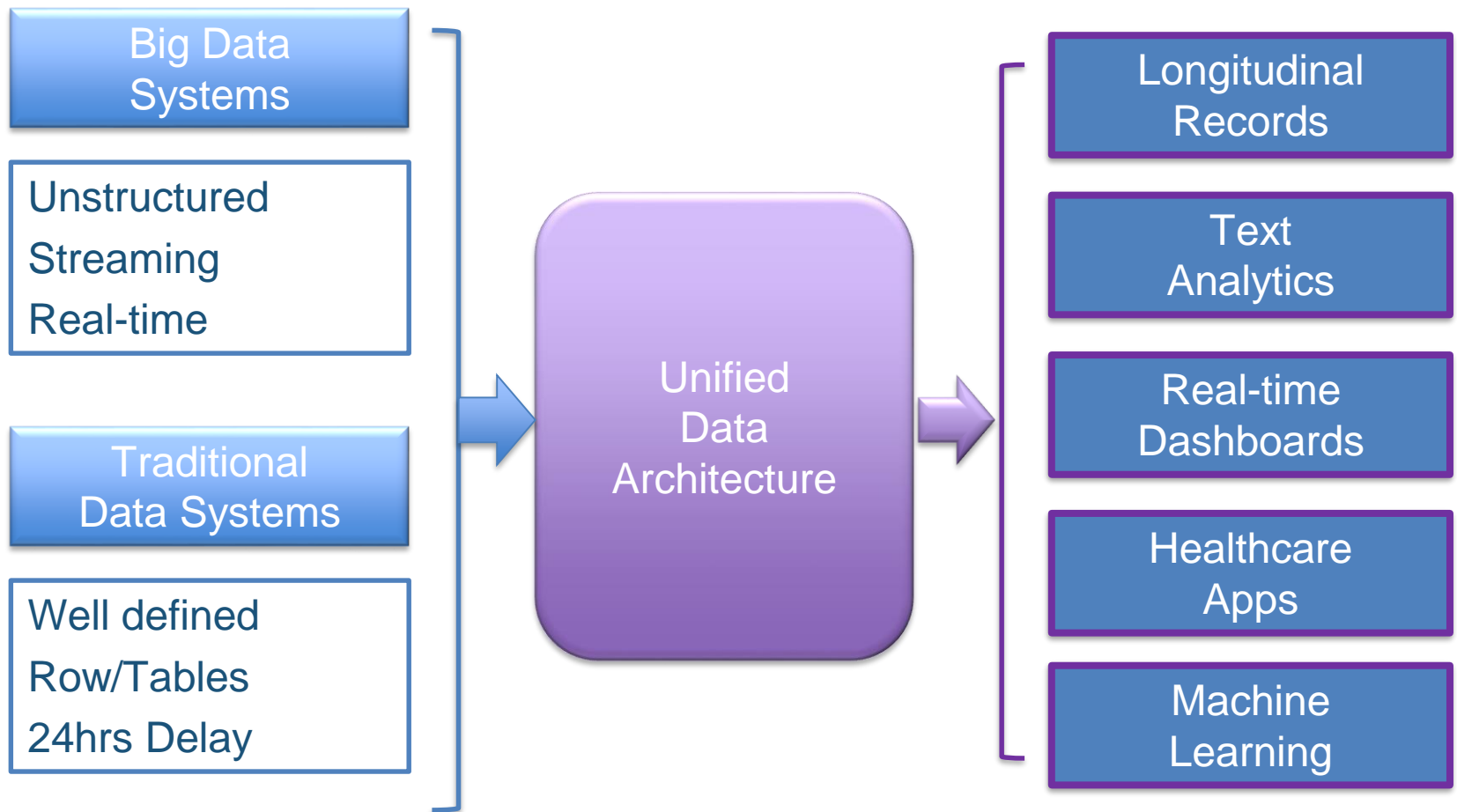


Courtesy Andy Mueller located [here](#)

