What is Population Health AI?

Shiva Kaul (CAB, TIDE)

CAB

CENTER FOR AI AND BIOMEDICAL INFORMATICS

Georgia Institute of Technology

HARVARD T.H. CHAN

Carnegie Mellon

DCHHS

Dallas County Health and Human Services

Anjum Khurshid (HPHCI)

Matti Hautala (HPHCI)

Geoffrey Gordon (Carnegie Mellon)

Sriram Vishwanath (Georgia Tech)

Kaan Kale (Georgia Tech)

Ege Tanrivierdi (Georgia Tech)

Min-Gyu Kim (Ajou University, Korea)

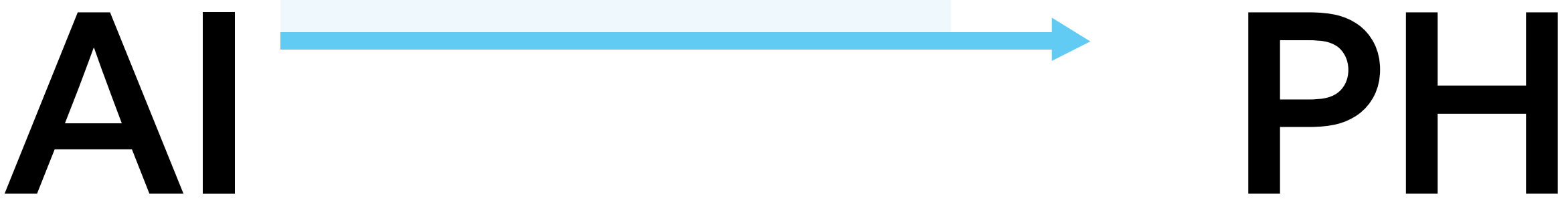
Philip Huang (Dallas County HHS)

Jiahao Yang (Harvard TH Chan)

Sijie Zhao (Harvard TH Chan)

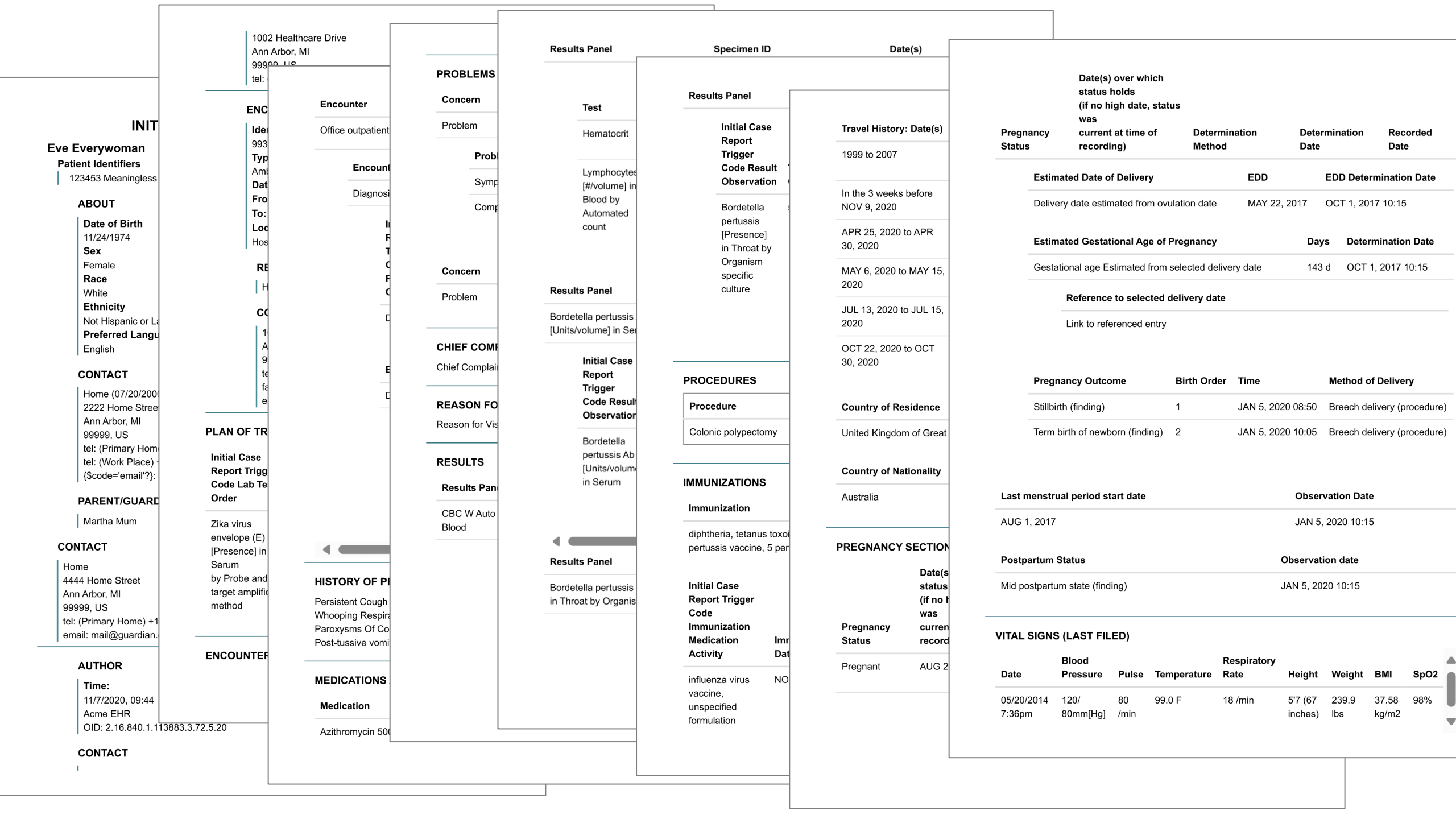
AI in Population Health

applying AI to automate or refine processes within current workflows.



