CPH 100:
Foundations for Computational Precision Health

10/23/26

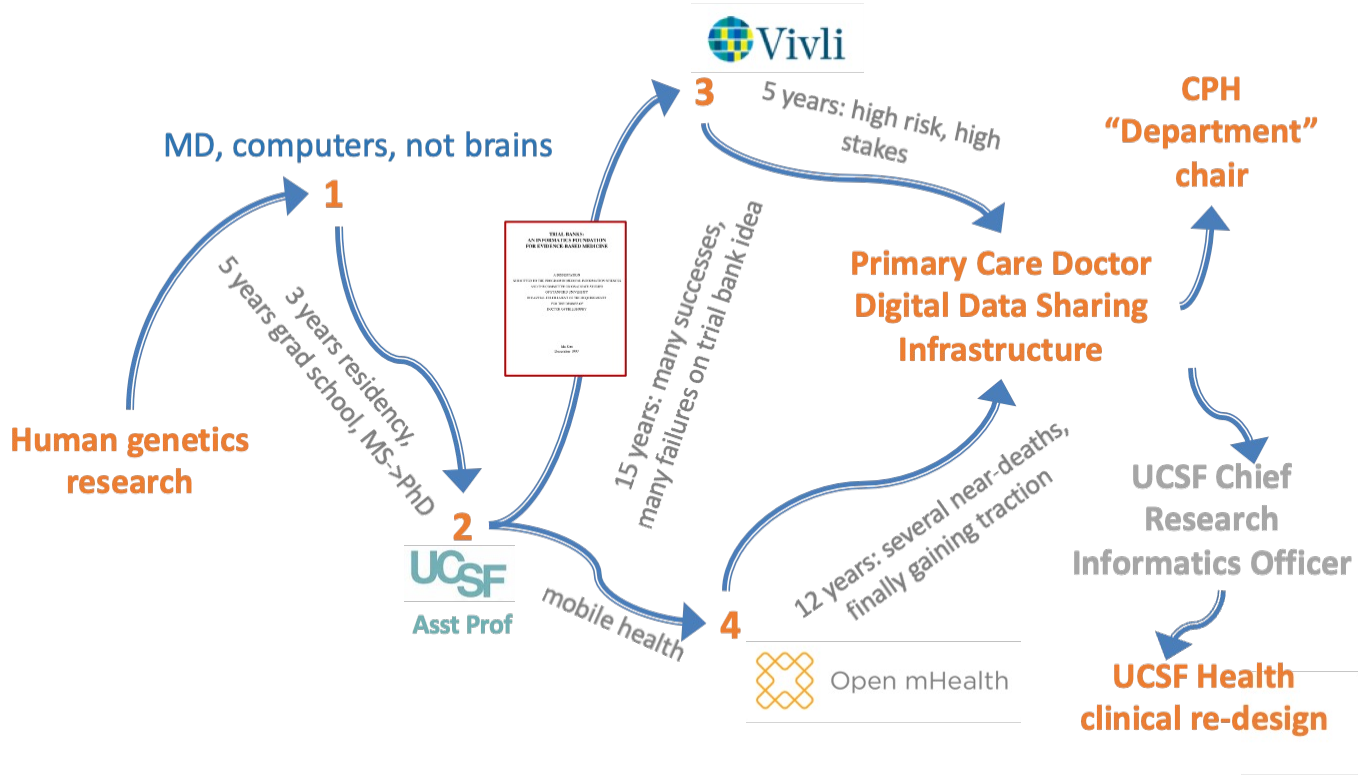
Ida Sim, MD, PhD
UCSF Professor of Medicine &
Computational Precision Health

Computational
PRECISION HEALTH
Berkeley | UCSF

Disclosures

- JupyterHealth - cofounder
- Vivli – cofounder, consultant, Board of Directors
- Open mHealth – cofounder
- Knit Health, Inc – advisor, stock
- CareX, Inc – advisor, stock
- Past
  - 98point6, virtual primary care - Medical Advisory Board, stock
  - Myovant, biotech - scientific advisor
  - Myia, remote care - advisor

My Journey (so far)





First week as a licensed MD

“Under the skin”: Computational Biology/Biomed

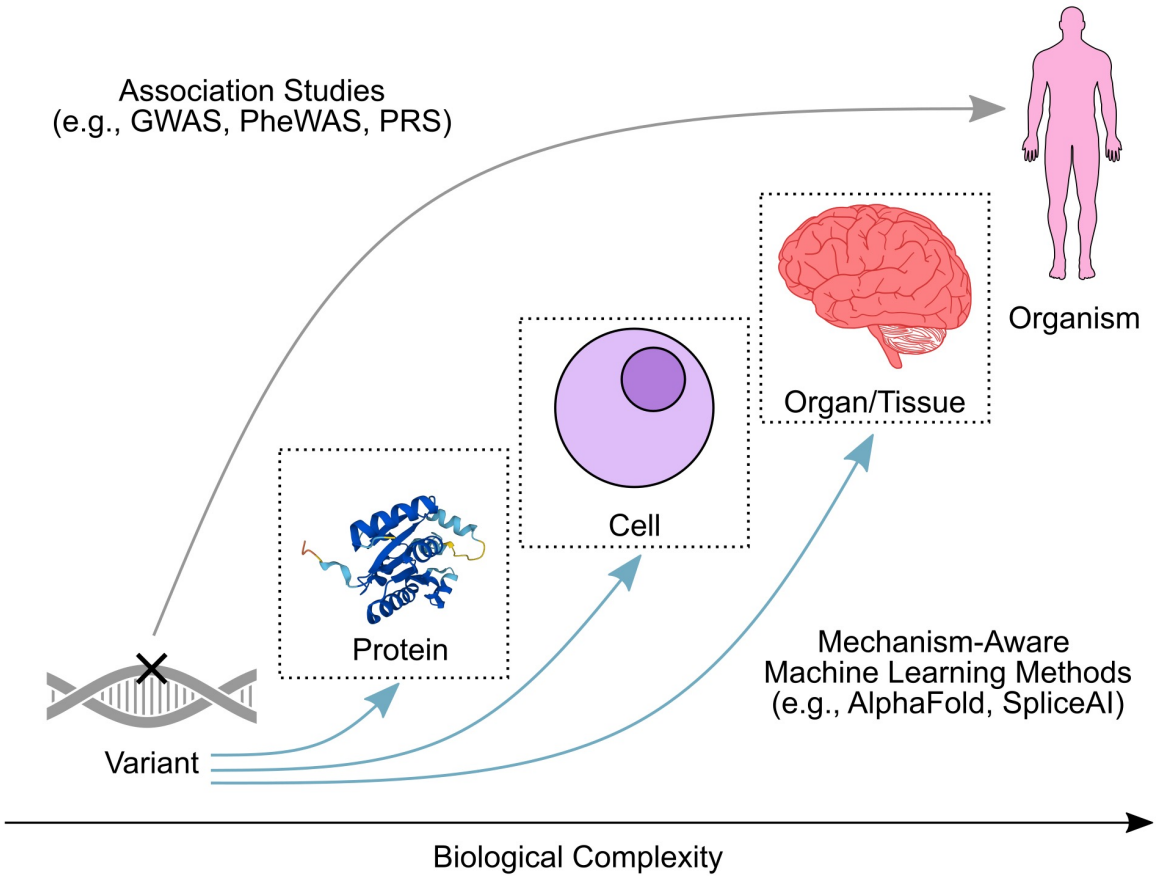
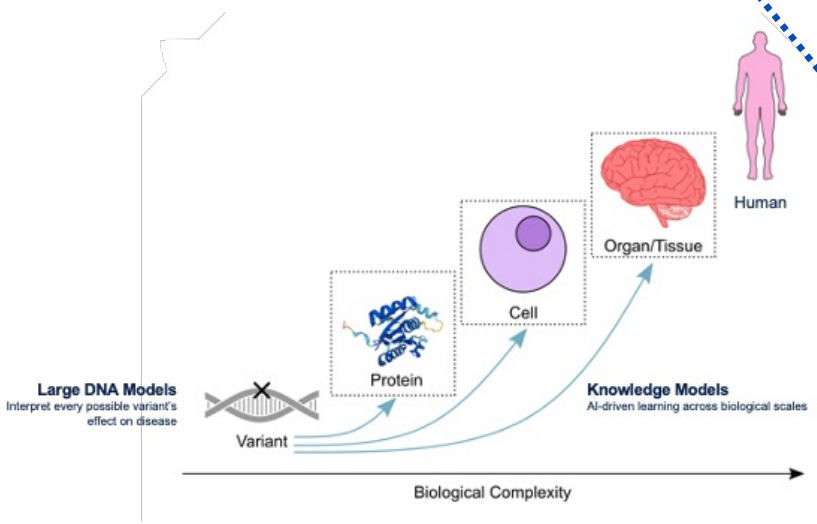
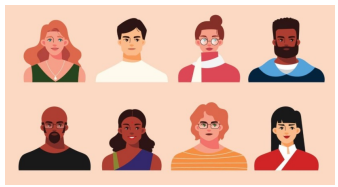


Image credit: Tony Capra, UCSF

“Above the skin”: Computational Health





Individuals

AI-enabled consumer health





Communities



Healthcare Systems

AI-enabled clinical care

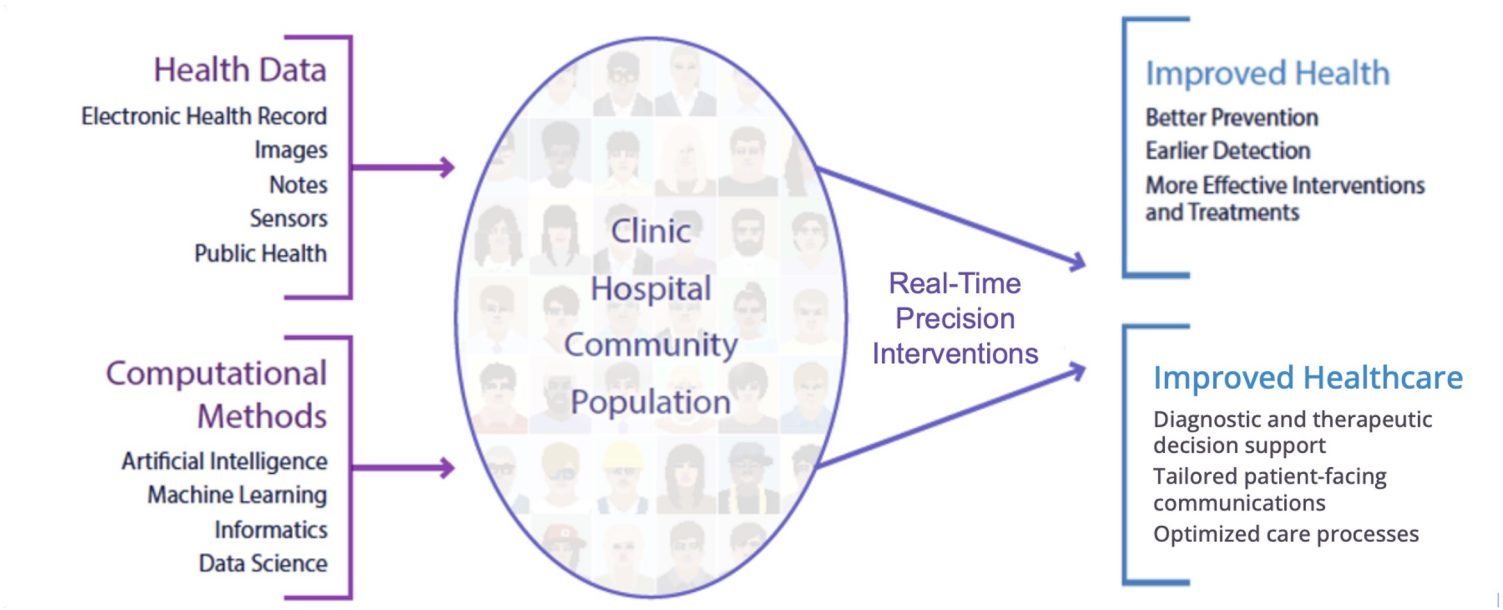


AI-enabled public and community health

Population Aggregation

What is Computational Precision Health?