# Data Types: Vitals signs enter the data systems in different formats with different timings and significance

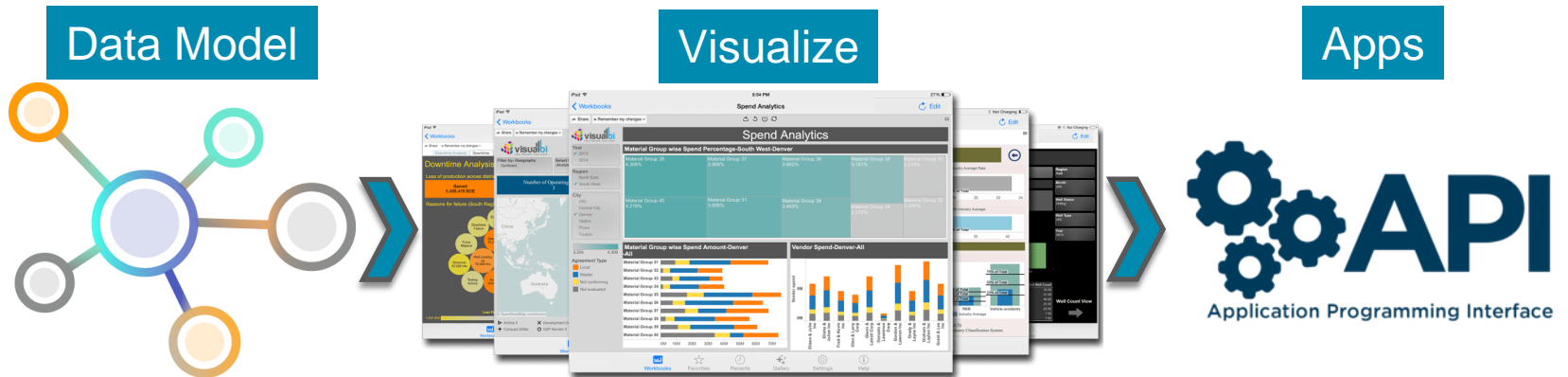
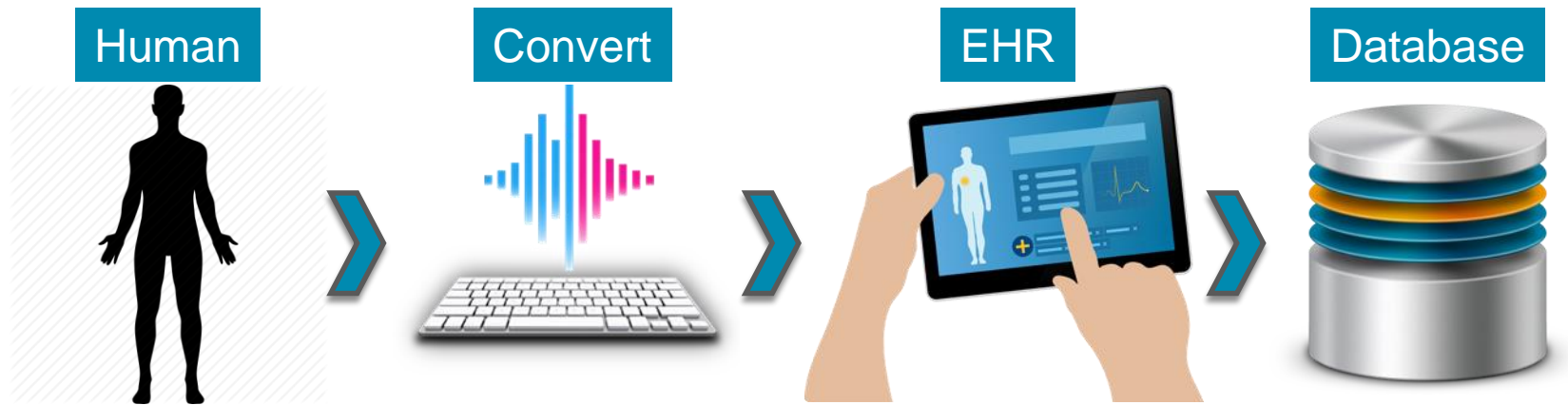


# Unified Data Architecture: hedged environment that addresses novel data types



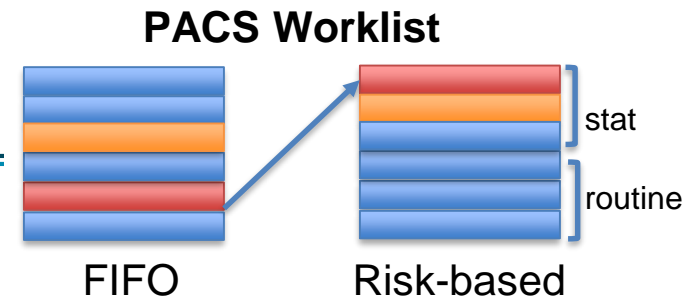
Erskine A et al, *How Geisinger Health System Uses Big Data to Save Lives*, Harvard Business Review, Dec 2016

# Real use-case: saved 27 patients lives by identifying patients with unrepaired Abdominal Aortic Aneurysms





# Real use-case: Image classification saves lives of patients with stroke



**Problem:** Needed to improve the timeliness ICH assessment for clinic patients without solely relying on the ordering physician priority designation.

**Approach:** 46,583 head CTs (~2 million images) acquired from 2007–2017 were collected from several facilities across Geisinger. A deep convolutional neural network was trained on 37,074 studies [training set] and subsequently evaluated on 9499 unseen studies [testing set]. The predictive model was implemented prospectively for 3 months to re-prioritize head CTs at high risk of ICH.

**Results:** The model achieved an area under the ROC curve of 0.85.

- 94 of 347 (27%) “routine” studies were re-prioritized to “stat”
- 60 of 94 (63%) had ICH identified by the radiologist
- 5 new cases of ICH were identified
- Median time to diagnosis was reduced ( $p < 0.0001$ ) from 512 to 19 min.

Arbabshirani et al, *npj Digital Medicine* volume 1, Article number: 9 (2018)