Processing Electronic Case Reports with Generative AI

Condition category	Number of conditions	Condition Name (s)
Birth Defects and Infant Disorders	58	Anencephaly; Anophthalmia; Anotia; Aortic Valve Stenosis; Atrial Septal Defect; Atrioventricular septal defect (Endocardial cushion defect); Biliary Atresia; Bladder Exstrophy; Choanal Atresia; Cleft Lip Alone; Cleft Lip with Cleft Palate; Cleft Palate Alone; Cloacal Exstrophy; Clubfoot; Coarctation of the Aorta; Congenital cytomegalovirus (cCMV) Infection and Disease; Congenital Posterior Urethral Valves; Cystic Fibrosis; Diaphragmatic Hernia; Double Outlet Right Ventricle (DORV); Down Syndrome; Ebstein Anomaly; Encephalocele; Esophageal Atresia/Tracheoesophageal Fistula; Fetal Alcohol Spectrum Disorders; Galactosemia; Gastroschisis; Homocystinuria; Hypoplastic Left Heart Syndrome (HLHS); Hypospadias; Infant Hearing Loss; Interrupted Aortic Arch; Limb Reduction; Medium-chain Acyl-CoA Dehydrogenase Deficiency; Microphthalmia; Microtia; Neonatal Abstinence Syndrome; Omphalocele; Phenylketonuria; Primary Congenital Hypothyroidism; Pulmonary Valve Atresia and Stenosis; Rectal and Large Intestinal Atresia and Stenosis; Renal Agenesis and Hypoplasia; Severe Combined Immunodeficiency; Sickle Cell Anemia (Hemoglobin SS Disease); Single Ventricle; Small Intestinal Atresia and Stenosis; Spina Bifida; Spinal Muscular Atrophy; Tetralogy of Fallot (TOF); Total Anomalous Pulmonary Venous Connection (TAPVC); Transposition of the Great Arteries (TGA); Tricuspid Valve Atresia and Stenosis; Trisomy 13; Trisomy 18; Truncus Arteriosus (Common Truncus); Ventricular Septal Defect; X-linked Adrenoleukodystrophy
Bloodborne Diseases	6	Hepatitis B Virus Infection; Hepatitis B Virus Infection, Perinatal; Hepatitis C Virus Infection; Hepatitis C Virus Infection, Perinatal; Hepatitis D Virus Infection; Hepatitis G Virus Infection
Cancer	1	Cancer
Enteric Diseases	22	Amebiasis; Campylobacteriosis; Cholera; Clostridioides difficile (C. diff) infection; Clostridium perfringens Infection; Cryptosporidiosis; Cyclosporiasis; Giardiasis; Hemolytic uremic syndrome (HUS); Hepatitis A Virus infection; Hepatitis E Virus infection; Listeriosis; Non-pestis Yersiniosis; Non-Polio Enterovirus Infection; Norovirus Infections; Rotavirus Disease; S. Paratyphi Infection; S. Typhi Infection; Salmonellosis; Shiga toxin-producing Escherichia coli (STEC) infection; Shigellosis; Vibriosis
Healthcare-Associated Events	16	Candida auris infection; Candidemia; Carbapenemase-Producing Organisms (CPO); Carbapenem-resistant Acinetobacter baumannii (CRAB); Carbapenem-resistant Enterobacteriaceae (CRE); Carbapenem-resistant Pseudomonas aeruginosa (CRPA); Catheter-associated Urinary Tract Infection (CAUTI); Central Line- associated Bloodstream Infection (CLABSI); Staphylococcus aureus Infection; Surgical Site Infection (SSI); Vaccine Adverse Event; Vaccinia Disease or Adverse Event; Vancomycin-intermediate Staphylococcus aureus (VISA); Vancomycin- resistant Enterococci (VRE) Infection; Vancomycin-resistant Staphylococcus aureus (VRSA); Ventilator-associated Event (VAE)
Injuries, NEC	7	Animal Bite Injury; Drowning and Submersion; Drug Overdose and Poisoning, Non-opioid; Firearm-related injury; Head Injury; Motor Vehicle Injury; Suicide
Neurological Diseases	7	Acute Flaccid Myelitis (AFM); Creutzfeldt-Jakob Disease (CJD) and Variant Creutzfeldt-Jakob Disease (vCJD); Encephalitis; Guillain-Barré Syndrome; Meningitis; Parkinson's disease; Prion Disease (Human)
Parasitic Diseases	3	Echinococcosis; Scabies; Strongyloidiasis
Respiratory Conditions (infectious)	16	Blastomycosis; Coccidioidomycosis; COVID-19; Cryptococcosis; Hansen's disease; Histoplasmosis; Influenza-like Illness (ILI); Legionellosis; Middle East Respiratory Syndrome (MERS); Nontuberculous Mycobacteria Infection, Pulmonary; Psittacosis; Respiratory Syncytial Virus (RSV); Respiratory Syncytial Virus (RSV)-Associated Mortality; Severe Acute Respiratory Syndrome (SARS); Tuberculosis; Tuberculosis, Latent Infection (LTBI)
Respiratory Conditions (non-infectious)	7	Asbestosis; Byssinosis; Chemical Pneumonitis; Coal Workers' Pneumoconiosis (CWP); Farmer's Lung; Silicosis or pneumoconiosis due to dust containing silica; Work-related Asthma (WRA)
Sexually Transmitted Diseases	13	Chancroid; Chlamydia trachomatis infection; Genital Warts; Gonorrhea; Granuloma Inguinale (Donovanosis); Herpes, Genital; Herpes, Neonatal; HIV Infection or AIDS; Nongonococcal Urethritis; Ophthalmia Neonatorum; Pelvic Inflammatory Disease; Syphilis; Syphilis, Congenital
Streptococcal Diseases	3	Rheumatic Fever; Streptococcal disease, invasive, Group A; Streptococcal disease, invasive, Group B
Systemic Conditions	6	Invasive Cronobacter Infection Among Infants; Kawasaki Disease; Methemoglobinemia; Multisystem Inflammatory Syndrome in Adults (MIS-A); Multisystem Inflammatory Syndrome in Children (MIS-C); Reye's Syndrome
Toxic Effect of Non-Medicinal Substances	16	Agricultural Chemicals (Fertilizer) Poisoning; Arsenic Exposure and Toxicity; Botulism; Botulism, Infant; Cadmium Exposure and Toxicity; Carbon Monoxide Poisoning; Cyanobacteria And Cyanotoxin Poisoning; Lead in Blood; Mercury Exposure and Toxicity; Non-Streptococcal Toxic Shock Syndrome; Opioid Overdose and Poisoning; Pesticide Related Illness or injury; Ricin Poisoning; Seafood Poisoning; Staphylococcal Enterotoxin B Poisoning; Streptococcal Toxic Shock Syndrome
Vaccine Preventable Diseases	19	Congenital Rubella Syndrome (CRS); Diphtheria; Influenza; Influenza-Associated Hospitalizations; Influenza-Associated Mortality; Influenza-associated pediatric mortality; Invasive Haemophilus Influenzae Disease; Invasive Pneumococcal Disease; Measles; Meningococcal disease; Mumps; Novel Influenza A Virus Infection; Orthopoxvirus Disease; Pertussis; Poliovirus Infection; Rubella; Smallpox; Tetanus; Varicella
Vectorborne Diseases	35	Alpha-gal Syndrome; Anaplasmosis; Arboviral Disease [Other]; Babesiosis; Bartonellosis; California Serogroup Virus Disease; Chagas Disease; Chikungunya virus disease; Colorado tick fever; Dengue Virus Infection; Eastern equine encephalitis virus disease; Ehrlichiosis ; Jamestown Canyon virus disease; Japanese encephalitis virus disease; Keystone virus disease; La Crosse virus disease; Leishmaniasis; Louse-borne relapsing fever (LBRF); Lyme disease; Lymphatic Filariasis; Malaria; Oropouche Virus Disease; Powassan virus disease; Snowshoe hare virus disease; Spotted Fever Rickettsiosis; St. Louis Encephalitis Virus Infection; Tick Paralysis; Tickborne relapsing fever (TBRF); Trivittatus virus disease; Tularemia; Typhus Fever; West Nile Virus Infection; Western equine encephalitis virus disease; Yellow fever; Zika Virus Disease
Waterborne (not enteric)	5	Acanthamoeba; Balamuthia mandrillaris Disease; Melioidosis; Naegleria fowleri Primary Amebic Meningoencephalitis; Nontuberculous Mycobacteria Infection, Extrapulmonary
Zoonotic Diseases	20	Angiostrongyliasis; Anthrax; Baylisascariasis; Brucellosis; Cysticercosis; Diphyllobothriasis; Glanders; Hantavirus Infection; Leptospirosis; Lymphocytic Choriomeningitis; Mpox; Nipah Virus Infection; Plague; Q fever; Rabies (Human); Taeniasis; Toxoplasmosis; Trichinellosis; Vesicular Stomatitis; Viral Hemorrhagic Fever (VHF)



INIT

Eve Everywoman

Patient Identifiers

123453 Meaningless

ABOUT

Date of Birth
11/24/1974
Sex
Female
Race
White
Ethnicity
Not Hispanic or La
Preferred Langu
English

CONTACT

Home (07/20/200
2222 Home Stree
Ann Arbor, MI
99999, US
tel: (Primary Hom
tel: (Work Place)
{$code='email'?}:

PARENT/GUARD

Martha Mum

CONTACT

Home
4444 Home Street
Ann Arbor, MI
99999, US
tel: (Primary Home) +1
email: mail@guardian.

