Advancing the Use of Artificial Intelligence & Machine Learning in Primary Care:
Roles & Opportunities for DFMs

Andrew Bazemore MD MPH
Bob Phillips MD MSPH

THE CENTER FOR PROFESSIONALISM & VALUE IN HEALTH CARE

American Board of Family Medicine Inc.

The Opportunity

PRIMARY CARE is

"the provision of integrated, accessible health care services by clinicians who are accountable for addressing a large majority of personal health care needs, developing a sustained partnership with patients, and practicing in the context of family and community"

– Burnout

*Martin S, Phillips RL, Petterson S, Levin Z, Bazemore AW. Primary Care Spending in the United States, 2002-2016. *JAMA Intern Med.* 2020;180(7):1019–1020.

The Opportunity

AI/ML has

- Revolutionized industries, including medicine, but has yet to transform primary care.
  - Review of primary care & AI/ML concluded…the field remains in "early stages of maturity," despite a 35 yr history*
  - Only 1 out of every 7 of these papers includes a primary care author; therefore, one barrier to greater impact is engagement from the primary care community.
- Infrequently involved PC end-users and researchers in development to date
- Scarcely tapped the wealth of data & technology available from PC practices

*Kueper J, Terry AL, Zwarenstein M, Lizotte DJ. Artificial Intelligence and Primary Care Research: A Scoping Review. *Ann Fam Med*.

The Opportunity

The **Quintuple Aim*** for U.S. Healthcare includes

- Better Health
- Better Patient Experience
- Lower Costs
- Improved Clinician Wellbeing
- Equity in Outcomes

*https://www.ahrq.gov/ncepcr/tools/workforce-financing/white-paper.html

Pathways connecting PC, AI/ML, & the Quintuple Aim?

THE CENTER FOR PROFESSIONALISM & VALUE IN HEALTH CARE

We aim to align how the professions are valued with the values of the professions

NASEM Report | About | Products & Activities | Measures That Matter | Work With Us | Laboratory | News & Events

SETTING A RESEARCH AGENDA FOR THE USE OF ARTIFICIAL INTELLIGENCE & MACHINE LEARNING IN PRIMARY CARE

Virtual Summit: March 18-19, 2021

FOR QUESTIONS CONTACT: Andrew Bazemore, & Mikel Severson at 1-202-600-9447

https://professionalismandvalue.org/setting-a-research-agenda-for-the-use-of-artificial-intelligence-machine-learning-in-primary-care/

I — **Infrastructure upgrade**
- Construct multidisciplinary longitudinal research data platform
- Facilitate collaboration in data generation within and outside of health sector

D — **Delivery transformation**
- Move beyond develop AI ON primary care to FOR primary care
- Diagnostics and risk prediction
- Holistic patient-centered disease management
- Medication and treatment plan optimization

E — **Evaluation modernization**
- Health risk adjustment
- SDOH risk adjustment
- Heterogeneity of SDOH risk

A — **Algorithm marketing authorization and reimbursement**
- Trust building with PCP and patients
- Understand clinicians need in workflow
- Data update and algorithm improvement

S — **Social justice**
- Develop AI/ML application to mitigate health equity in primary care
- Collaborative for ethical algorithm development
- Social epidemiology research for marginalized populations

Efficiency
Effectiveness
Equity

Better Health
Better Experience
Lower Cost
Better Provider Wellness
Equity

Ongoing ABFM Investment in Advancement of AI/ML in Depts of Family Medicine

- Primary Care Specific Data Laboratories
  - PRIME Registry, Supporting National Labs(AHRQ)
- Convenings
- Presentations in AI/ML Communities
- Human Capital Investment

Family Medicine Artificial Intelligence and Machine Learning Faculty Support

2022 Grant Awards Announcement

American Board of Family Medicine Inc.

Why?

Enhance the capacity for AI/ML methods in Family Medicine to study primary care research questions using real-world, primary care data.