# Big tech: big bets takes aiming at almost 20% of US GDP

*Investments in wearables, AI, cloud services, diagnostics, navigators..*



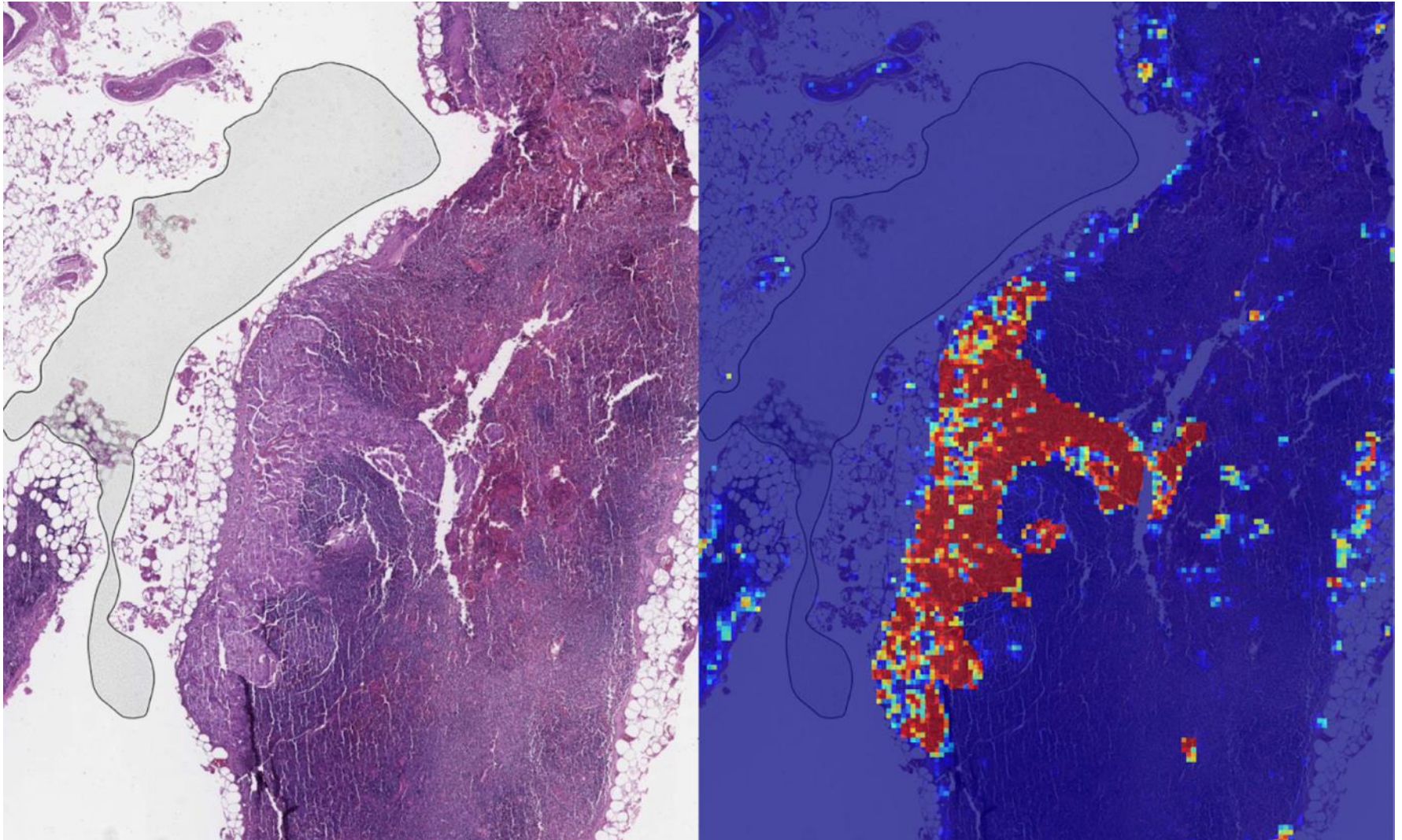
Microsoft

amazon

JPMORGAN CHASE & CO.

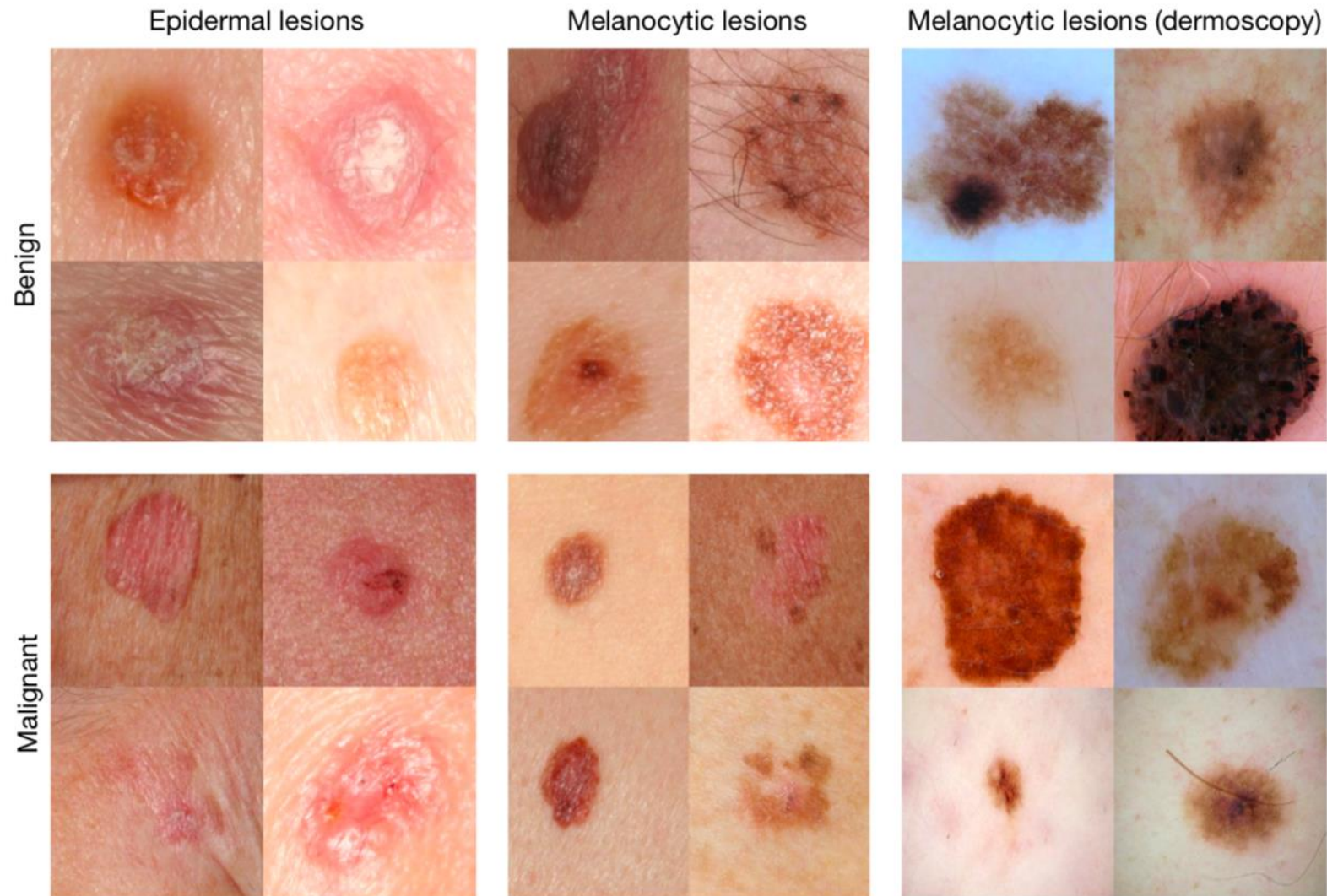
BERKSHIRE HATHAWAY INC.