AUTHOR

Time:
11/7/2020, 09:44
Acme EHR
OID: 2.16.840.1.113883.3.72.5.20

CONTACT

1002 Healthcare Drive
Ann Arbor, MI
99999, US
tel:

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PLAN OF TR

Initial Case Report Trigg
Code Lab Te
Order

Zika virus envelope (E) [Presence] in Serum by Probe and target amplifi method

ENCOUNTER

Encounter

Office outpatient

Encount

Diagnosi

HISTORY OF PI

Persistent Cough
Whooping Respira
Paroxysms Of Co
Post-tussive vomi

MEDICATIONS

Medication

Azithromycin 50

PROBLEMS

Concern

Problem

Prob

Symp

Comp

Concern

Problem

CHIEF COMP

Chief Complai

REASON FO

Reason for Vis

RESULTS

Results Pan

CBC W Auto Blood

Results Panel **Specimen ID** **Date(s)**

Test

Hematocrit

Lymphocytes [#/volume] in Blood by Automated count

Results Panel

Bordetella pertussis [Units/volume] in Se

Initial Case Report Trigger Code Result Observation

Bordetella pertussis Ab [Units/volum in Serum

Results Panel

Bordetella pertussis in Throat by Organis

Results Panel

Initial Case Report Trigger Code Result Observation

Bordetella pertussis [Presence] in Throat by Organism specific culture

PROCEDURES

Procedure

Colonic polypectomy

IMMUNIZATIONS

Immunization

diphtheria, tetanus toxoi pertussis vaccine, 5 per

Initial Case Report Trigger Code Immunization Medication Activity

influenza virus vaccine, unspecified formulation

Imr Dat

NO

Travel History: Date(s)

1999 to 2007

In the 3 weeks before NOV 9, 2020

APR 25, 2020 to APR 30, 2020

MAY 6, 2020 to MAY 15, 2020

JUL 13, 2020 to JUL 15, 2020

OCT 22, 2020 to OCT 30, 2020

Country of Residence

United Kingdom of Great

Country of Nationality

Australia

PREGNANCY SECTION

Pregnancy Status **Date(s status (if no h was curren record**

Pregnant AUG 2

Pregnancy Status | **Date(s) over which status holds (if no high date, status was current at time of recording)** | **Determination Method** | **Determination Date** | **Recorded Date**

Estimated Date of Delivery | **EDD** | **EDD Determination Date**

Delivery date estimated from ovulation date | MAY 22, 2017 | OCT 1, 2017 10:15

Estimated Gestational Age of Pregnancy | **Days** | **Determination Date**

Gestational age Estimated from selected delivery date | 143 d | OCT 1, 2017 10:15

Reference to selected delivery date

Link to referenced entry

Pregnancy Outcome | **Birth Order** | **Time** | **Method of Delivery**

Stillbirth (finding) | 1 | JAN 5, 2020 08:50 | Breech delivery (procedure)

Term birth of newborn (finding) | 2 | JAN 5, 2020 10:05 | Breech delivery (procedure)

Last menstrual period start date | **Observation Date**

AUG 1, 2017 | JAN 5, 2020 10:15

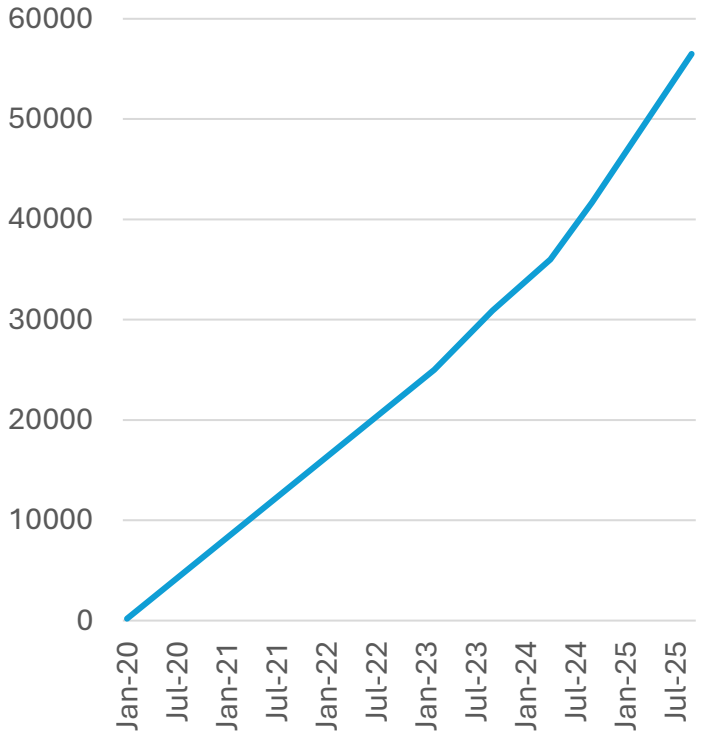
Postpartum Status | **Observation date**