A new discipline at the intersection of machine learning, statistics, medicine, and population health



Precision Questions: What interventions work best for which patients/communities and when?
Precision Solutions: Machine Learning + Statistics + Causality; HCI & Augmented Intelligence
Precision Deployment: Learning systems embedded in real-world health settings

Agenda

- Setting the Context: Healthcare in America today
- Frontline Practice: Complexities and Burdens
- Epic Electronic Health Record Demo
- Health AI: Brave New (Scary) Frontier

Setting the Context

- Whole person care
- Workforce shortage
- Health care access
- Payment models

Multiple Chronic Conditions (MCC)

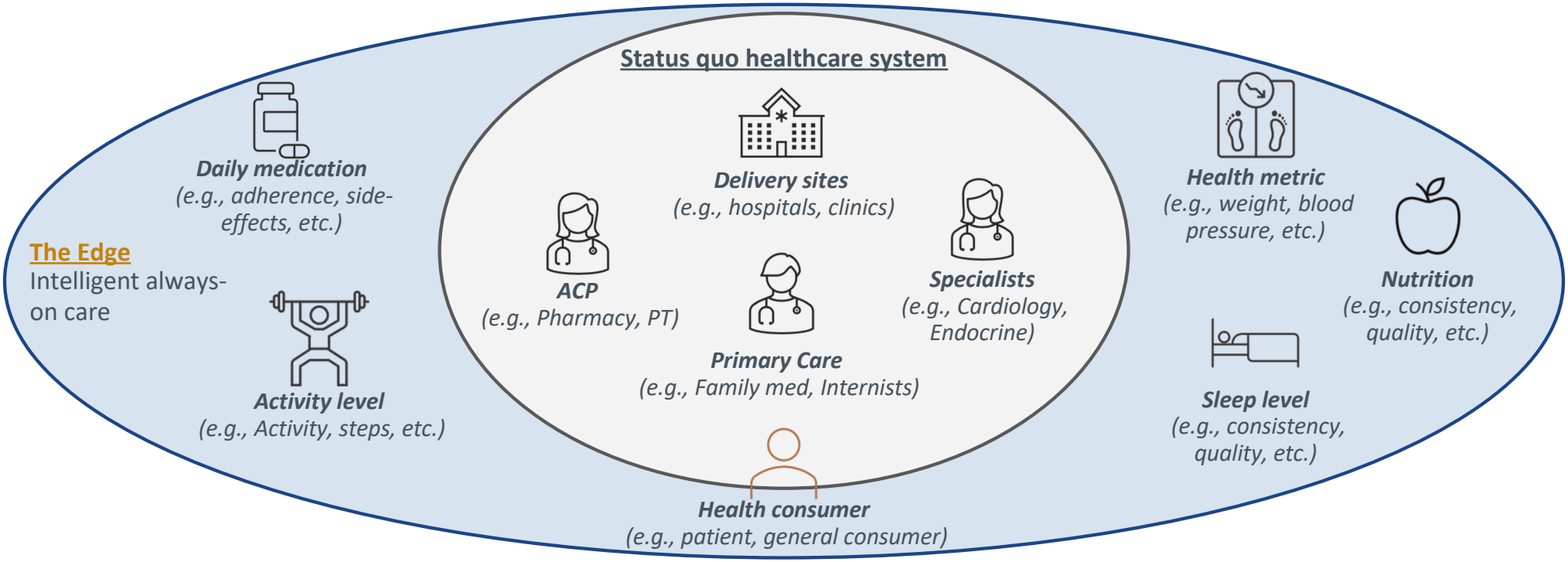


Multiple Chronic Conditions (MCC)



Edgemedicine.org

Edge Medicine: True Frontline of Health is 24/7 at The Edge



Source: Center for Edge Medicine

CENTER FOR EDGE MEDICINE

Setting the Context

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Clinician Shortage

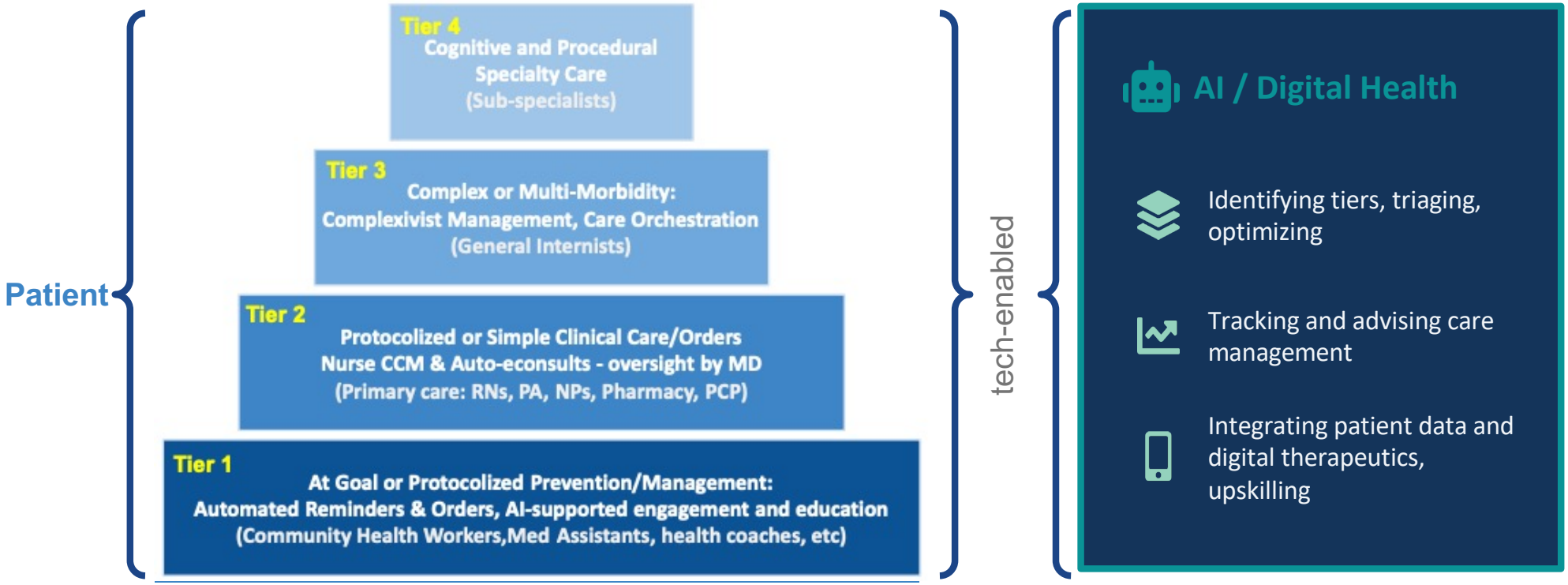
United States

- Older sicker population (55% in those > 75 years)
- 20% of physicians are > 65 y/o
- Projecting shortage of 13,500 to 86,000 physicians by 2036
  - Short 20-40,000 primary care physicians by 2036
- Nursing shortage of >100,000 in 2025

UCSF and Local

- 22 months to get in to a new Primary Care Physician (PCP) in Monterey County (April 2026)
- Specialty appointments are booking months out
- Staff are overworked, burnout decreased after pandemic but now increasing again

AI Healthcare Workforce Stack



Setting the Context

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Health Care Payment Models

Capitated

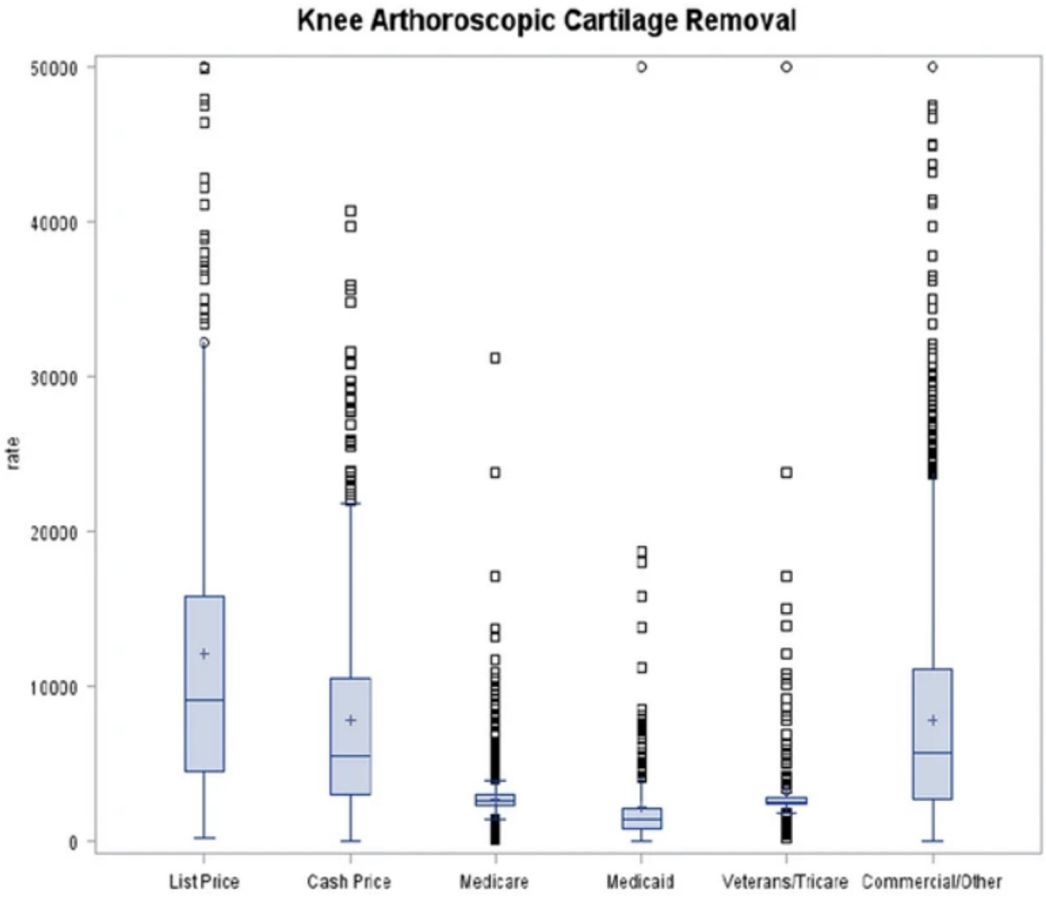
- Doctor or health system paid a flat sum for services, e.g.,
  - bundled payment: flat fee for knee cartilage removal
  - Pmpm: set $ per patient per month
  - Carveout: set $ per patient per month for primary care, or behavioral health