# Oncology: LYNA Algorithm performs **better** than pathologist at detecting breast cancer cells



Liu et al (2018) *Artificial Intelligence–Based Breast Cancer Nodal Metastasis Detection*. Archives of Pathology & Laboratory Medicine In-Press

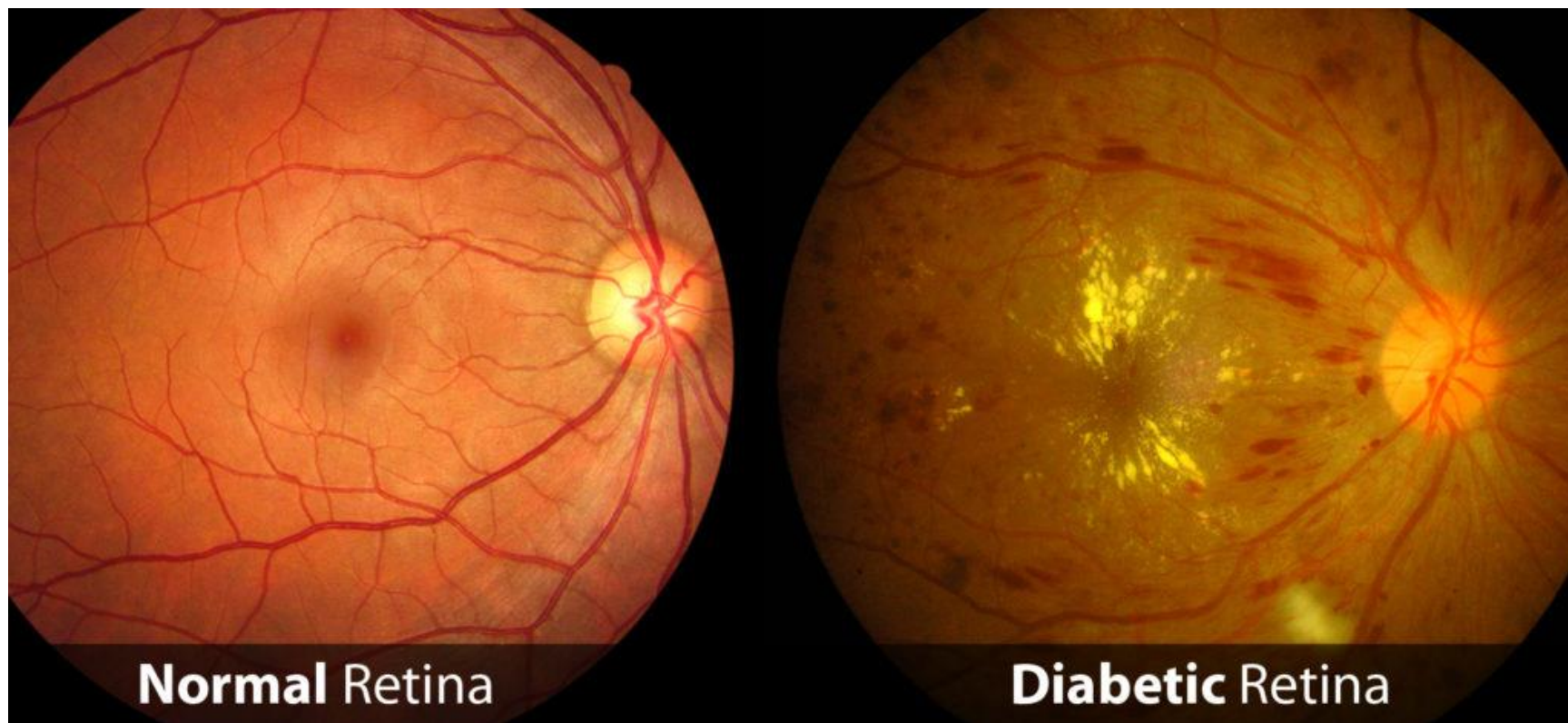
# Dermatology: Deep neural network classifies skin conditions *as well as* dermatologist



Esteva et al, *Dermatologist-level classification of skin cancer with deep neural networks*, Nature, VOL 542, 2 February 2017

# Ophthalmology: Deep learning system detects diabetic retinopathy across multiethnic population

The Deep Learning System had high sensitivity and specificity for identifying diabetic retinopathy and related eye diseases using retinal images from multiethnic populations with diabetes.



Ting et al, *Development and Validation of a Deep Learning System for Diabetic Retinopathy*, JAMA. 2017;318(22):2211-2223.

# Headwinds: As with any new technology adoption, AI comes with its own set of barriers to adoption

---

- **Hype:** The marketing of AI tends to get ahead of the real-world application of useful AI models
- **Validation:** AI models are highly dependent on the data that feeds them, and might need to be re-tested in different care settings/locations to avoid bias
- **Education:** How and when should AI be applied? When is one algorithm more appropriate than another?
- **Adoption:** Intent needs to be to make clinician lives easier, provide a less expensive solution, generate fewer clicks, craft the path of least resistance for the desired outcome and make sure that AI tools are bulletproof
- **Leadership:** key as with any change management and care transformation requiring buy-in at all levels and answering the "how is this affecting me" questions.
- **Incentives:** Compensation structure might not support what AI offers and it is worth taking the time to align incentives
- **Consent:** consent to treat might be different than consent to make secondary use of data from AI models
- **Privacy:** sophisticated machine algorithms have been used to re-identify previously anonymize patients

# Data currency: market for clinical data on the dark web and at your local coffee shop



*At Shiru Cafe in Providence, R.I., students "pay" for coffee, but not with money*