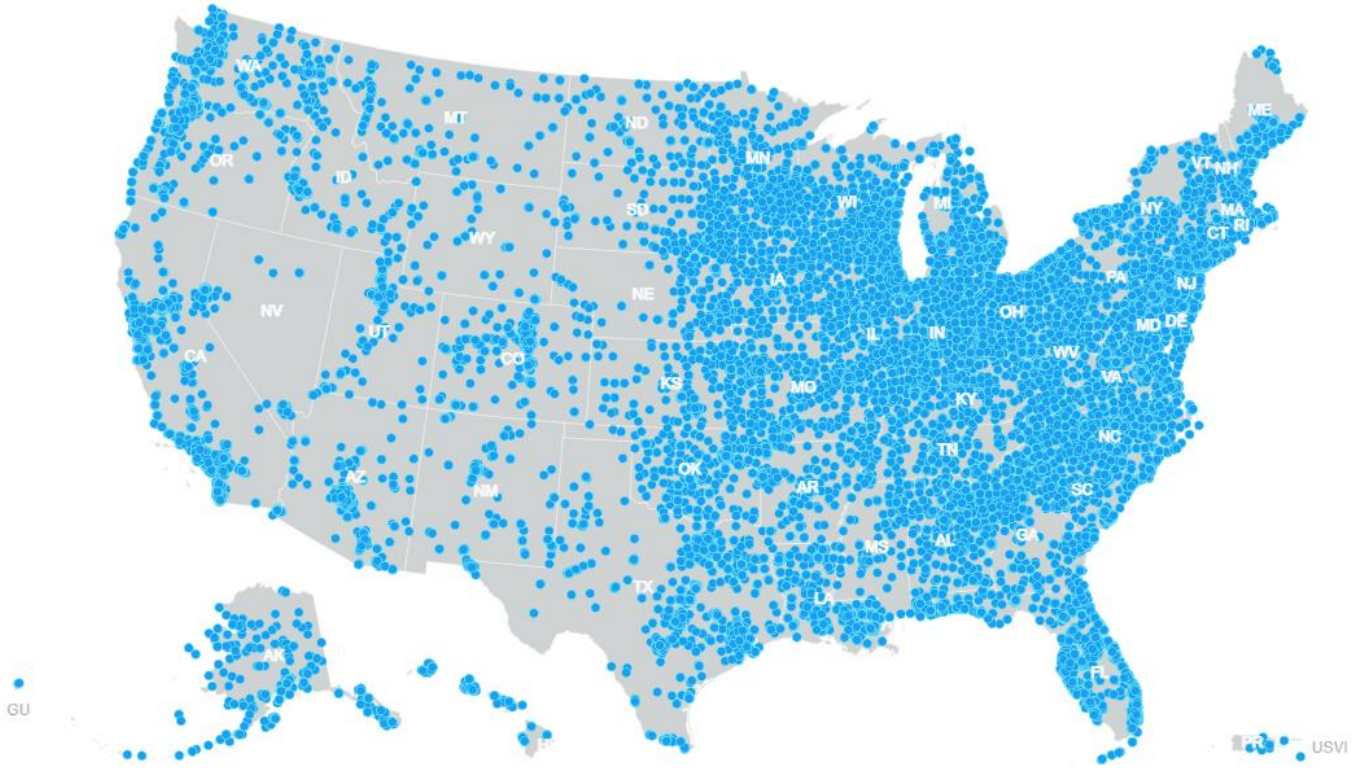
Mid postpartum state (finding) | JAN 5, 2020 10:15

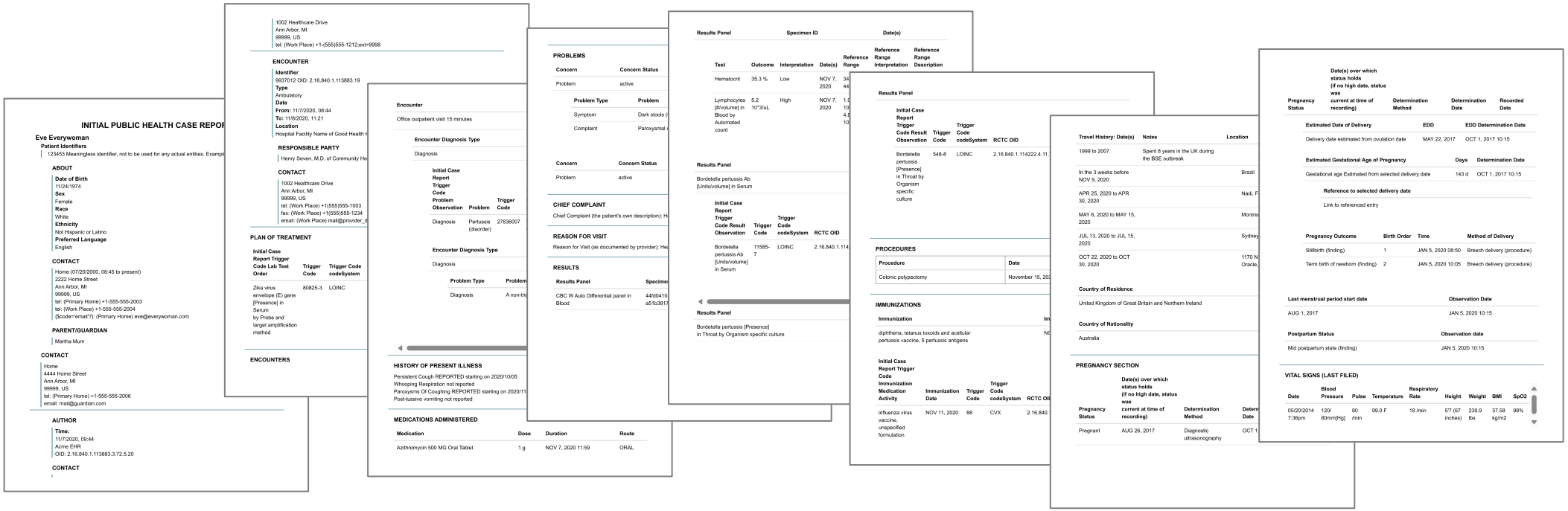
VITAL SIGNS (LAST FILED)

Date	Blood Pressure	Pulse	Temperature	Respiratory Rate	Height	Weight	BMI	SpO2
05/20/2014 7:36pm	120/ 80mm[Hg]	80 /min	99.0 F	18 /min	5'7 (67 inches)	239.9 lbs	37.58 kg/m2	98%

Sep 2025: “56,500 facilities in all 50 states and three territories are actively sending electronic initial case reports to public health”