Health Care Payment Models

Fee-for-Service (FFS)

- Doctor/health system is paid for services provided
- Price ≠ cost, e.g., MRI at MGH
  - $1,019, Cigna plan
  - $3101, Aetna plan
  - $3809, Humana



Health Care Payment Models

Pay for Performance (P4P)

- Doctor/health system rewarded for achieving health metrics (still under FFS)
- Penalties
  - Lose $ if goals not met
- Extra payments
  - Paid lower global FFS amount, get bonus if meets goals
- E.g., BP, A1c (diabetes), hospital readmission, hospital infections

P4P Example

Pneumonia*			
Performance Measure	**Measure Description**	**Criterion Met or Acceptable Alternative**	**Rate Calculation****
Initial Antibiotic Timing (Less time is better for this measure.)	Average (mean) time from hospital arrival to first dose of antibiotics at the hospital for pneumonia patients.	Time, in minutes, from hospital arrival to any antibiotic administration in the hospital.	Continuous Variable Statement; Average (mean) time from hospital arrival to first dose of antibiotics at the hospital for pneumonia patients.

- For patients with pneumonia, receiving antibiotics within 4 hours of presentation in Emergency Room correlated with better outcomes

P4P Perverse Effects

Academic Emergency Medicine
A GLOBAL JOURNAL OF EMERGENCY CARE

Free Access

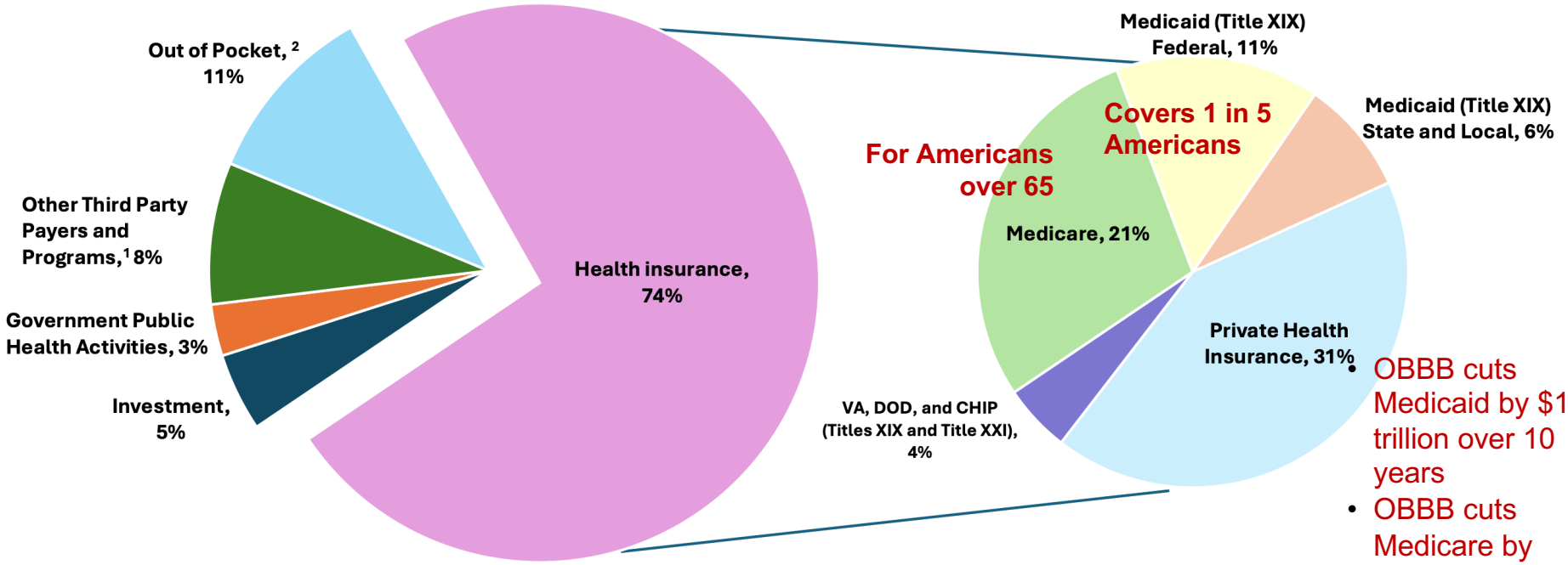
The Centers for Medicare and Medicaid Services (CMS) Community-Acquired Pneumonia Core Measures Lead to Unnecessary Antibiotic Administration by Emergency Physicians

Results: A total of 121 EPs completed the study instrument (81%). All respondents were aware of the CMS CAP guidelines. Of these, 95% (95% confidence interval [CI] = 92% to 98%) correctly understood the time-based guidelines for antibiotic administration, although 24% (95% CI = 17% to 31%) incorrectly identified the onset of this time period. Nearly all physicians (96%; 95% CI = 93% to 99%) reported institutional commitment to meet these core measures, and 84% (95% CI = 78% to 90%) stated that they had a department-based CAP protocol. More than half of the respondents (55%; 95% CI = 47% to 70%) reported prescribing antibiotics to patients they did not believe had pneumonia in an effort to comply with the CMS guidelines, and 42% (95% CI = 34% to 50%) of these stated that they did so more than three times per month. Only 40% (95% CI = 32% to 48%) of respondents indicated a belief that the guidelines improve patient care. Of those, this was believed to occur by increasing pneumonia awareness (60%; 95% CI = 52% to 68%) and improving hospital processes when pneumonia is suspected (86%; 95% CI = 80% to 92%).

Setting the Context

- Whole person care
- Clinician shortage
- Payment models
- Health care access

THE NATION'S HEALTH DOLLAR ($5.3 TRILLION), CALENDAR YEAR 2024: WHERE IT CAME FROM



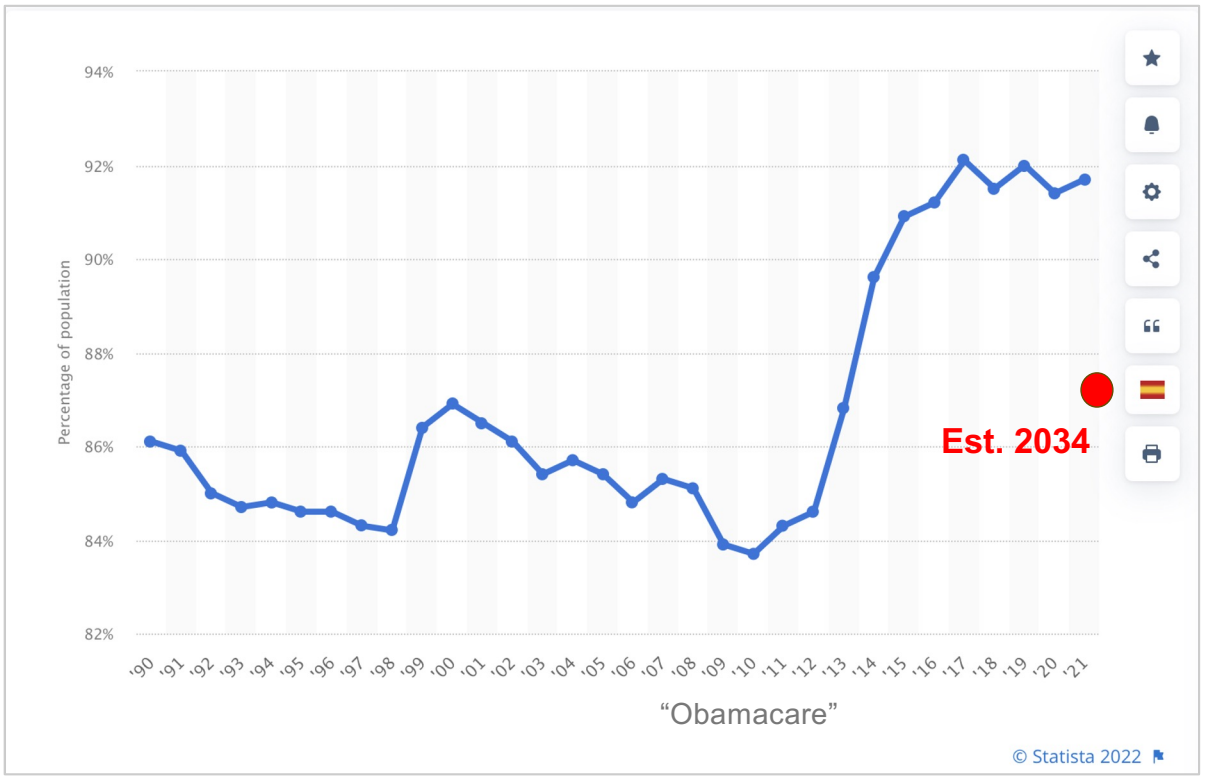
- OBBB cuts Medicaid by $1 trillion over 10 years
- OBBB cuts Medicare by $45 billion in 2026, $75 billion in 2034

[1] Includes worksite health care, other private revenues, Indian Health Service, workers' compensation, general assistance, maternal and child health, vocational rehabilitation, Substance Abuse and Mental Health Services Administration, school health, and other federal and state and local programs.

[2] Includes co-payments, deductibles, and any amounts not covered by health insurance.