Expected Outcomes

Per Department/Division

- One AI/ML researcher embedded for at least five years
- Two proposals for externally funded research
- Three peer-reviewed publications

University of Houston

PI: Winston Liaw, MD, MPH

Project Title: Primary Care Forecast: Using Social Risk Factors and Actionable, Explainable Artificial Intelligence/Machine Learning to Prevent the Progression of Diabetes Complications

Co-Investigators: Ioannis A. Kakadiaris, PhD; LeChauncy Woodard, MD, MPH; Omolola Adepoju, PhD, MPH

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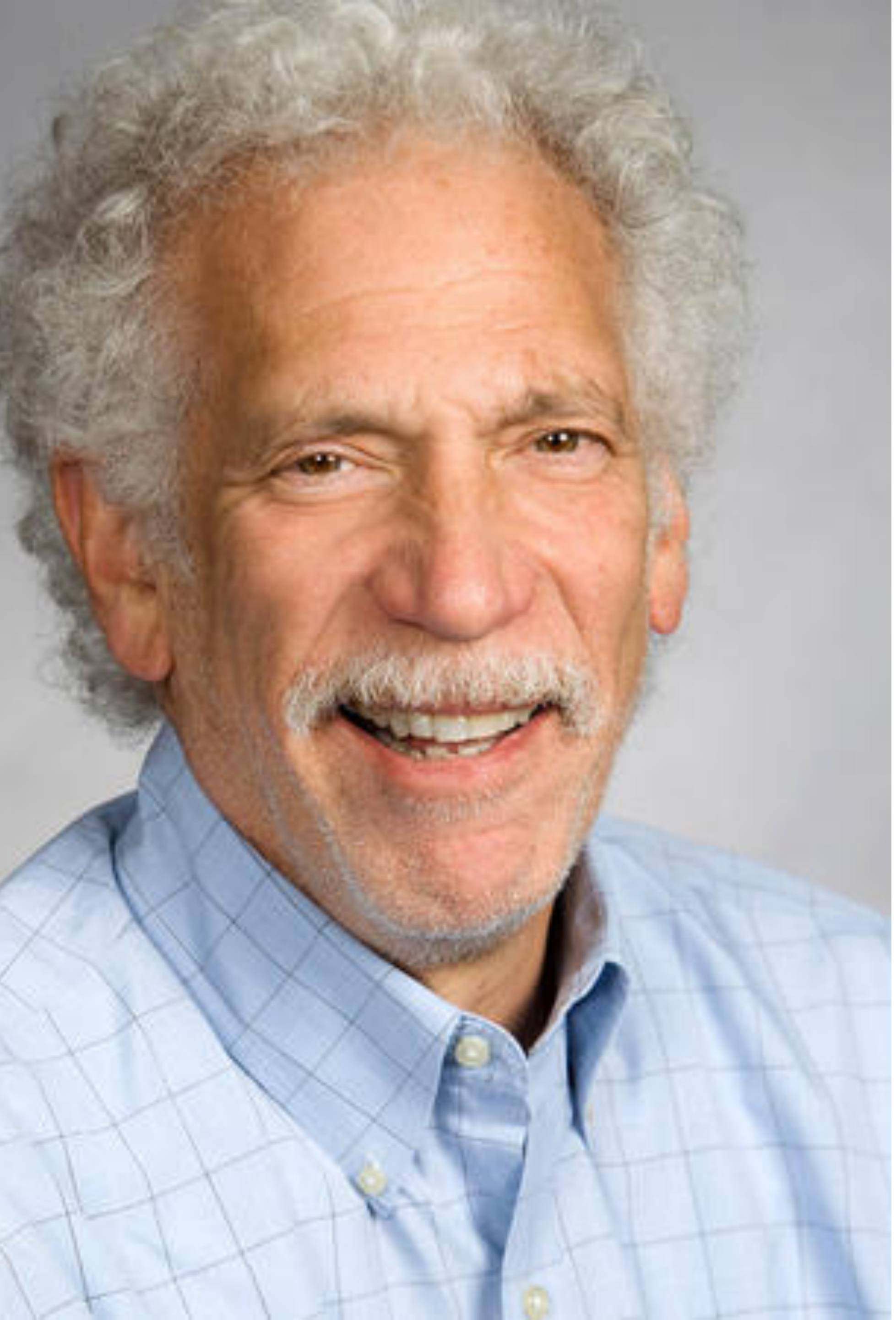
University of Pittsburgh