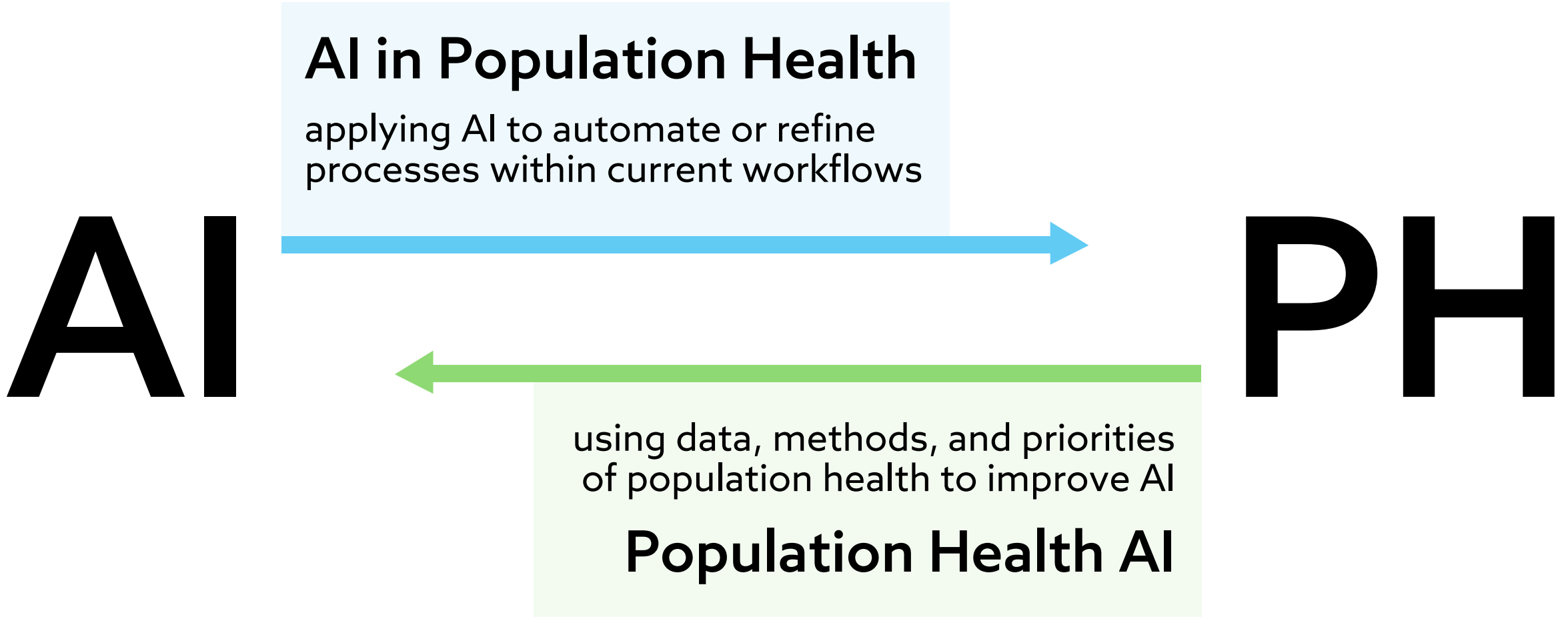


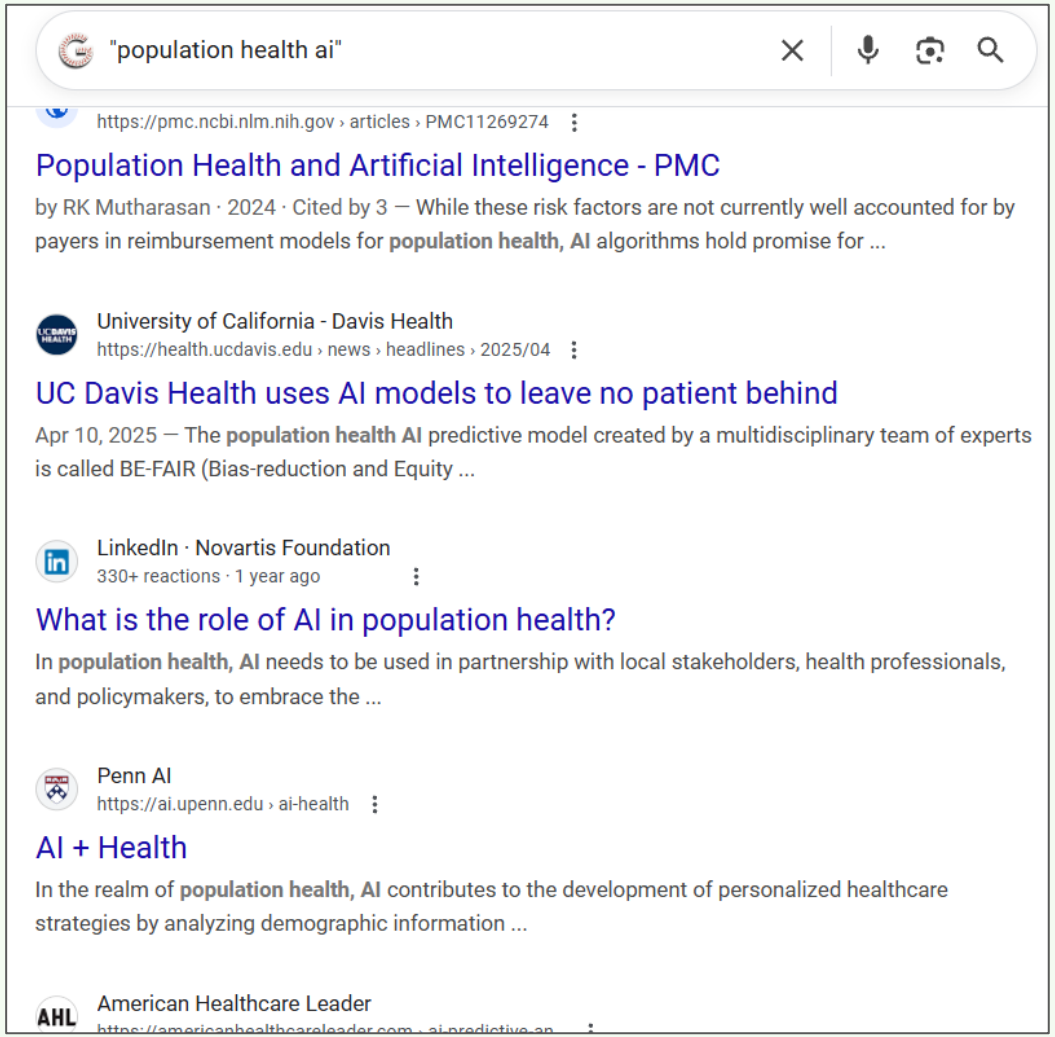




Harmonize, structure, monitor

ECRBench: how well does AI do?