Note: Sum of pieces may not equal 100% due to rounding

Health Insurance and Access



2022

- Almost 92% of Americans had some form of health insurance
- 8% were underinsured

January 1, 2027

- 2 million Californians going to fee-for-service Medi-Cal

By 2034 (with One Big Beautiful Bill)

- 3–5+% of Americans will have lost health insurance
- ~14 million more will be uninsured (1.7m in CA)

Impact of One Big Beautiful Bill

MOUNTING LOSSES: FEBRUARY IN NUMBERS

Over 50%

Of people who re-enrolled in an ACA health insurance plan this year said they have cut or plan to cut spending on food or other basic household expenses to afford health care (KFF)

19

Hospital /clinic closures & service reductions across 11 states

(CA, GA, ID, IA, KY, ME, MT, OH, OR, TN, VT)

477

Employees laid off across 4 states because of Republican health care cuts

(MA, NY, OR, TX)

https://www.finance.senate.gov/imo/media/doc/february_2026_obbba_impacts_report.pdf

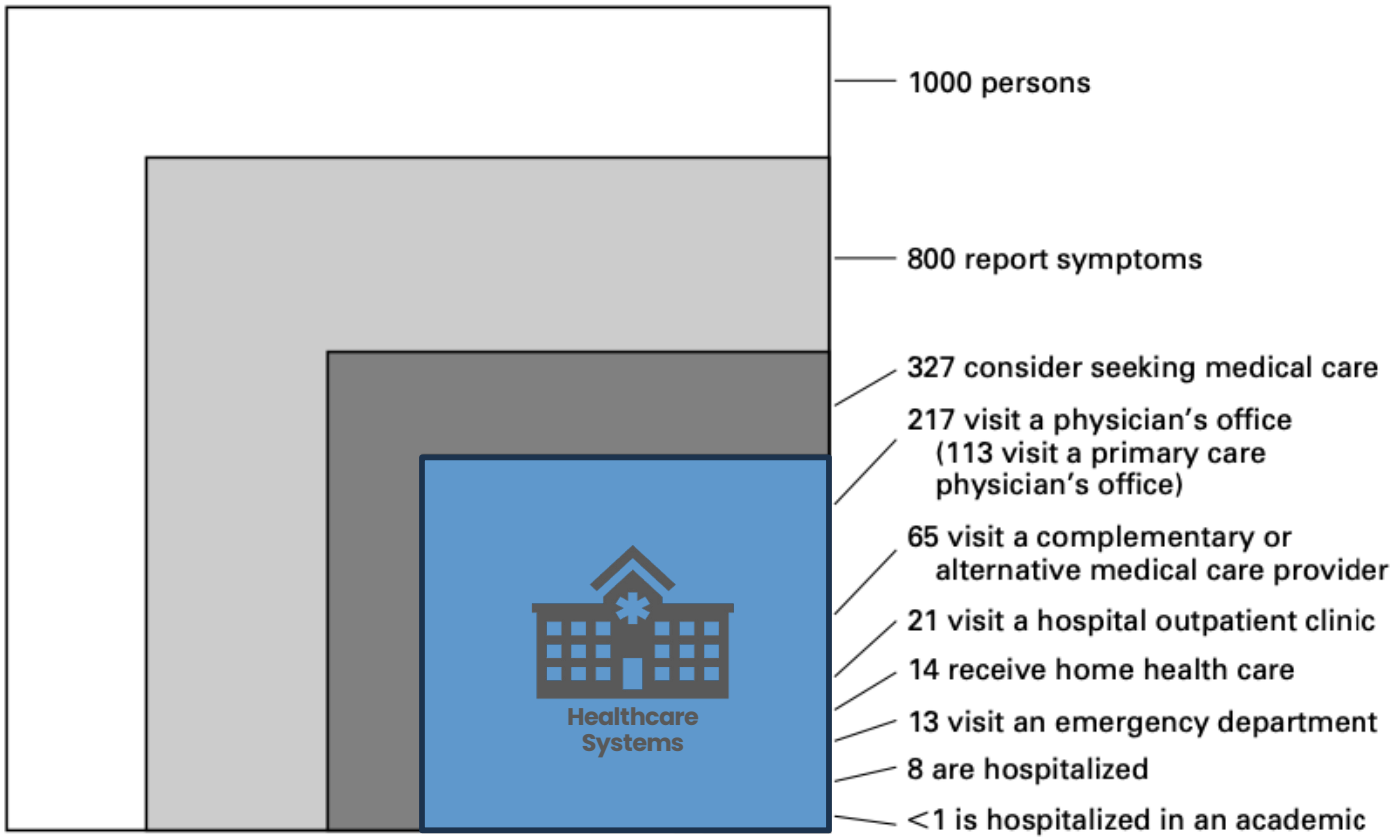
Setting the Context

- Whole person care – most patients have more than one chronic disease
- Clinician shortage - need to upskill patients, families, generalists, specialists, everyone. Role of AI is TBD.
- Perverse health care payment models - FFS incentivizes more care; P4P incentivizes weakly and can be gamed; $$$ rules
- Health care access – long delays, decreasing access to specialists, hospital and clinic closures, worsening especially in rural areas and for marginalized communities

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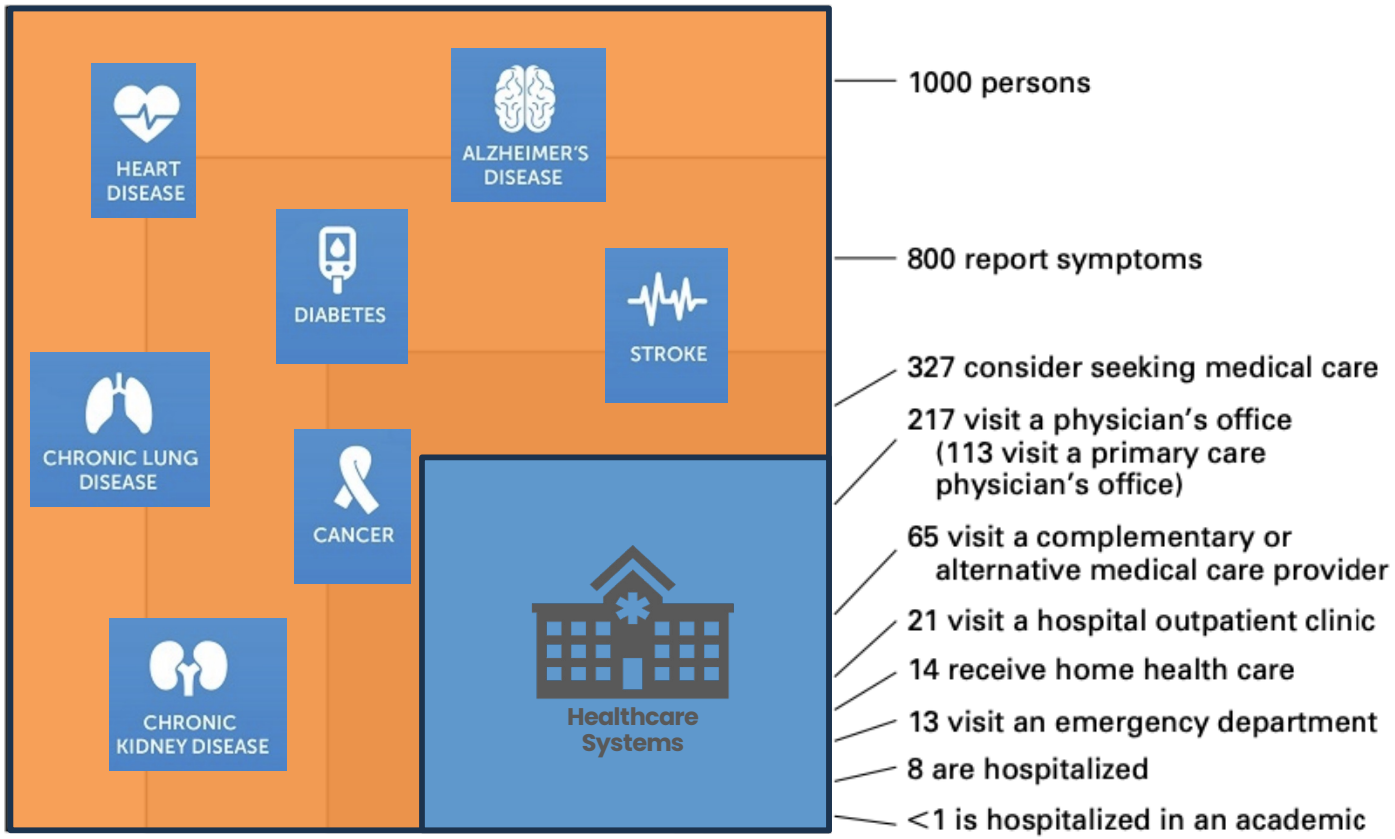
Ecology of Healthcare



Green, et al. N Engl J Med 2001;344:2021-2025.