PI: John S Maier, PhD, MD

Project Title: Growing Primary Care Informatics using AI/ML to Understand Patients Not Just Diseases

Co-Investigators: Tracey Conti, MD; Shyam Visweswaran, MD, PhD; José Abad, MD



University of California, San Diego

PI: Gene Kallenberg, MD

Project Title: Building AI/ML Capacity in the UCSD Department of Family Medicine

Co-Investigators: Ming Tai-Seale, PhD, MPH; Lucila Ohno-Machado, MD, PhD, MBA; Christopher Longhurst, MD

AI/ML Fellow: Ammar Mandvi, MD

University of Texas, San Antonio

PI: Carlos Roberto Jaén, MD, PhD

Project Title: Harnessing Complexity: Applying AI/ML to discover solutions of multi-morbidity in Primary Care

Co-Investigators: Meredith Nahm Zozus, PhD; Zhu Wang, PhD; Robert L. Ferrer, MD, MPH; David A. Katerndahl, MD, MA

AI/ML Fellows: Shorabuddin Syed, PhD; Yun Shi, MD, PhD

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MAYO
CLINIC

WAKING THE SLEEPING GIANT

ENGAGING FAMILY MEDICINE IN DIGITAL/ AI TRANSFORMATION

David Rushlow, MD
Chair, Family Medicine
Mayo Clinic
Rochester, Minnesota, USA

Presentation Overview

- The Power of AI to Transform Primary Care
- Challenges and Opportunities for AI in Family Medicine
- Overview of Mayo Clinic Midwest Dept. of Family Medicine
- Our Experience using AI and Pragmatic Trials to Transform Practice
- Example of the EAGLE study as a prototype project
- Healthcare Delivery Innovation Laboratory (iLab)

Power of AI to Transform Primary Care

Most comprehensive care delivery platform in US*

Enormous clinical data repository largely unused.

Not limited by disease, age, geography, race, ethnicity, social determinants of health, etc.

Focus on wellness, disease prevention and chronic disease management leading to greater downstream impact on over health

*Petterson, et al. *Washington: Robert Graham Center* (2018).