# Enterprise Data and Digital Health



# Why 'digital Health' - less about 'digital' and more about modern 'Health' approaches

- **Improve access:** online scheduling, symptoms checkers, triage functions, virtual care options, patient portals
- **Participatory:** patient can better engaged in shared decision making, connect to the entire care team in-between visits
- **Home options:** moving care outside of hospital/clinic, remote monitoring for chronic illness, access patient-generated data
- **Better decisions:** tailored treatments, adherence to guidelines, elimination of unwarranted variation, up to date evidence-based medicine
- **Anticipatory:** consume and model healthcare and non-healthcare data (e.g. credit scores) towards prescriptive intelligence.
- **Imaging:** dashboard view of available modalities, remote interpretation of diagnostic imaging and pathology, sharing studies with patients
- **Digitalization:** generating 'big-data' ready analysis, converting tribal knowledge into business process automation
- **Pop Health:** care gaps closure by cohorts of patients, by providers, by illnesses
- **Life-sciences:** aggregation of biotech and pharma ultramodern advances in treatment options

# Call to Action: Enterprise Data and Digital Health

As we respond to increasing healthcare market pressures and learn about new opportunities to advance patient care, research, and education, **digital health is vital to the future of Partners HealthCare, and our patient experience and growth strategies.**

By supporting significant new investments in inpatient, ambulatory, and digital health, **we will have a cohesive strategy and the necessary capabilities that will allow us to compete** in our local, national and global markets.

*Total Capital Requested*



*Inpatient ~\$2B funding request*



*Ambulatory ~\$900M funding request*



*Digital ~\$500M\* funding request*

\*First tranche request (FY19/20) is \$133M; current 5 year request is above \$500M but will be refined by next tranche

- Improve the patient experience
- Support our growth strategies
- Provide greater system cohesion and operational alignment