AI in Population Health
applying AI to automate or refine processes within current workflows
AI
PH
using data, methods, and priorities of population health to improve AI
Population Health AI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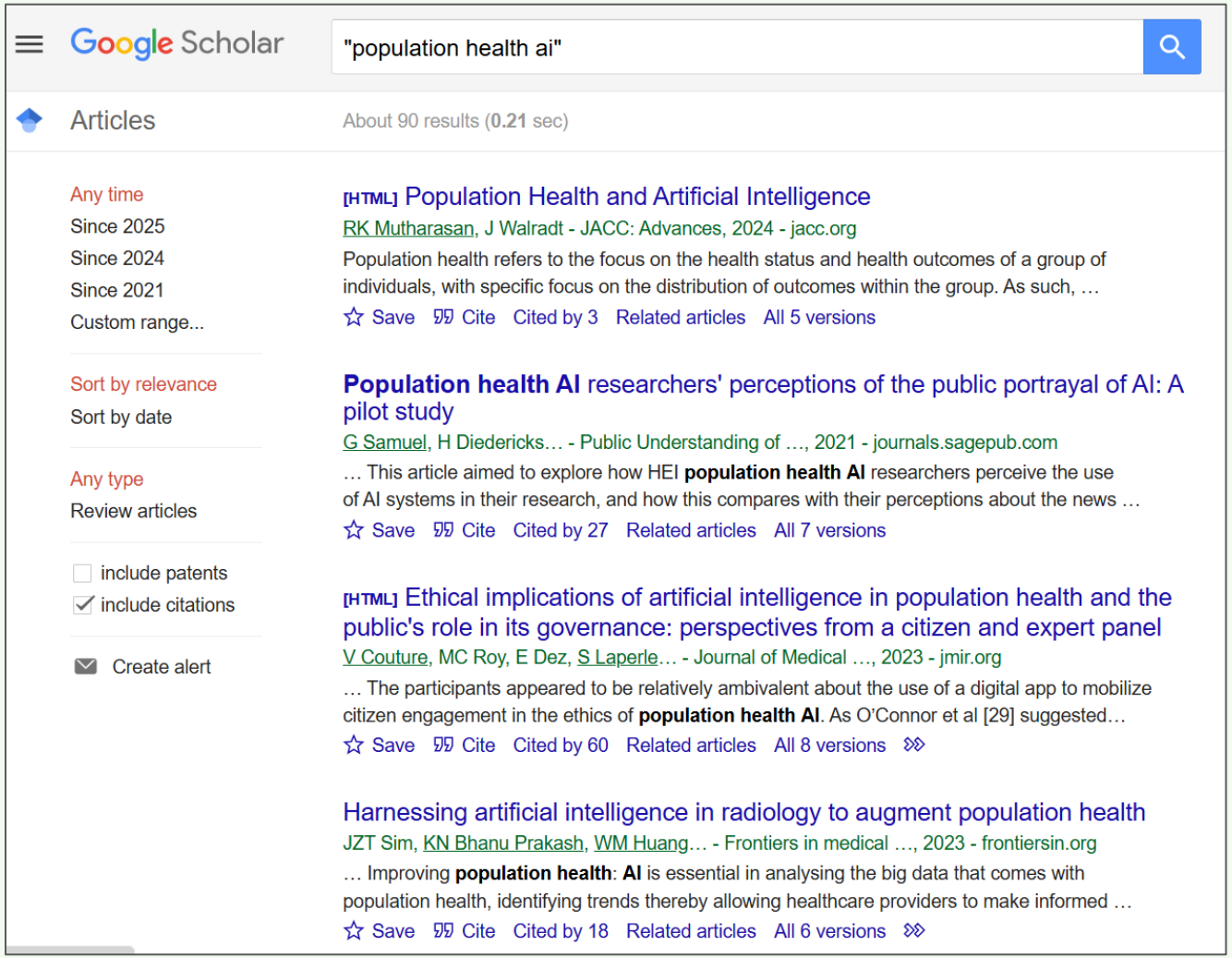
Population Health and Artificial Intelligence - PMC
by RK Mutharasan · 2024 · Cited by 3 — While these risk factors are not currently well accounted for by payers in reimbursement models for population health, AI algorithms hold promise for ...
University of California - Davis Health
https://health.ucdavis.edu › news › headlines › 2025/04
UC Davis Health uses AI models to leave no patient behind
Apr 10, 2025 — The population health AI predictive model created by a multidisciplinary team of experts is called BE-FAIR (Bias-reduction and Equity ...
LinkedIn · Novartis Foundation
330+ reactions · 1 year ago
What is the role of AI in population health?
In population health, AI needs to be used in partnership with local stakeholders, health professionals, and policymakers, to embrace the ...
Penn AI
https://ai.upenn.edu › ai-health
AI + Health
In the realm of population health, AI contributes to the development of personalized healthcare strategies by analyzing demographic information ...
American Healthcare Leader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[HTML] Population Health and Artificial Intelligence
RK Mutharasan, J Walradt - JACC: Advances, 2024 - jacc.org
Population health refers to the focus on the health status and health outcomes of a group of individuals, with specific focus on the distribution of outcomes within the group. As such, …
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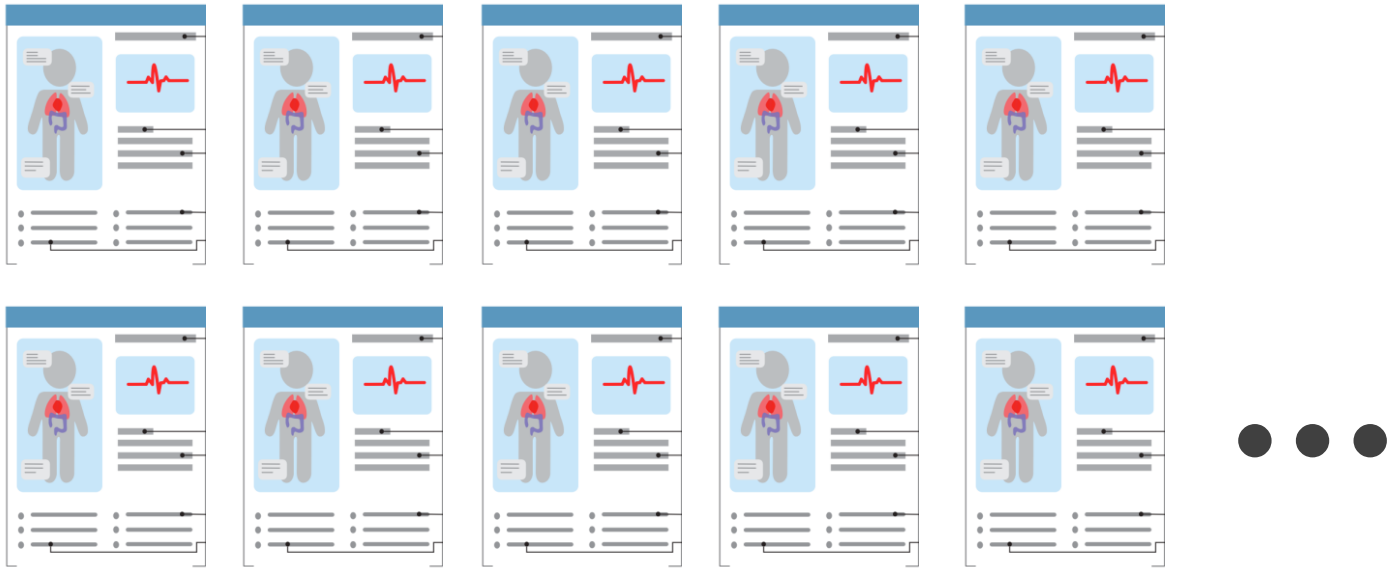
“Use data, methods, and priorities of population health to improve AI”

Why?

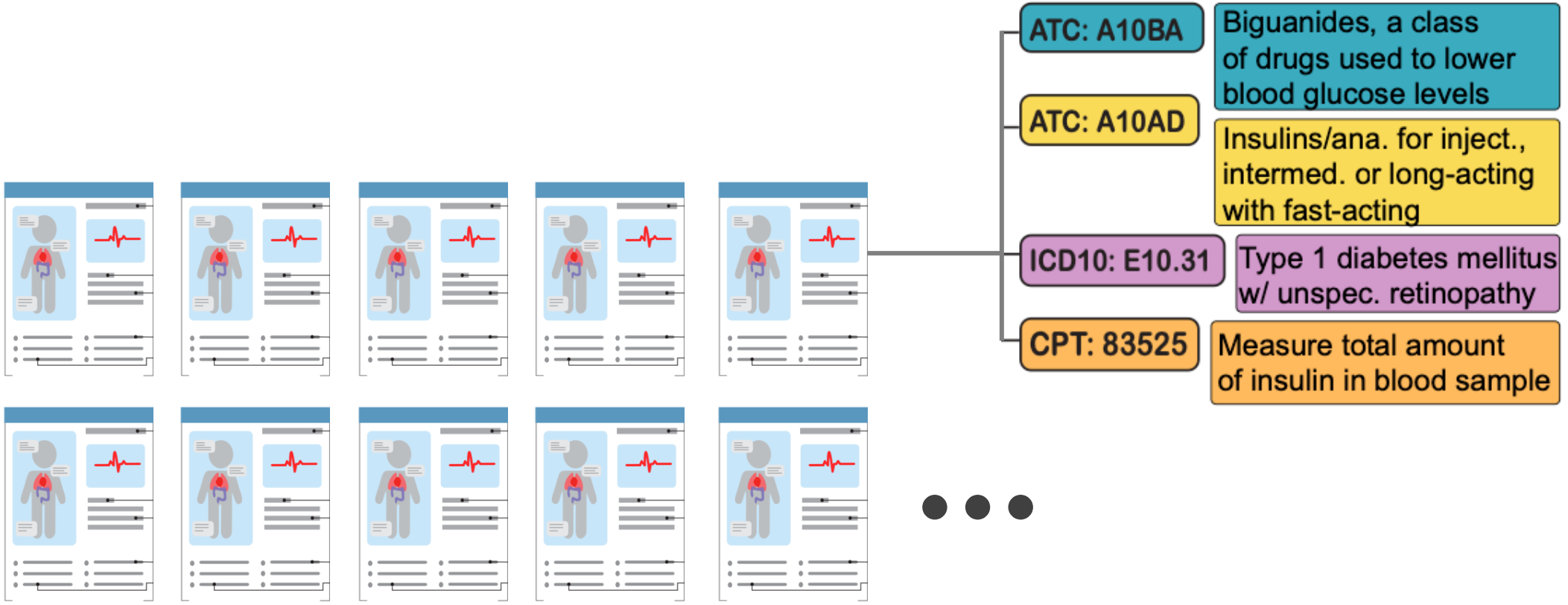
Answering Population-Scale Health AI Questions