Power of AI to transform Primary Care

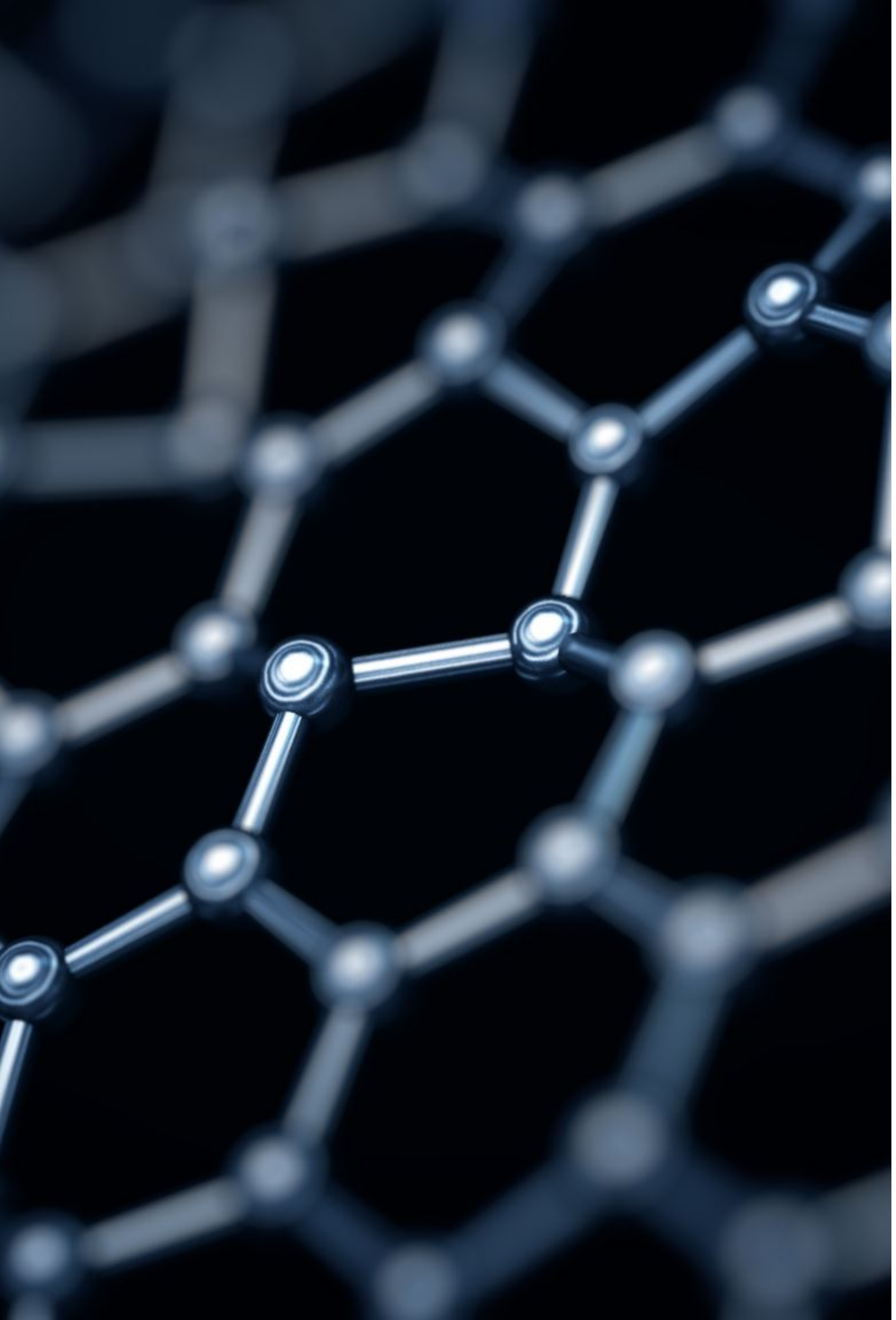
- Primary care providers are burning out at record pace*
- Breadth of knowledge base provides excellent opportunity for decision support
- Evidenced-based decision support provides opportunity to reduce cost through lower hospitalizations and diagnostic testing.
- Must be well aligned with front line workflow to reduce disruption and alert fatigue.

*Goldberg et al, JBFM 5/2020

Strategic Challenges for Mayo Clinic Family Medicine

- Not meeting expectations of the Quadruple Aim
- Information overload!!
- Gap between innovation and front-line practice too long – 17 years*
- Significant disparities in health equity
- Disruptors are active and moving fast

*Morris ZS, Wooding S, *J R Soc Med*.