# Investment: Upgraded facilities function synergistically with digital technologies

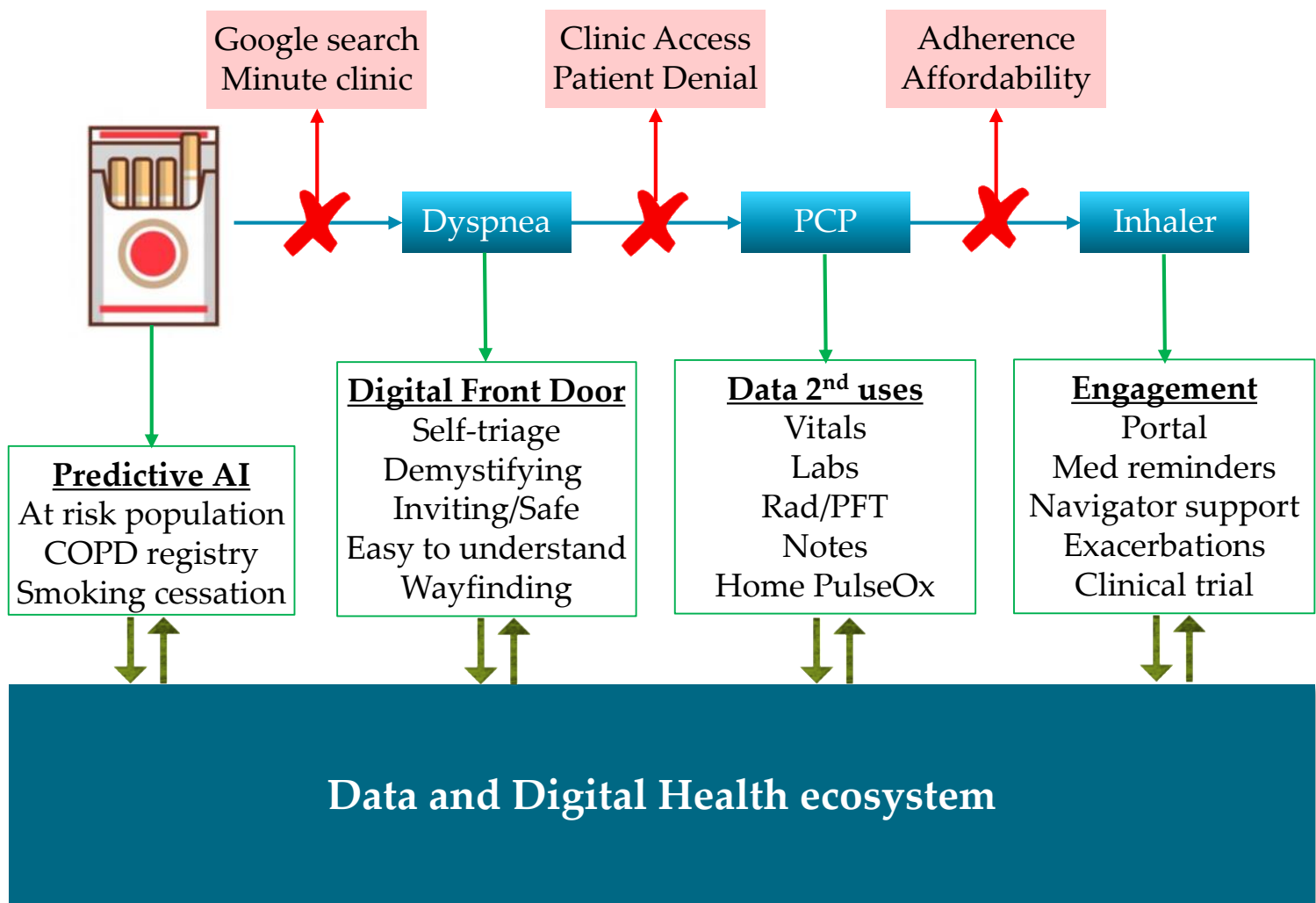
## Future Towers



## Digital bricks

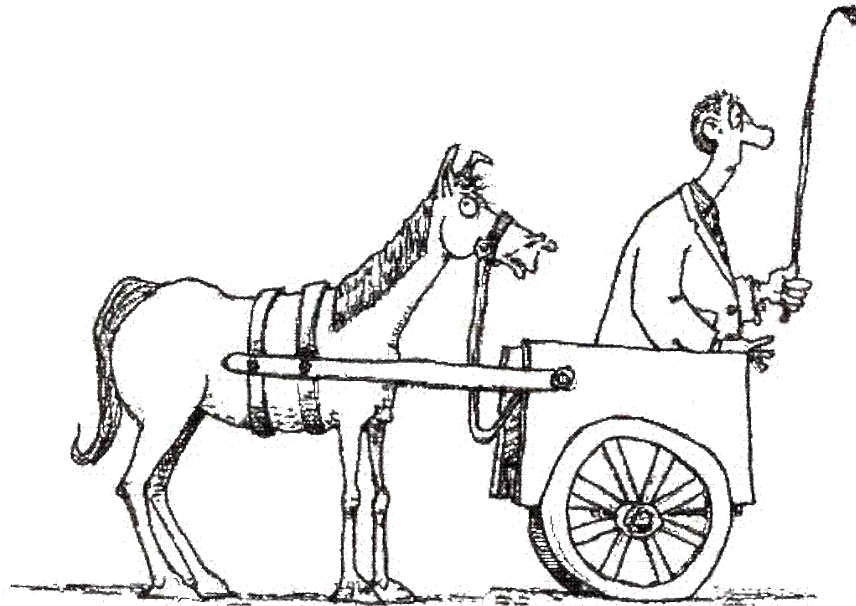
Patient experience  
Improved operations  
Care transformation  
Digital innovation  
Artificial Intelligence

# Digital Health can help identify cohorts of patients, enroll them into care process and make better use of their data



But first...

*Avoid placing the cart before the horse*



# The Basics

# Basics – Scale horizontally across Partners

*Take example of best practice/implementation and scale elsewhere*

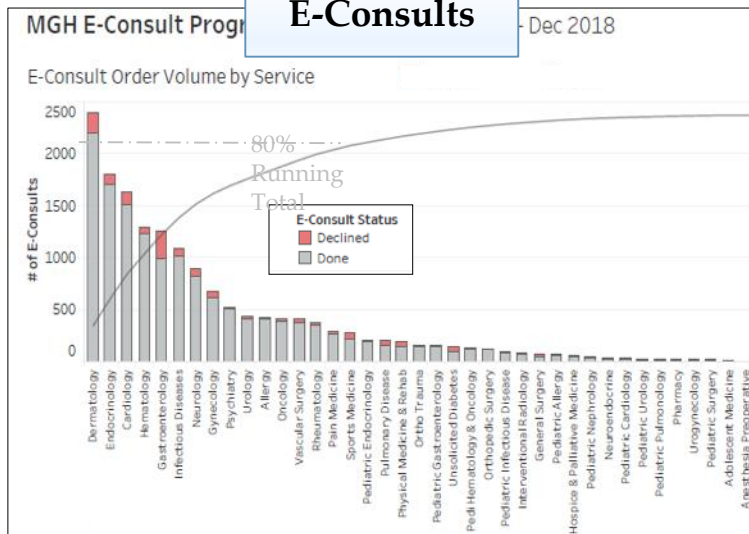
**Teleneurology**



**Wayfinding**



**E-Consults**



**Call Centers**



# Basics - be mindful of the user ecosystem

*Login, virtual scribes, at-the-elbow support and secured texting*

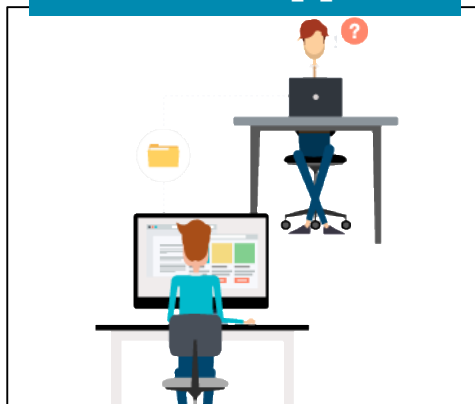
## Simplified login



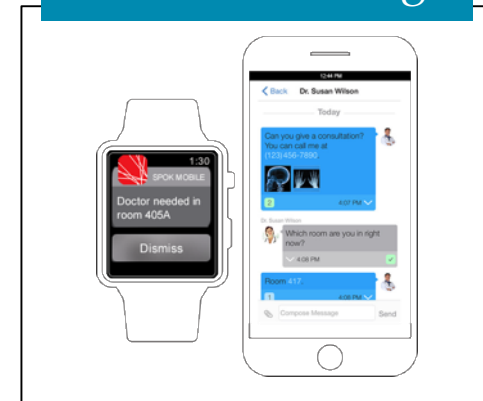
## Virtual Scribes



## Virtual support



## Secured Texting







# User Experience

# Users - Making Alert actionable

## -- Improving Documentation of Pregnancy Status

- Updating “Patient may be pregnant” alert to allow clinician to mark the patient as pregnant directly from alert.
- The scope of the previous alert was narrowed to focus on marking patients as pregnant

Feedback

Feedback

provide feedback

Positive Pregnancy Test

Your patient has a **positive HCG (7/27/2018)** in the past week and may be pregnant. If pregnant, please set the pregnancy status indicator by clicking on the link below.