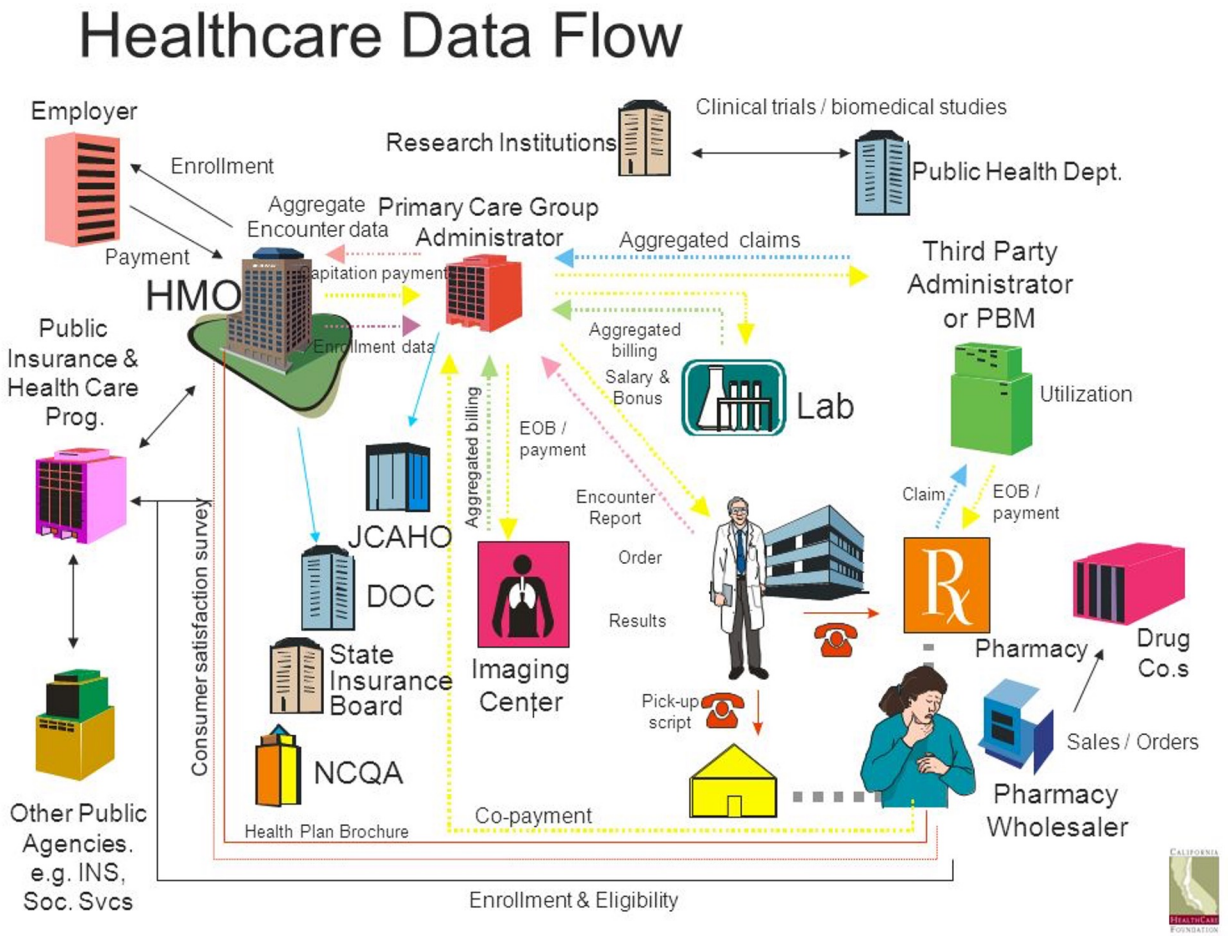
- Most health and disease occurs outside of health care
- Deployment settings: home, school, community, public health, clinics, urgent care, hospital
- Electronic Health Record (EHR) only captures data and transactions in healthcare systems

Most Health Care Happens Outside of Healthcare



Green, et al. N Engl J Med 2001;344:2021-2025.

Health Care System Complexity



1. Patient enrollment/eligibility verified, set up in EHR
2. MD reviews data (may get CareEverywhere data from other Epics)
3. Orders a drug
    a. Formulary, Prior Authorization, PBM, Pharmacy, pickup
4. EHR information blocking rule in effect Oct 6, 2022
5. EHR FHIR API requirement in effect Aug, 2022

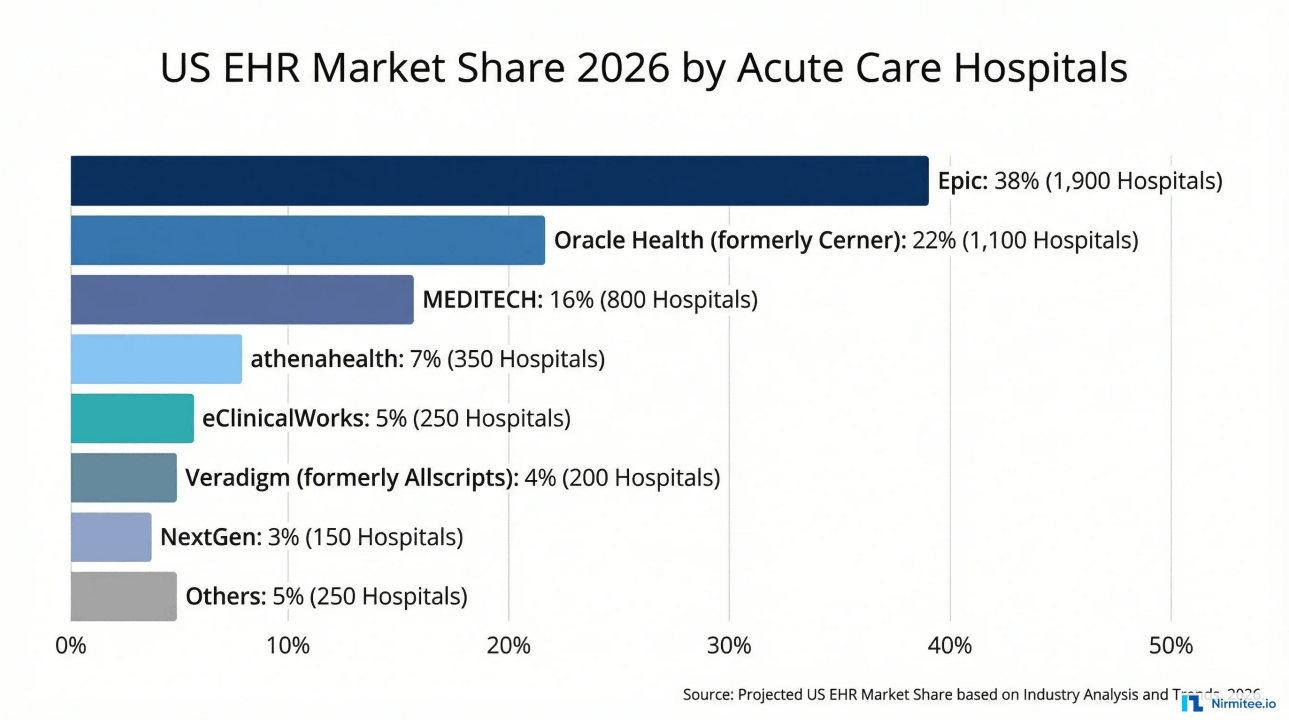
Outpatient Primary Care Clinic Session

Visit Time	Age	Primary Care: Reason for visit
1:05	70M	Stable heart disease, high cholesterol, high BP, pre-diabetes, chronic joint pain, preventive care, **end-of-life discussion**
1:25	92F	**Mild dementia,** HTN, Syndrome X (cardiac), high chol, osteoporosis
1:45	52M	**Hole in his heart (PFO)** ?surgery, hx of stroke, anticoagulated, s/p prostatis, foot pain, trigger thumb
2:05	71F	**s/p right hip fracture** and pin, diabetes, **unexplained weight loss with high cancer marker,** s/p resection for pancreatic neuroendocrine cancer, chronic kidney failure, HTN, back and neck pain on opioids, etc.
2:25	87F	**Poorly controlled diabetes**, HTN, heart disease, aortic stenosis & regurgitation, eczema, unstable gait, s/p stroke, carotid stenosis, left knee and shoulder pain, insomnia
3:05	91F	**Episodes of whole body weakness,** HTN with labile blood pressure, CAD, DM, vertigo, hx of falls, esophageal stricture, profound hearing loss, **moderate dementia**
3:25	89F	Hx of stroke with spasticity and gait disorder, HTN, s/p aortic valve surgery, osteoporosis, **needs COVID Booster**
3:45	97M	**Decreased kidney function, new abdominal mass,** HTN, heart failure, vertigo, r/o aortic stenosis, skin sun damage, large prostate
4:05	65M	Degenerative neck and lumbar spine, **left and right arm/hand neuropathy,** carpal tunnel syndrome, **needs COVID Booster**

Practice Burdens

- Mental pressure
  - Sicker, older patients; mental bandwidth demands; vast clinical knowledge base; administrivia; hard to practice at top of license
- Time pressure/workflow burdens
  - 20 minute primary care visits
  - 2 hours of time on computer for every 1 hour of patient-facing time
  - Daily average of 45 minutes spent searching for orders, reconciling orders, and navigating order decision support tools.
- System capacity and operational friction
  - Specialty consults available months out or not at all
  - Medication shortages, pharmacy inventory limitations,
  - Prior authorization: for drugs, procedures, imaging, referrals, diapers
- Emotional pressure/moral injury and existential/identity concerns
  - human connection with patients, social/economic/safety difficulties, AI

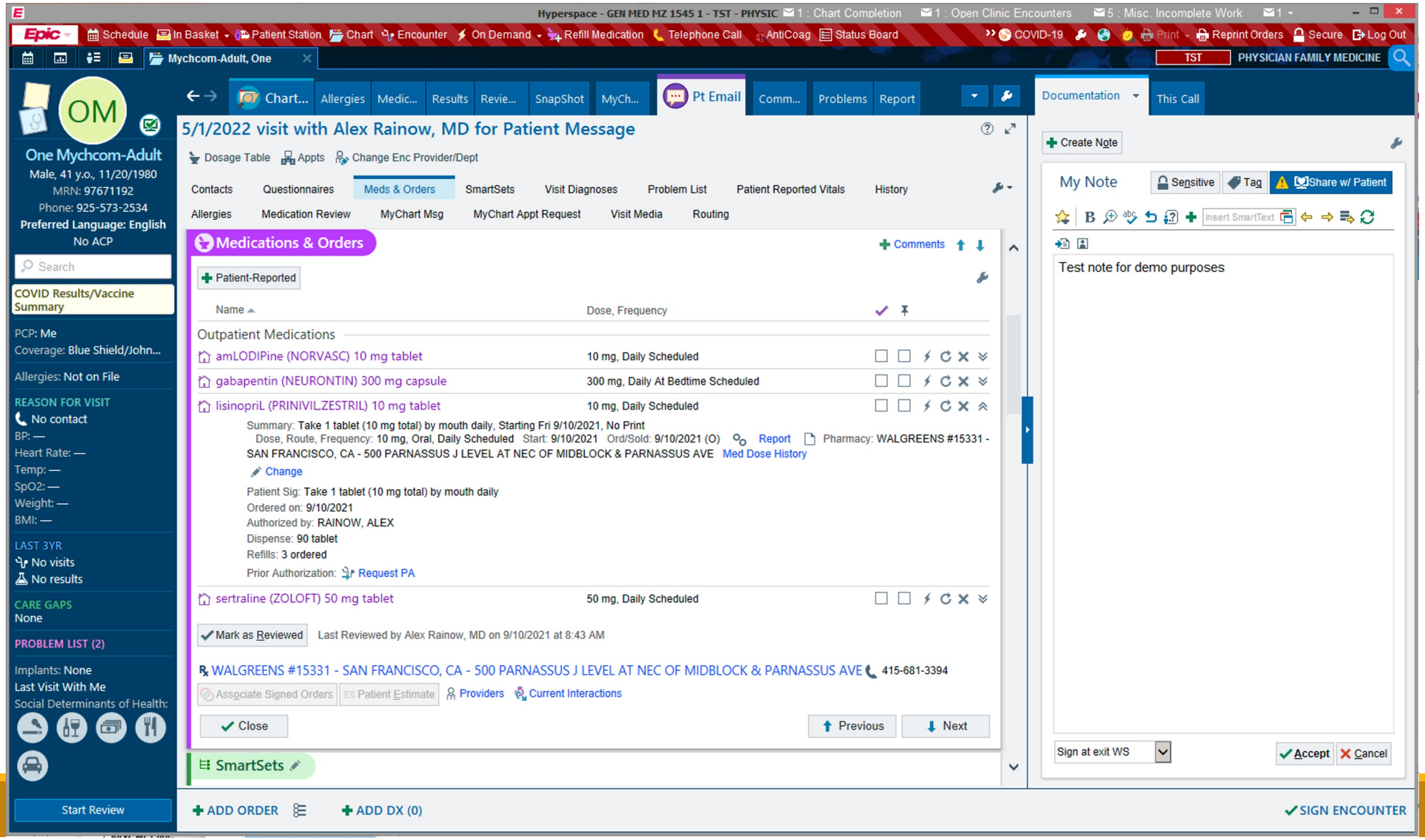
“Electronic Health Record”



https://nirmitee.io/blog/ehr-integration-guide-methods-vendor-apis-security-cost/