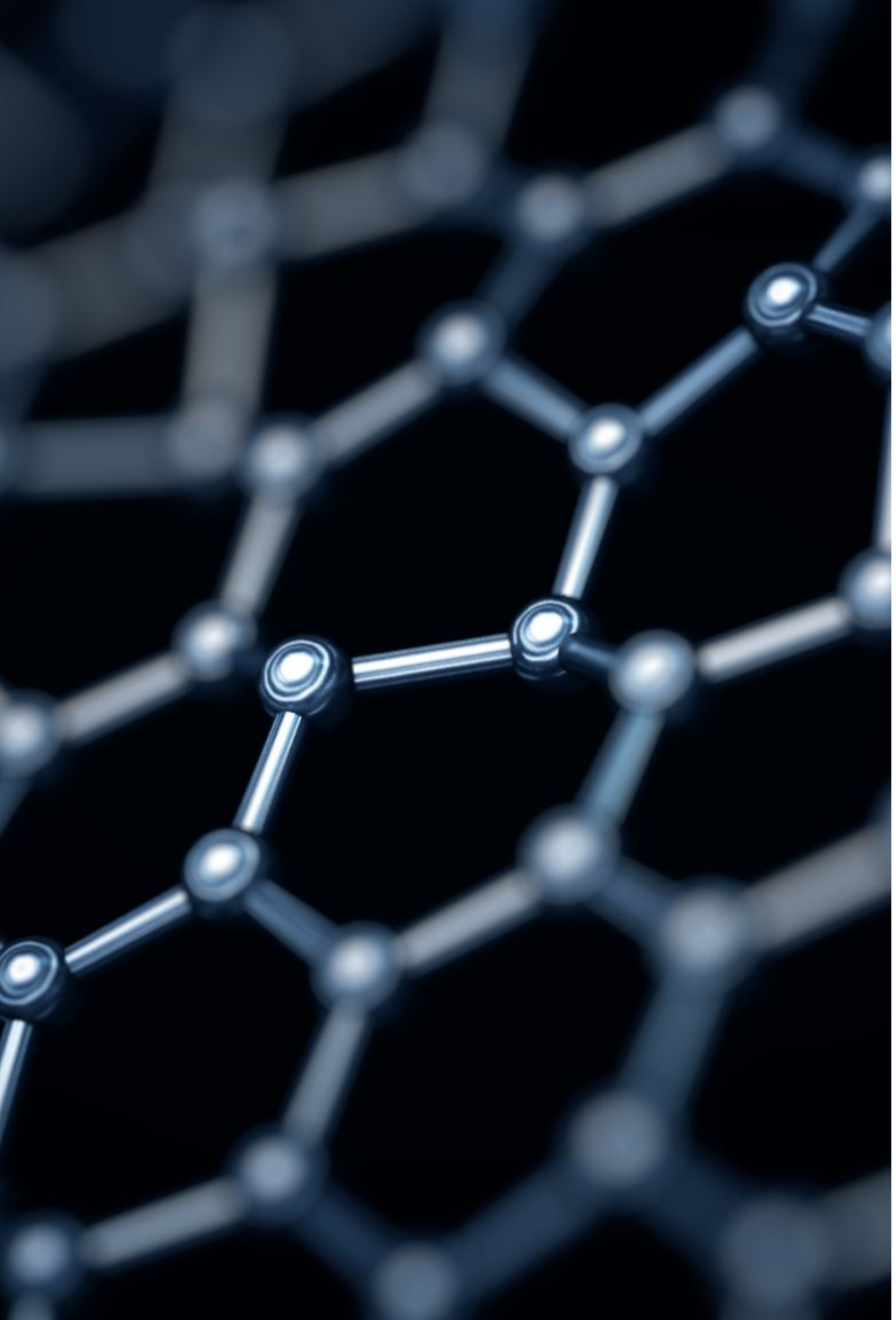
AI Opportunities for Mayo Clinic Family Medicine

Leverage the value of a large integrated Family Medicine Department

- Leadership Infrastructure.
- Single EHR database.
- 400K patients
- 550 engaged provider pragmatists!

Leverage Mayo Clinic’s Digital/AI Expertise

- Center for Digital Health
- Clinical and Pragmatic Trials Research Infrastructure
- Implementation Science
- Embedded expertise within specialty departments



Opportunities for Alignment cont.

Aligned Strategic Priorities

- Mayo Clinic Enterprise 2030 vision
- Department of Family Medicine
- Research shield
- Specialty departments

Proven Success

- EAGLE Study

Mayo Clinic Midwest Dept. of Family Medicine:

Mayo Midwest Family Medicine

Who are We?