Click Here to Set the Pregnancy Status ↗

Acknowledge Reason \_\_\_\_\_

Mark Patient as Pregnant Not Pregnant Not Primary Team

Accept & Stay Accept Dismiss

Option in Alert

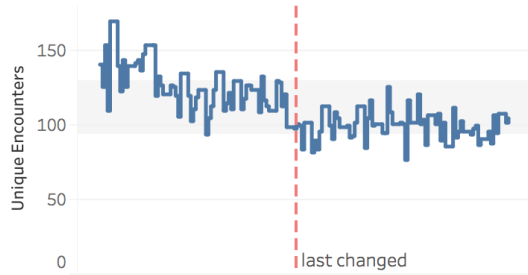


# Evaluation and Monitoring– Tableau Dashboard

BASE PHS ED/IP DISEASE PROVIDER MANAGEMENT (SEPSIS)

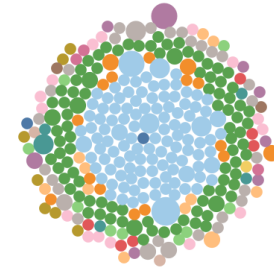
3/3/2018 12:00:00 AM to 8/29/2018 11:59:59 PM

Override Comment

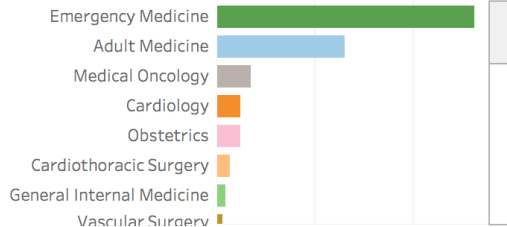


metrics

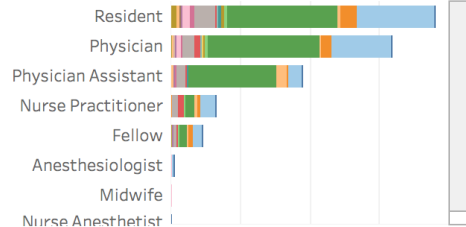
Total Alerts	64,324
Avg. Alerts per Day	355
Unique Encounters	14,427
Avg. Unique Enc per Day	80
Unique Patients	12,028
Unique Users	4,478



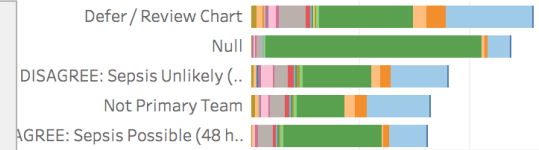
Department Specialty



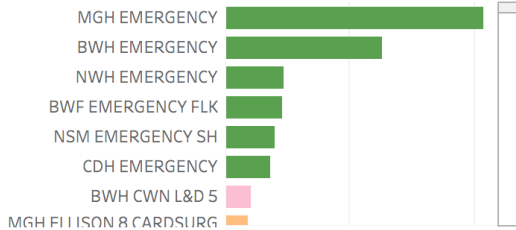
User Type



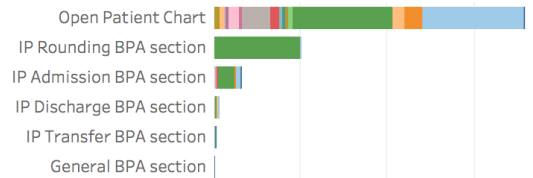
Acknowledgment Caption



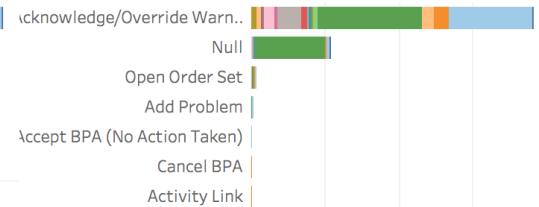
Department



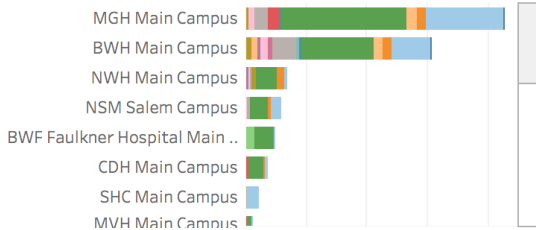
Trigger



Followup Action



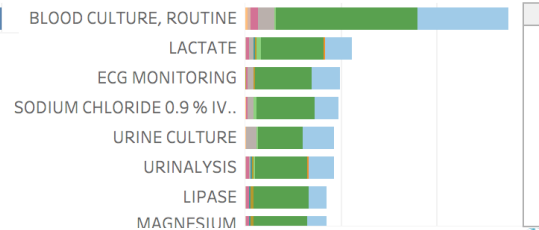
Facility



Encounter Type



Signed Orders



# Patient Experience

# Patient Experience will become the new differentiator to those less bound by loyalty and more tuned to relevance

Value =

**Digital  
Innovation**

$$\left( \frac{\text{Quality} + \text{Experience}}{\text{Cost}} \right)$$



Access



Online



Cost



Personalize



Caring



Tech



Share



Guide

# New directions



# New Models: virtual care has the potential improving access and offering more convenient options for patients



**“Access Anytime Anywhere”**



Patients can receive virtual care, view medical information, manage appointments, and renew prescriptions through various digital assets

Click in.



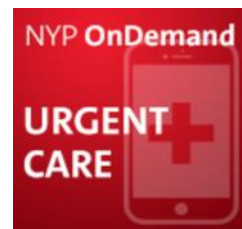
Cleveland Clinic leverages a network of express care clinics, urgent care, and 24/7 EDs to expand patient access. Patients use website to find “walk in” treatment locations

Walk in.

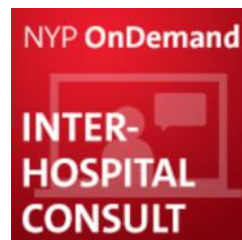


Patients can schedule appointments via phone across 150 area locations

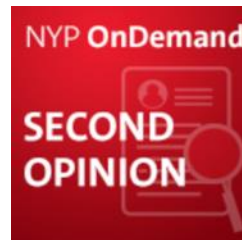
Call in.