EHR is two components

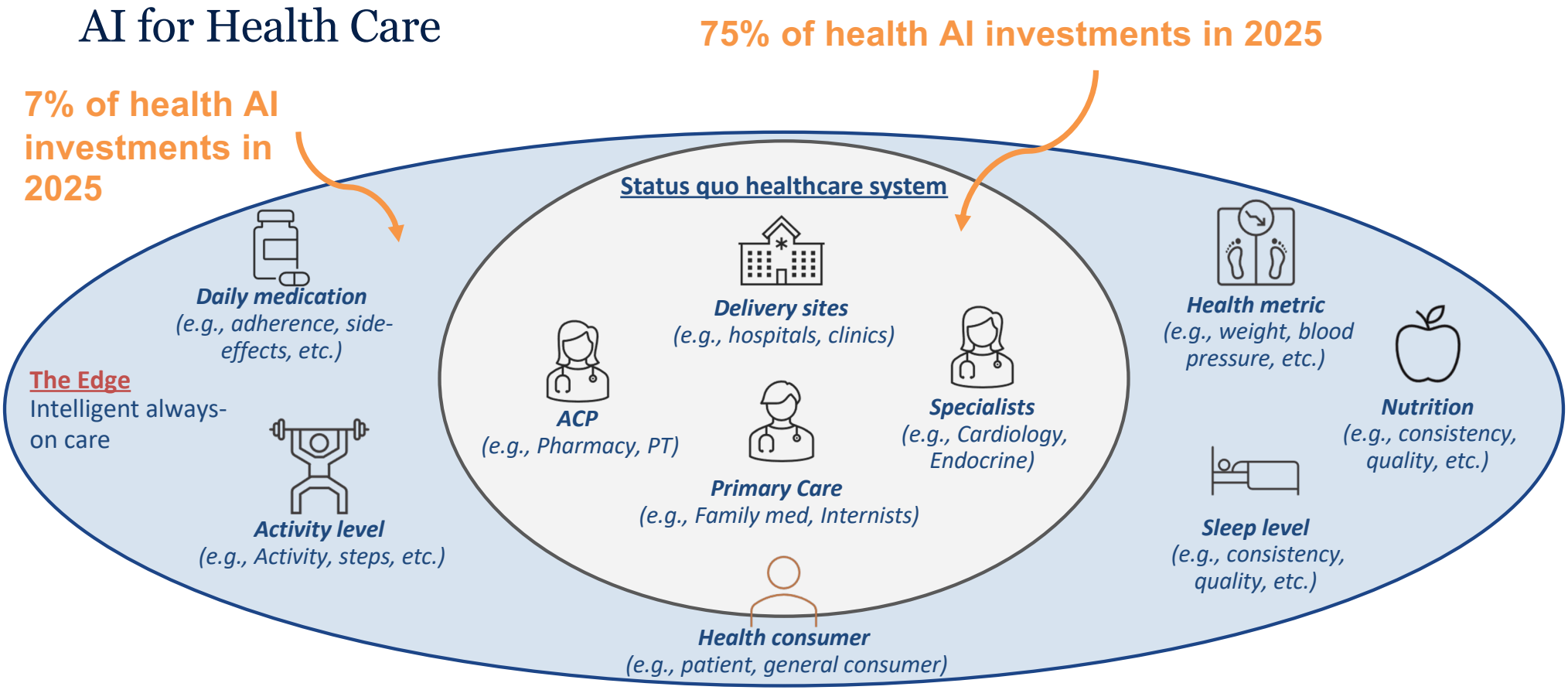
- Workflow engine
  - ”APeX” name of UCSF’s Epic installation, for doctors
  - MyChart is Epic’s patient-facing EHR
- Database of clinical data and clinical transactions


Hyperspace - GEN MED MZ 1545 1 - TST - PHYSIC
1 : Chart Completion
1 : Open Clinic Encounters
5 : Misc. Incomplete Work
Schedule
In Basket
Patient Station
Chart
Encounter
On Demand
Refill Medication
Telephone Call
AntiCoag
Status Board
COVID-19
Print
Reprint Orders
Secure
Log Out
Mychcom-Adult, One
TST
PHYSICIAN FAMILY MEDICINE
Chart...
Allergies
Medic...
Results
Revie...
SnapShot
MyCh...
Pt Email
Comm...
Problems
Report
Documentation
This Call
OM
One Mychcom-Adult
Male, 41 y.o., 11/20/1980
MRN: 97671192
Phone: 925-573-2534
Preferred Language: English
No ACP
Search
COVID Results/Vaccine Summary
PCP: Me
Coverage: Blue Shield/John...
Allergies: Not on File
REASON FOR VISIT
No contact
BP: —
Heart Rate: —
Temp: —
SpO2: —
Weight: —
BMI: —
LAST 3YR
No visits
No results
CARE GAPS
None
PROBLEM LIST (2)
Implants: None
Last Visit With Me
Social Determinants of Health:
Start Review
5/1/2022 visit with Alex Rainow, MD for Patient Message
Dosage Table
Appts
Change Enc Provider/Dept
Contacts
Questionnaires
Meds & Orders
SmartSets
Visit Diagnoses
Problem List
Patient Reported Vitals
History
Allergies
Medication Review
MyChart Msg
MyChart Appt Request
Visit Media
Routing
Medications & Orders
Comments
Patient-Reported
Name
Dose, Frequency
Outpatient Medications
amLODIPine (NORVASC) 10 mg tablet
10 mg, Daily Scheduled
gabapentin (NEURONTIN) 300 mg capsule
300 mg, Daily At Bedtime Scheduled
lisinopriL (PRINIVIL,ZESTRIL) 10 mg tablet
10 mg, Daily Scheduled
Summary: Take 1 tablet (10 mg total) by mouth daily, Starting Fri 9/10/2021, No Print
Dose, Route, Frequency: 10 mg, Oral, Daily Scheduled Start: 9/10/2021 Ord/Sold: 9/10/2021 (O) Report Pharmacy: WALGREENS #15331 - SAN FRANCISCO, CA - 500 PARNASSUS J LEVEL AT NEC OF MIDBLOCK & PARNASSUS AVE Med Dose History
Change
Patient Sig: Take 1 tablet (10 mg total) by mouth daily
Ordered on: 9/10/2021
Authorized by: RAINOW, ALEX
Dispense: 90 tablet
Refills: 3 ordered
Prior Authorization: Request PA
sertraline (ZOLOFT) 50 mg tablet
50 mg, Daily Scheduled
Mark as Reviewed
Last Reviewed by Alex Rainow, MD on 9/10/2021 at 8:43 AM
WALGREENS #15331 - SAN FRANCISCO, CA - 500 PARNASSUS J LEVEL AT NEC OF MIDBLOCK & PARNASSUS AVE 415-681-3394
Associate Signed Orders
Patient Estimate
Providers
Current Interactions
Close
Previous
Next
SmartSets
Create Note
My Note
Sensitive
Tag
Share w/ Patient
Insert SmartText
Test note for demo purposes
Sign at exit WS
Accept
Cancel
ADD ORDER
ADD DX (0)
SIGN ENCOUNTER

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AI for Health Care

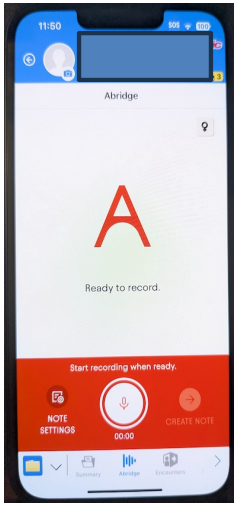


CENTER FOR EDGE MEDICINE

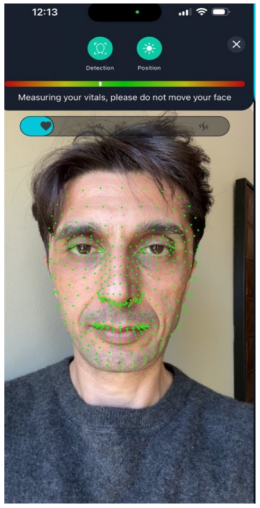
AI for Health Care: Major Issues

- No clear regulatory body
- Patchwork of federal and state laws, regulations
- Difficult to evaluate
  - Lack of transparency of models
  - Methods for monitoring in the wild
- Practicing medicine without a license, unclear accountability