	Rochester	NWWI	SWWI	SEMN	SWMN	Total
Total Sites	5	9	9	10	14	47
MD/DO	61	68	53	46	47	275
NP/PA (APP)	58	45	25	68	57	253
Residents	27	15	25	0	0	60
Total Patient	70,678	92,710	64,265	113,640	73,702	414,995
Care Teams	11	23	27	27	28	116
Average Panel Size	1843	1547	1475	2136	1386	1677 (ave)

Path to AI Collaboration

- Mayo Clinic’s strategy to improve care delivery and rapid diagnosis through Artificial Intelligence (AI)
- AI is most mature in the Cardiology and Radiology departments
- FM lacks personnel and resources to develop AI independently
- Approached by Cardiology to test ECG algorithm for detection of heart failure (low ejection fraction)
- Bringing cutting-edge Mayo innovation to the primary care level

Benefits of Collaboration

- Engaging clinicians in research
- Interdepartmental collaboration
- FM contributes to Mayo Clinic's strategic mission

The EAGLE Trial

ECG **AI**-**G**uided Screening for **L**ow **E**jection Fraction (EAGLE) trial

Primary care clinicians were recruited from 120 care teams in 45 clinics or hospitals

Patients with ECG obtained as part of routine care in subjects without a prior diagnosis of heart failure

Primary outcome: new diagnosis of low EF (≤50%) within 90 days of the ECG

Yao X, et al. Nature Med 2021

Study Outcomes

- Diagnosis of low EF

	Intervention	Control	OR (95% CI)	P value
Overall	2.1%	1.6%	1.3 (1.0-1.6)	.007
Positive AI	19.5%	14.5%	1.4 (1.1-1.9)	.01

- AI algorithm based on ECGs can enable the early diagnosis of low EF in patients in the setting of routine primary care

Outcomes

- Successful collaborative pragmatic trial
- 8 of 22 authors in Family Medicine

nature medicine

ARTICLES

https://doi.org/10.1038/s41591-021-01335-4

Check for updates

Artificial intelligence-enabled electrocardiograms for identification of patients with low ejection fraction: a pragmatic, randomized clinical trial

Xiaoxi Yao[1,2] ✉, David R. Rushlow[3], Jonathan W. Inselman[1], Rozalina G. McCoy[1,4], Thomas D. Thacher[3], Emma M. Behnken[5], Matthew E. Bernard[3], Steven L. Rosas[6], Abdulla Akfaly[7], Artika Misra[8], Paul E. Molling[9], Joseph S. Krien[10], Randy M. Foss[11], Barbara A. Barry[1], Konstantinos C. Siontis[2], Suraj Kapa[2], Patricia A. Pellikka[2], Francisco Lopez-Jimenez[2], Zachi I. Attia[2], Nilay D. Shah[1], Paul A. Friedman[2] and Peter A. Noseworthy[2]

Healthcare Delivery Innovation Laboratory (iLab)

- Accelerate the cycle from innovation to everyday practice.
- Projects aimed at improving the Quadruple Aim.
- Leverage our front-line care teams as the laboratory “bench”.

iLab Core Capabilities

Guide the development of pragmatic research designs for real world effectiveness.

Leverage Digital/AI technology

Develop evidence-based implementation plans to support adoption.

Disseminate best practice recommendations through collaboration and publications

iLab Infrastructure

iLab Executive Team

Center for Digital Health.

Robert D. and Patricia E. Kern Center for the Science of Health Care Delivery

Center for Clinical and Translational Sciences (CCaTS)

Specialty Departments (Cardiology, Psychiatry and Psychology, Gastroenterology)

Example Projects

- EAGLE Implementation
- Depression treatment and assessment of remission
- Point of care decision support tools
- Patient identification for specific therapies (atrial fibrillation)
- Early disease identification (fatty liver, osteoporosis, amyloidosis)
- Digital clerical assistant to aid in documentation.