For patients who require urgent care treatment but are unable or don't want to travel, app provides virtual examination, diagnosis, and treatment



Feature provides patients within NYP Regional Network Hospitals access to NYP Hospital specialists and increases communication between providers



Online portal allows patients to access second opinions from NYP specialists within the ColumbiaDoctors and Weill Cornell Medicine network

Sources: Sg2 2017, clevelandclinic.org

Source: nyp.org/ondemand

# New Tech: Patient Relationship Management is new to the digital health lists of transactional systems (beyond EHR)

## View: Physicians/Advanced Practitioners

Patient Name: Jennifer Doe

- ✓ Prefers to be called **Jenny**
- ✓ Reportedly screens calls; always leave voicemail



Jenny has outstanding care gaps including flu vaccine, colonoscopy and pap smear.

- ⚠ Has trouble getting up steps
- ⚠ Scared of doctor/hospital
- ⚠ Gets lightheaded around blood and needles

Forgetful ● Retired ● Widowed ● Flexible

### How to talk to Jenny:

- Jenny prefers the to understand her health in a direct manner.
- Jenny is motivated to extend her life to see her grandchildren grow up.
- Jenny has high levels of anxiety when coming to the doctor.
- Jenny's reported decision making style indicates she likes to understand all her options before making a decision.

### Appointments:

- Brought to all appointments by son

### Follow-up Information:

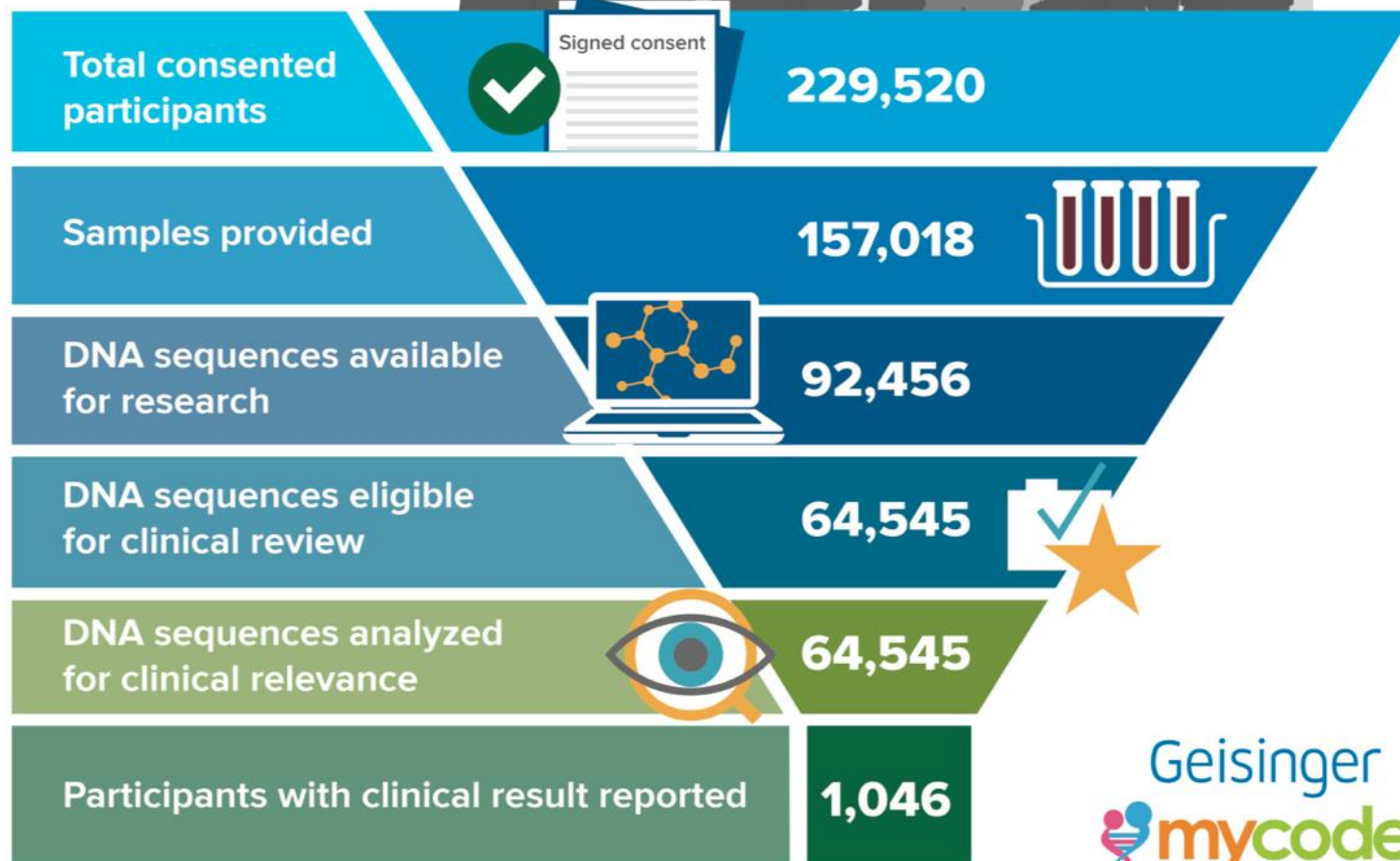
- Patient likes using technology for healthcare and is due for a colonoscopy. Nurse encouraged the patient to download the colonoscopy mobile app to prepare for procedure and provided brochure.



# New Data: Geisinger's Health Plan has begun covering the cost of whole exome genetic testing for its members

## MyCode<sup>®</sup> scorecard

2 million Geisinger patients



# New partners: Geisinger adds a grocery store to its diabetic clinics through its Fresh Food Farmacy program



Apple Video - <https://apple.co/2B5e19A>

Feinberg A et al, *How Geisinger Treats Diabetes by Giving Away Free, Healthy Food*, HBR October 2017  
Feinberg A et al, *Prescribing Food as a Specialty Drug*, NEJM Catalyst, April 10 2018