Choose Your Adventure

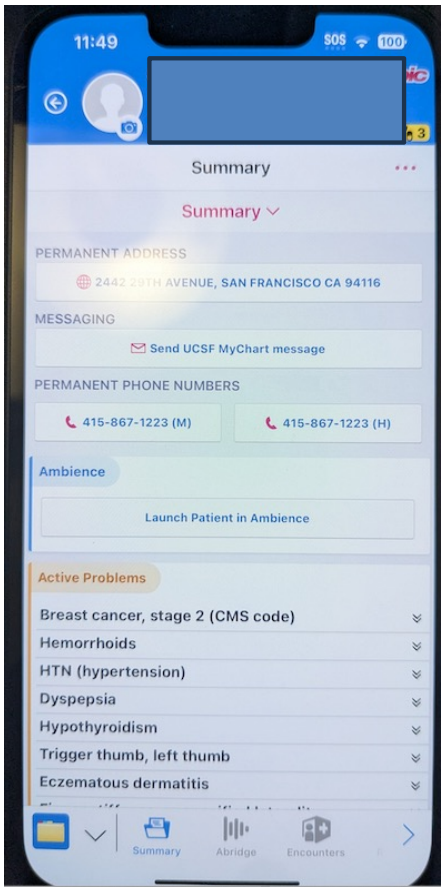


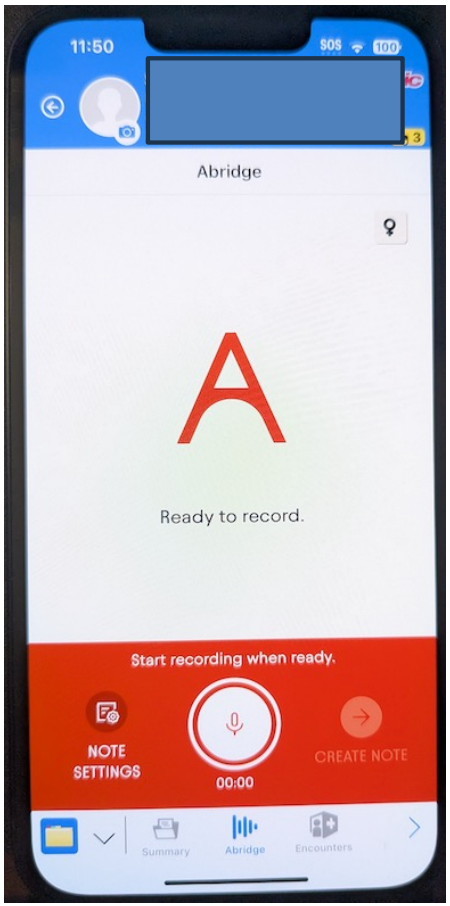
AI Scribing

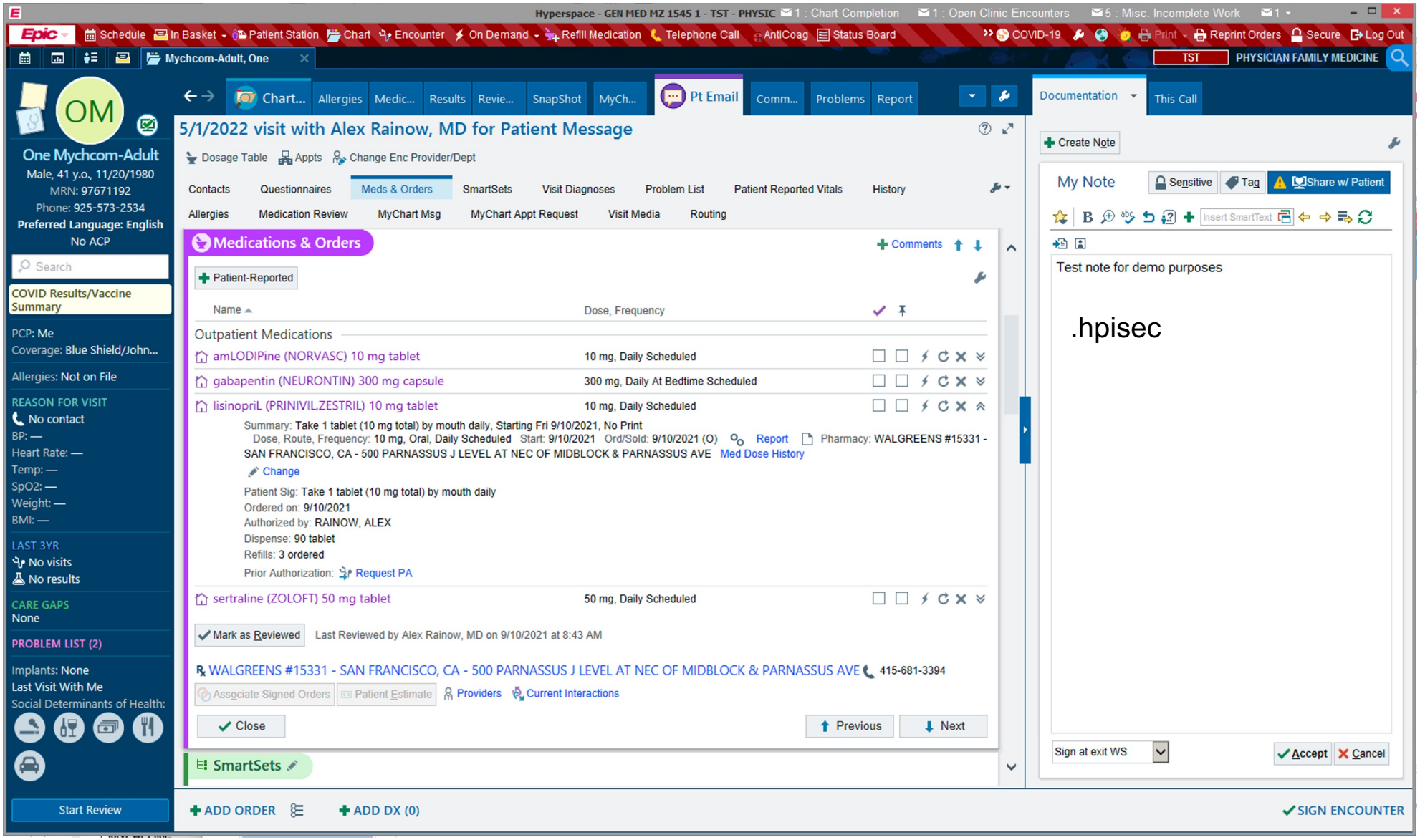


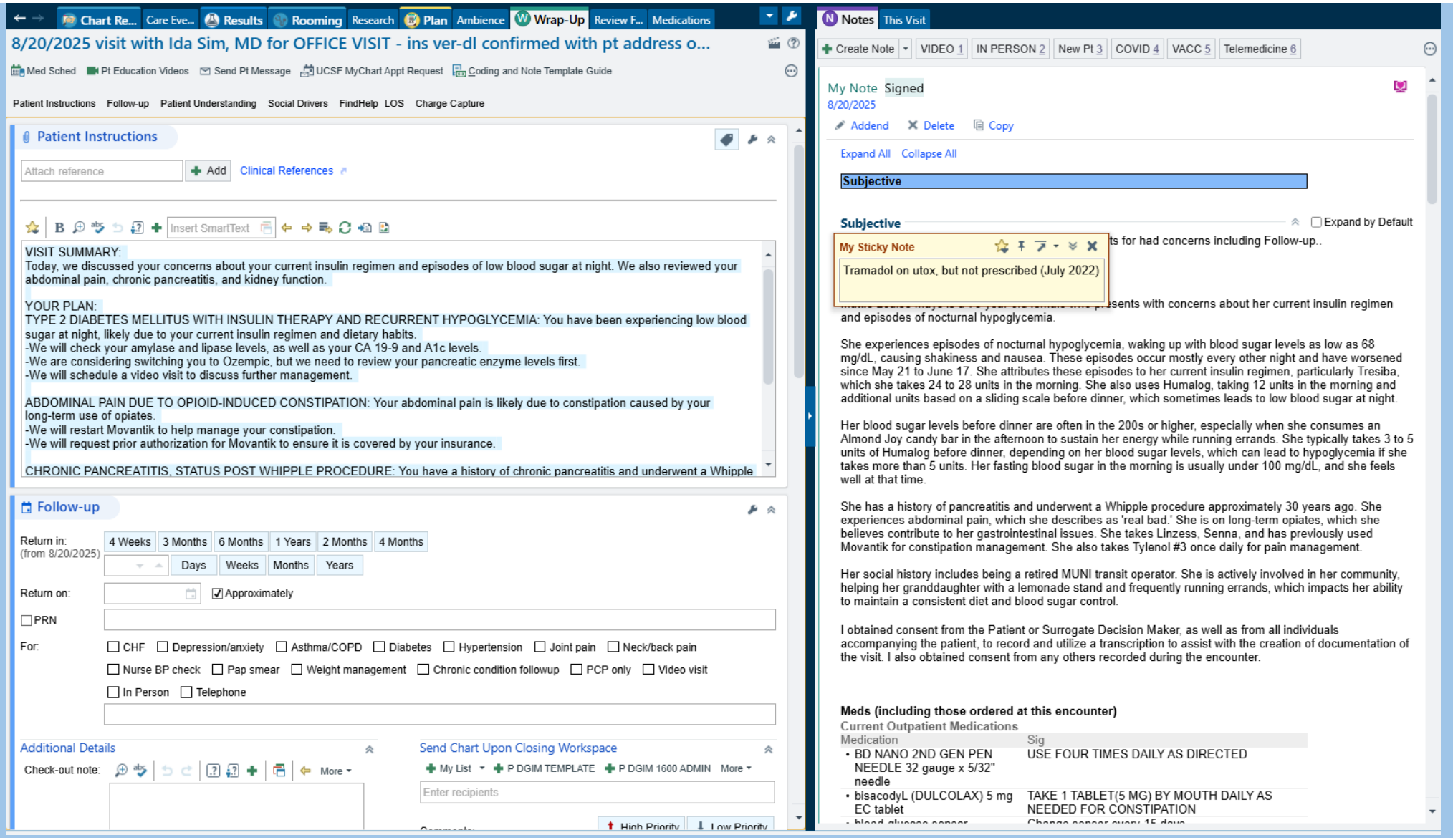
BP using your phone

Abridge AI Scribing






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Print
Reprint Orders
Secure
Log Out
Mychcom-Adult, One
TST
PHYSICIAN FAMILY MEDICINE
OM
One Mychcom-Adult
Male, 41 y.o., 11/20/1980
MRN: 97671192
Phone: 925-573-2534
Preferred Language: English
No ACP
Search
COVID Results/Vaccine Summary
PCP: Me
Coverage: Blue Shield/John...
Allergies: Not on File
REASON FOR VISIT
No contact
BP: —
Heart Rate: —
Temp: —
SpO2: —
Weight: —
BMI: —
LAST 3YR
No visits
No results
CARE GAPS
None
PROBLEM LIST (2)
Implants: None
Last Visit With Me
Social Determinants of Health:
Start Review
Chart...
Allergies
Medic...
Results
Revie...
SnapShot
MyCh...
Pt Email
Comm...
Problems
Report
Documentation
This Call
5/1/2022 visit with Alex Rainow, MD for Patient Message
Dosage Table
Appts
Change Enc Provider/Dept
Contacts
Questionnaires
Meds & Orders
SmartSets
Visit Diagnoses
Problem List
Patient Reported Vitals
History
Allergies
Medication Review
MyChart Msg
MyChart Appt Request
Visit Media
Routing
Medications & Orders
Comments
Patient-Reported
Name
Dose, Frequency
Outpatient Medications
amLODIPine (NORVASC) 10 mg tablet
10 mg, Daily Scheduled
gabapentin (NEURONTIN) 300 mg capsule
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Patient Estimate
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Close
Previous
Next
SmartSets
Create Note
My Note
Sensitive
Tag
Share w/ Patient
Insert SmartText
Test note for demo purposes
.hpisec
Sign at exit WS
Accept
Cancel
ADD ORDER
ADD DX (0)
SIGN ENCOUNTER