Population Health answers questions about groups of people.

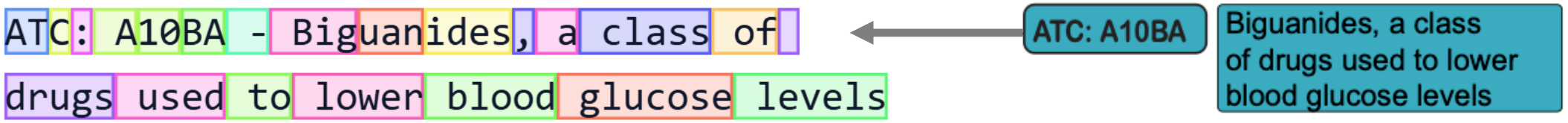
- “Between these two cohorts, were there systematic deviations in quality of care?”
- “Given a treatment and control group, did the protocol work? (Adjust for confounders).”
- “Among these emergency department patients, select the 5 most emergent.”



Population Health answers questions about groups of *n > 20* longitudinal patient records (time series of medical codes).



Population Health answers questions about groups of *n > 20* longitud**LLMs currently can't do this.**inal patient records (time series of medical codes).



~**20** tokens/code x ~**6000** codes/outpatient = **120K** tokens/outpatient

Maximum input tokens to GPT-5 = **272K** tokens

Can we skip text and directly, efficiently convey codes to LLMs?

"Use data, methods, and priorities of population health to improve AI"

Why?

Faithfully answer PH questions with domain-specific engineering

Unifying AI and Evidence-Based Medicine

Carnegie Mellon

Model	Med-Gemini-* [Yang et al., 2024]	Med-Gemini-{L,M} [Saab et al., 2024]	AMIE [Tu et al., 2025]	Med-PaLM 2 [Singhal et al., 2025]	Med-PaLM [Singhal et al., 2023]	OpenBioLLM [Pal and Sankarasubbu, 2024]	Me-LLaMA [Xie et al., 2024]	MEDITRON [Chen et al., 2023]	Med42-v2 [Christophe et al., 2024]	TxAgent [Gao et al., 2025]	LLaVA-Med [Li et al., 2023]	BioMistral [Labrak et al., 2024]
Size	100B+ MoE	100B+ MoE	300B+	300B+	540B	70B	70B	70B	70B	8B	7B	7B
Web Crawl	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
QA Training Splits	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Publications	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Clinical Trials	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Guidelines	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Patient Data	✓	✓	✓			✓	✓			✓	✓	
Treatment Outcomes	*											

* Yang et al. [2024] use genomic and outcome data, but not treatment data, from the UK BioBank.

Longitudinal, observational data are the foundation of PH.

They are nonexistent in current medical LLMs.

An 87-year-old female with a documented medical history of atrial fibrillation, chronic heart failure with preserved ejection fraction (HFpEF), hypertension, hypokalemia, vitamin D deficiency, and glaucoma is taking the following medications:
Aspirin 81 mg, once daily
Diltiazem 240 mg extended-release, once daily
Furosemide 40 mg, once daily
Metoprolol tartrate 50 mg, twice daily
Potassium chloride 20 mEq, once daily
The patient is experiencing moderate pedal edema and has an unstable gait. Medication non-adherence is an ongoing issue. Additionally, a recent echocardiogram indicates that the patient's Left Ventricular Ejection Fraction (LVEF) has worsened to less than 40%. What are the next steps of treatment?

- Diltiazem: consider sacubitril-valsartan for further optimization of GDMT.
- Furosemide: increase dose to address volume overload and pedal edema.
- Metoprolol tartrate: consider succinate for hypertension management - no consideration for pill burden.
- *Added*: SGLT2 inhibitors and spironolactone. No consideration for pill burden.

Optimizing Medications in Patients with Cardiovascular Disease: A Case Report on Unrecognized Prescribing Cascades in Older Adults

Ha M; Meyer K; Matos A; Turgeon J; * Chandni Bardolia;

Author Information

Sep 03, 2021 | Volume: 2 | Issue: 3 | Views: 3468 | Downloads: 2325 |

Abstract

Objective: Older adults with cardiovascular diseases are especially prone to polypharmacy due to comorbidities and consequent complexity of medication regimens. Prescribing cascades can occur when a side effect is misinterpreted as a new medical conditi ce, it can be difficult to initiate without s case demonstrates how a healthcare t with chronic heart failure.