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The Impact of AI/ML in Family Medicine at UAB

Thursday |June 9 | 3:15 PM – 4:15 PM

Irfan Asif, M.D.

Professor and Chair; Department of Family and Community Medicine

Associate Dean for Primary Care and Rural Health

UAB Heersink School of Medicine

Team Physician: UAB Athletics, Birmingham Legion FC, USA Wheelchair Rugby

Outline

Describe **2 ways** that AI/ML will impact Family Medicine at UAB

- Imaging
- Language Processing

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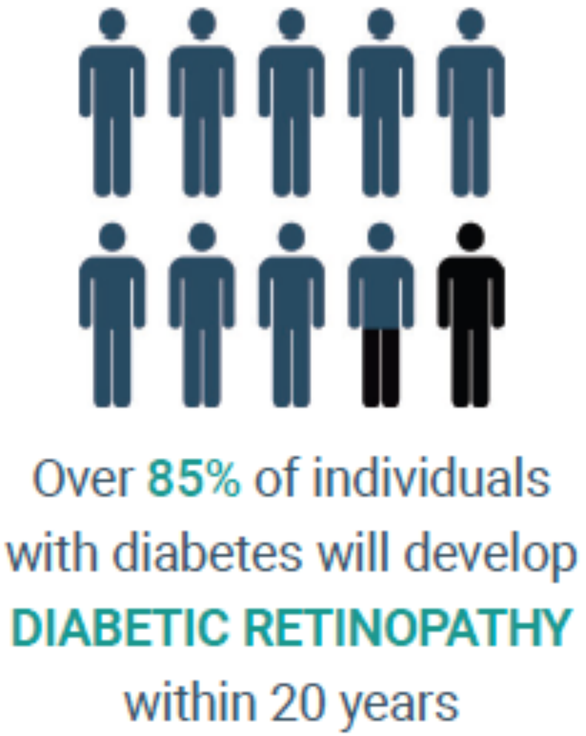
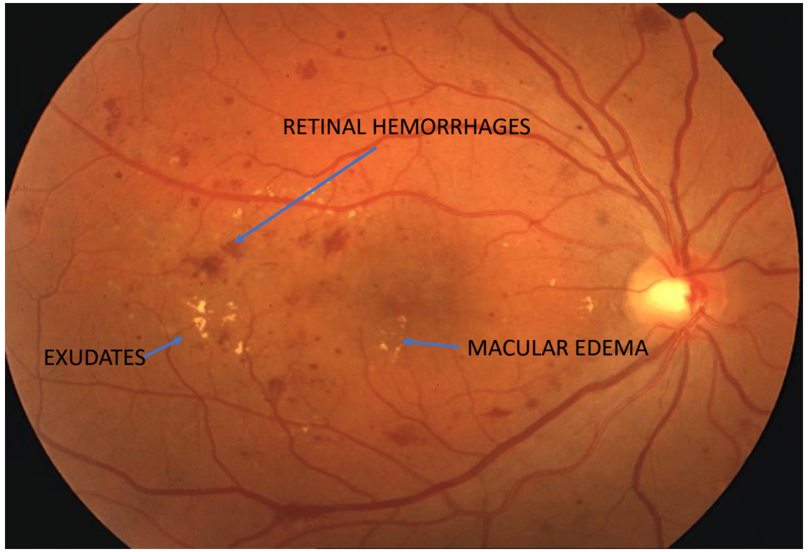
Imaging

Diabetic Retinopathy
#1 cause of blindness in working age adults



Diabetic Retinopathy: Barriers to Detection

- Lack of Access to Specialists
- Social Determinants of Health
  - Lack of insurance
  - Lack of transportation