Chart Re...
Care Eve...
Results
Rooming
Research
Plan
Ambience
Wrap-Up
Review F...
Medications
8/20/2025 visit with Ida Sim, MD for OFFICE VISIT - ins ver-dl confirmed with pt address o...
Med Sched
Pt Education Videos
Send Pt Message
UCSF MyChart Appt Request
Coding and Note Template Guide
Patient Instructions
Follow-up
Patient Understanding
Social Drivers
FindHelp
LOS
Charge Capture
Patient Instructions
Attach reference
Add
Clinical References
Insert SmartText
VISIT SUMMARY:
Today, we discussed your concerns about your current insulin regimen and episodes of low blood sugar at night. We also reviewed your abdominal pain, chronic pancreatitis, and kidney function.
YOUR PLAN:
TYPE 2 DIABETES MELLITUS WITH INSULIN THERAPY AND RECURRENT HYPOGLYCEMIA: You have been experiencing low blood sugar at night, likely due to your current insulin regimen and dietary habits.
-We will check your amylase and lipase levels, as well as your CA 19-9 and A1c levels.
-We are considering switching you to Ozempic, but we need to review your pancreatic enzyme levels first.
-We will schedule a video visit to discuss further management.
ABDOMINAL PAIN DUE TO OPIOID-INDUCED CONSTIPATION: Your abdominal pain is likely due to constipation caused by your long-term use of opiates.
-We will restart Movantik to help manage your constipation.
-We will request prior authorization for Movantik to ensure it is covered by your insurance.
CHRONIC PANCREATITIS, STATUS POST WHIPPLE PROCEDURE: You have a history of chronic pancreatitis and underwent a Whipple
Follow-up
Return in:
(from 8/20/2025)
4 Weeks
3 Months
6 Months
1 Years
2 Months
4 Months
Days
Weeks
Months
Years
Return on:
Approximately
PRN
For:
CHF
Depression/anxiety
Asthma/COPD
Diabetes
Hypertension
Joint pain
Neck/back pain
Nurse BP check
Pap smear
Weight management
Chronic condition followup
PCP only
Video visit
In Person
Telephone
Additional Details
Check-out note:
More
Send Chart Upon Closing Workspace
My List
P DGIM TEMPLATE
P DGIM 1600 ADMIN
More
Enter recipients
High Priority
Low Priority
Notes
This Visit
Create Note
VIDEO 1
IN PERSON 2
New Pt 3
COVID 4
VACC 5
Telemedicine 6
My Note Signed
8/20/2025
Addend
Delete
Copy
Expand All
Collapse All
Subjective
Subjective
Expand by Default
My Sticky Note
Tramadol on utox, but not prescribed (July 2022)
ts for had concerns including Follow-up..
sents with concerns about her current insulin regimen and episodes of nocturnal hypoglycemia.
She experiences episodes of nocturnal hypoglycemia, waking up with blood sugar levels as low as 68 mg/dL, causing shakiness and nausea. These episodes occur mostly every other night and have worsened since May 21 to June 17. She attributes these episodes to her current insulin regimen, particularly Tresiba, which she takes 24 to 28 units in the morning. She also uses Humalog, taking 12 units in the morning and additional units based on a sliding scale before dinner, which sometimes leads to low blood sugar at night.
Her blood sugar levels before dinner are often in the 200s or higher, especially when she consumes an Almond Joy candy bar in the afternoon to sustain her energy while running errands. She typically takes 3 to 5 units of Humalog before dinner, depending on her blood sugar levels, which can lead to hypoglycemia if she takes more than 5 units. Her fasting blood sugar in the morning is usually under 100 mg/dL, and she feels well at that time.
She has a history of pancreatitis and underwent a Whipple procedure approximately 30 years ago. She experiences abdominal pain, which she describes as 'real bad.' She is on long-term opiates, which she believes contribute to her gastrointestinal issues. She takes Linzess, Senna, and has previously used Movantik for constipation management. She also takes Tylenol #3 once daily for pain management.
Her social history includes being a retired MUNI transit operator. She is actively involved in her community, helping her granddaughter with a lemonade stand and frequently running errands, which impacts her ability to maintain a consistent diet and blood sugar control.
I obtained consent from the Patient or Surrogate Decision Maker, as well as from all individuals accompanying the patient, to record and utilize a transcription to assist with the creation of documentation of the visit. I also obtained consent from any others recorded during the encounter.
Meds (including those ordered at this encounter)
Current Outpatient Medications
Medication
Sig
BD NANO 2ND GEN PEN NEEDLE 32 gauge x 5/32" needle
USE FOUR TIMES DAILY AS DIRECTED
bisacodyL (DULCOLAX) 5 mg EC tablet
TAKE 1 TABLET(5 MG) BY MOUTH DAILY AS NEEDED FOR CONSTIPATION

Abridge™ AI Scribe

"Subjective"/History part of the note

Summary from a 30+ minute conversation

I edited as shown.

Subjective Expand by Default

My Sticky Note

Tramadol on utox, but not prescribed (July 2022)

ts for had concerns including Follow-up..

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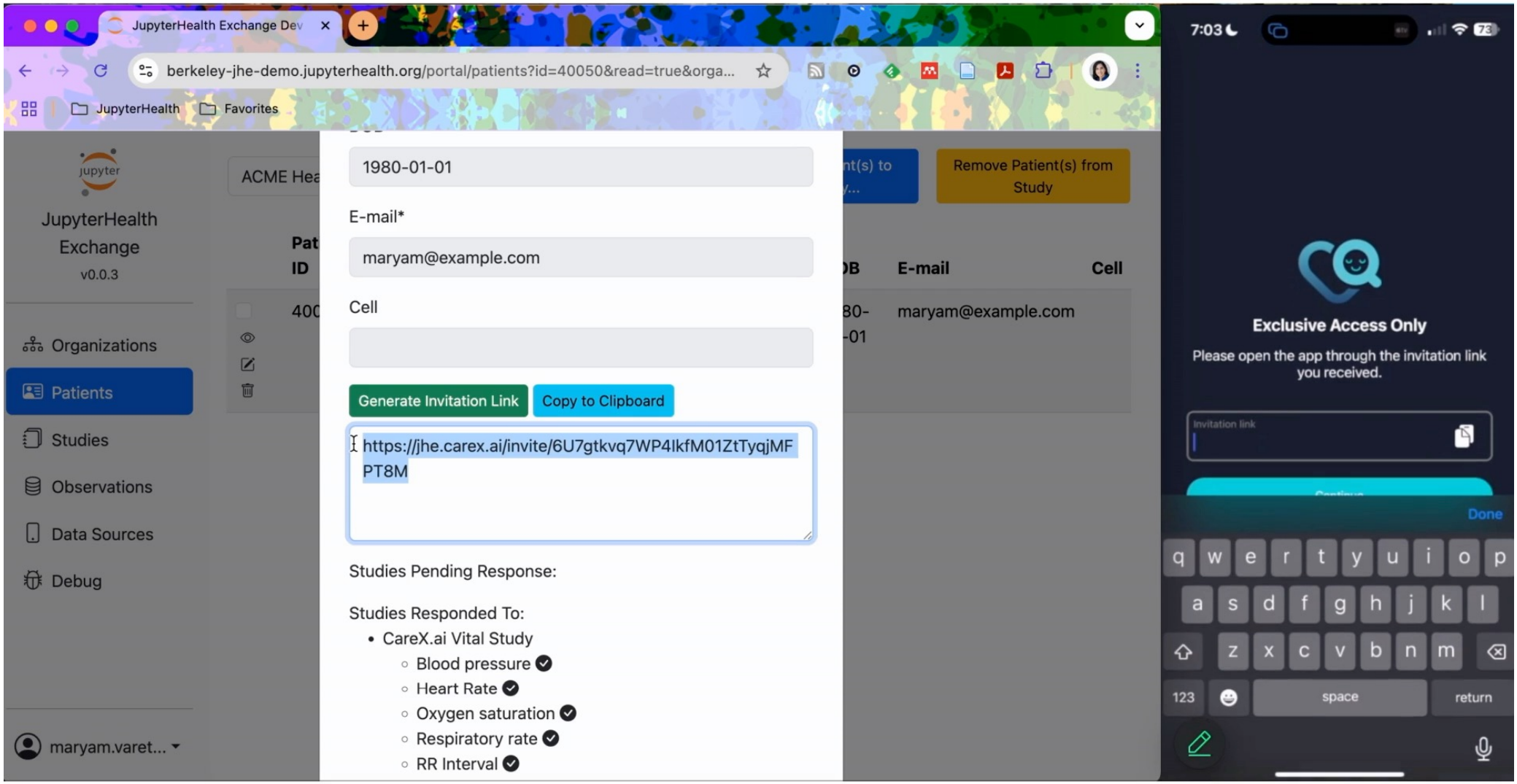
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JupyterHealth Exchange Dev
berkeley-jhe-demo.jupyterhealth.org/portal/patients?id=40050&read=true&orga...
JupyterHealth
Favorites
JupyterHealth Exchange
v0.0.3
Organizations
Patients
Studies
Observations
Data Sources
Debug
maryam.varet...
ACME Hea
Remove Patient(s) from Study
ID
E-mail
Cell
maryam@example.com
1980-01-01
E-mail*
maryam@example.com
Cell
Generate Invitation Link
Copy to Clipboard
https://jhe.carex.ai/invite/6U7gtkvq7WP4lkfM01ZtTyqjMFPT8M
Studies Pending Response:
Studies Responded To:
CareX.ai Vital Study
Blood pressure
Heart Rate
Oxygen saturation
Respiratory rate
RR Interval
7:03
Exclusive Access Only
Please open the app through the invitation link you received.
Invitation link
Done

Summary

- 7 chronic diseases account for 90% of healthcare expenses, and 60% of Americans have more than one chronic disease.
- Healthcare system is under tremendous stress: workforce shortages, lack of access, deeply threatened finances, and perverse payment models that do not reward better care or better outcomes
- Clinicians practice under high mental, time/workflow, resource, and emotional pressures.
- Epic is the dominant electronic health record (EHR). EHRs serve as medicine's workflow system with a database attached to it.
- AI for health and healthcare is in an "accelerationist posture" with few guardrails

Take Home Points

- Treat the whole patient not individual diseases! Find the optimal solution for the *set of diseases* each patient has, not the local single-disease optimum.
- Most of healthcare is delivered at The Edge, outside the healthcare system
- Do not add net mental, time, or emotional burden to the health system or health workers
- Partner with clinicians and patients to understand the real problems that need solving
- We must shape AI to preserve humanity in health and healthcare

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