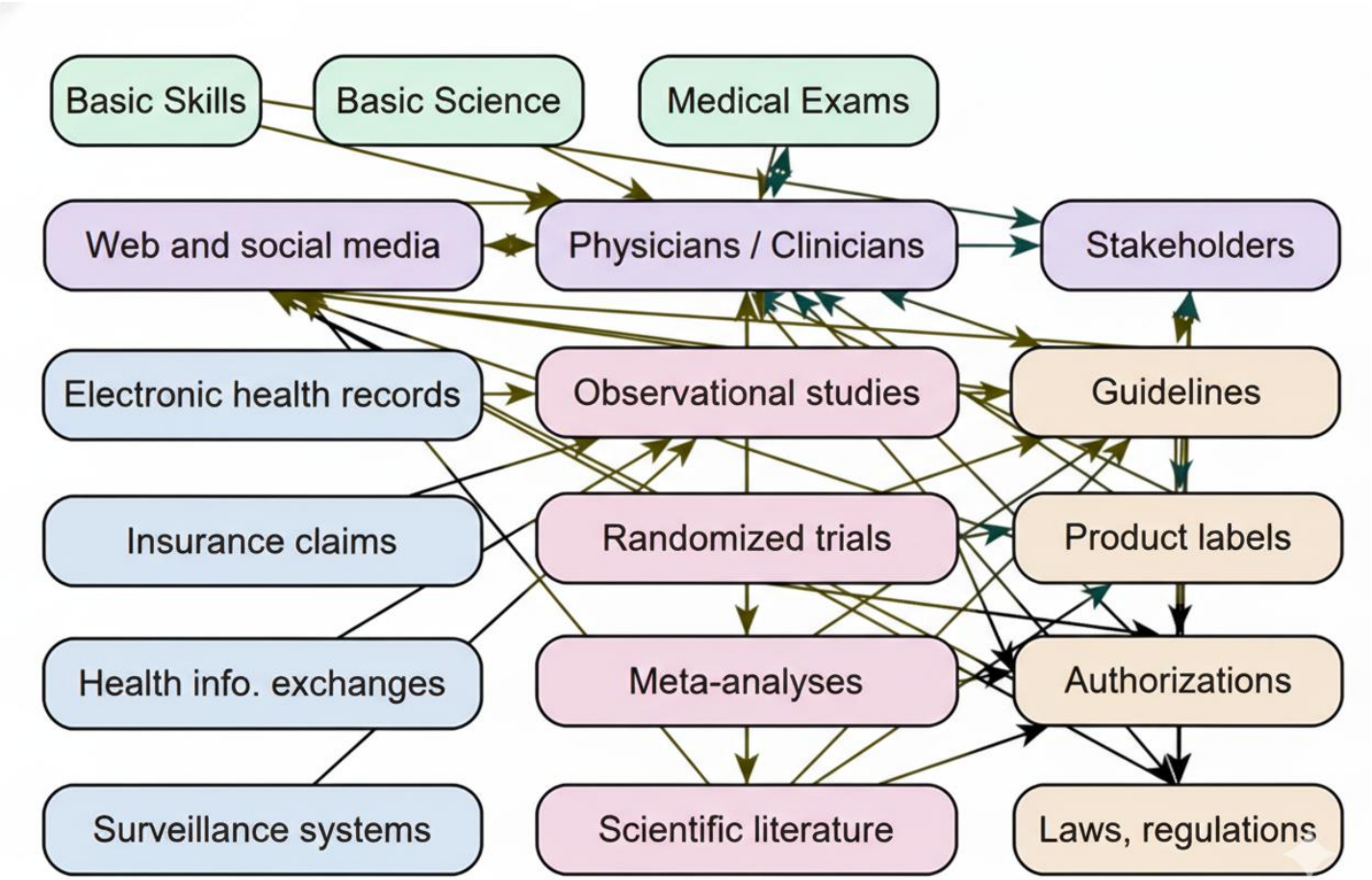
Case Presentation: A de effects related to polypharmacy. Her deemed no longer appropriate due to t ide, resulting in the need for potassium recognized as well, including reducing The patient's new healthcare team, in cribing cascade and create a personalize oms.

Conclusion: Resolvir hcare professionals are often involved. Deprescribing should be a top priority in medication safety, particularly for older adults with cardiovascular disease. Polypharmacy interventions are necessary to encourage safe use and improve patients' overall wellbeing.

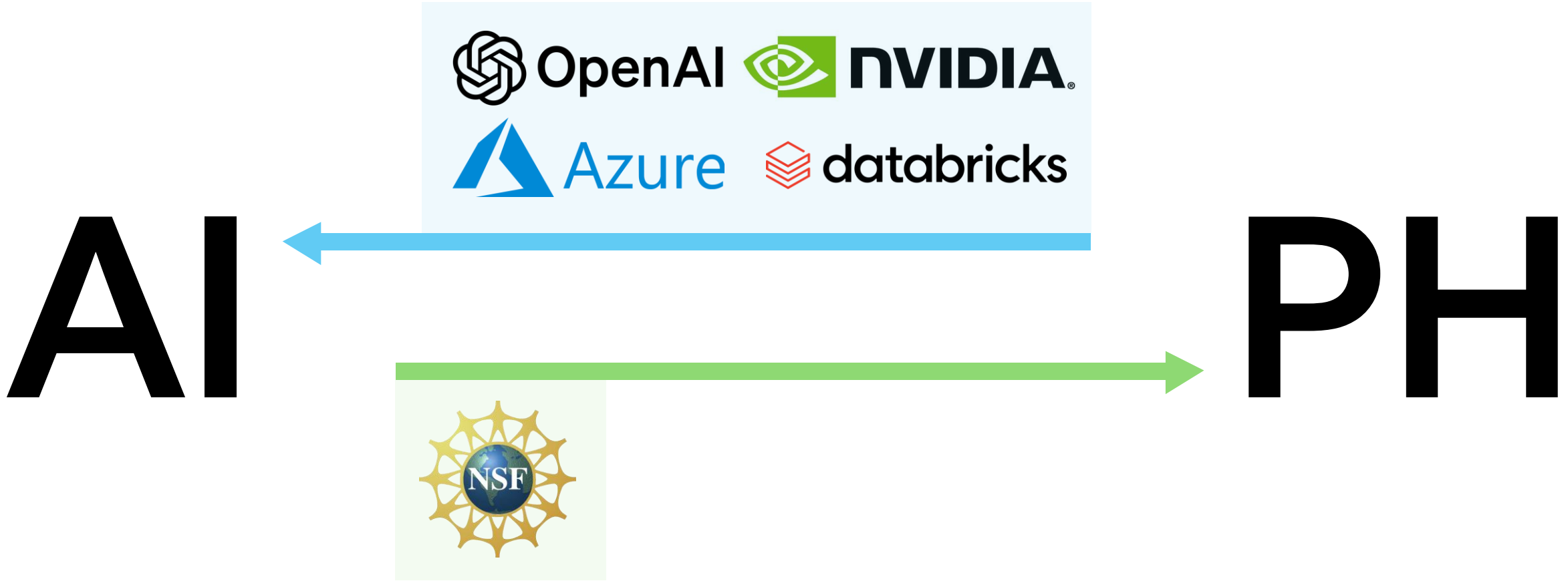
- Diltiazem: discontinued. Replaced by losartam due to HFrEF, edema.
- Furosemide: reduce dose because of diltiazem → edema cascade.
- Metoprolol tartrate: switch to succinate to reduce pill burden (once daily) and maintain outcome.

1. **Sodium-glucose cotransporter-2 inhibitors (SGLT2i).** Initiate

Where is ground truth?



If human-written text is ground truth, can AI go beyond it?


OpenAI
NVIDIA
Azure
databricks
AI
PH
NSF

"Use data, methods, and priorities of population health to improve AI"

Why?

Faithfully answer PH questions with domain-specific engineering

Build medical superintelligence with observational data

Targeting subgroup interventions with AI

Internal Business User

"Help me find a subgroup of members who would benefit from this intervention"

Language Model with Reasoning, Tool Calling

CAB

Call into software stack, obtain analyses

Call LLM to automate internal processes

Analytics Software

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Internal, read-only database queries

Insurance Claims Database

Internal Business User

"Help me find a subgroup of members who would benefit from this intervention"

Language Model with Reasoning, Tool Calling

CAB

Population Health AI

AI in Population Health

Analytics Software

TIDE

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Internal, read-only database queries

Insurance Claims Database

"Use data, methods, and priorities of population health to improve AI"

Why?

Faithfully answer PH questions with domain-specific engineering

Build medical superintelligence with observational data

Expose analytics software to more use cases

"Use data, methods, and priorities of population health to improve AI"

How? Where?

CAB

CENTER FOR AI AND BIOMEDICAL INFORMATICS

Reading Group

1st Monday, every month