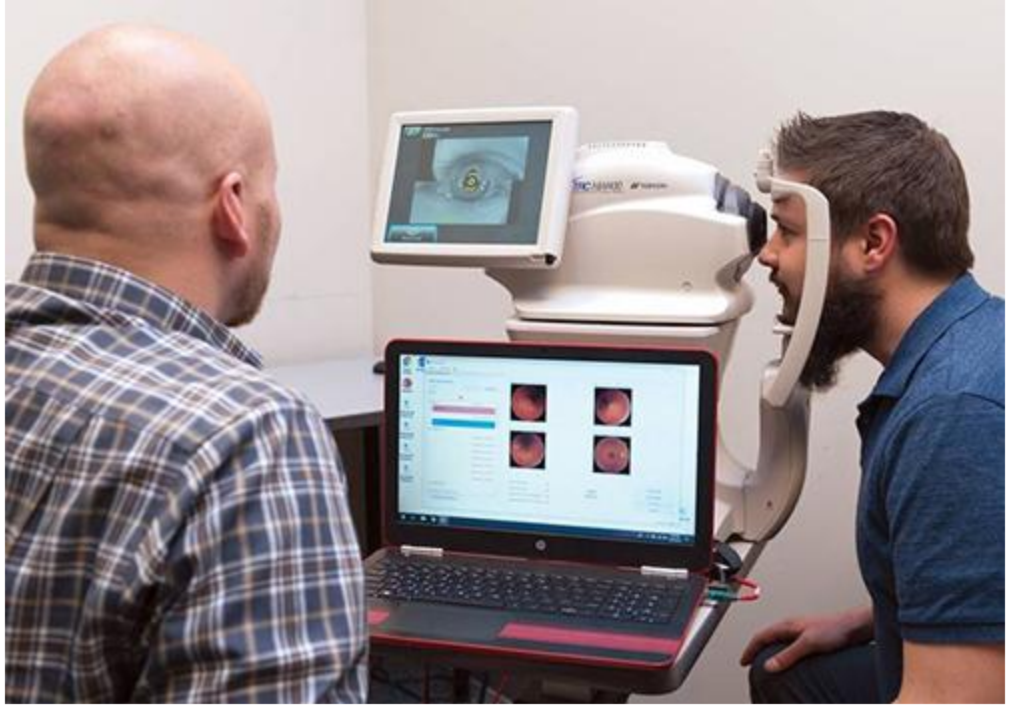
Non-Proliferative Diabetic Retinopathy

https://avruc.com/procedures/diabetic-retinopathy/

Detecting Diabetic Retinopathy: Artificial Intelligence

Normal:
Retest in 12 months

Diabetic Retinopathy or Macular Edema:
Refer to Eye Specialist



Robotic fundus camera captures two images per eye

https://www.darkdaily.com/2019/01/02/fda-clears-ai-device-for-diagnosis-of-diabetic-retinopathy-is-this-favorable-for-use-of-ai-in-digital-pathology/

Preliminary Results: 3 Months

	FQHC #1	FQHC #2	Total
Identified Diabetic Patients	529	272	801
Exams Performed	73	32	105
Positive Results	20 (27%)	10 (31%)	30 (29%)

Benefits

- Immediate results and contributes to comprehensive diabetes management
- Potential to save time and quality of care for patients

Challenges

Benefits

- Immediate results and contributes to comprehensive diabetes management
- Potential to save time and quality of care for patients

Challenges

- Need to develop clear workflows, including space and staff training (e.g. eye dilation)
- Does not detect mild diabetic retinopathy

Cardiomegaly on CT Scans

- At UAB, 80,000 CT exams of the chest or abdomen per year
- UAB Radiology will begin a pilot of an image-based AI algorithm to opportunistically screen for cardiomegaly on routine CT exams of the chest or abdomen obtained for other purposes
- The AI algorithm has 97% specificity for cardiomegaly

Cardiomegaly on CT Scans

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Colorectal Screening

- Screening for colorectal cancer can identify premalignant lesions and improve survival
- Computer aided AI platform being used by UAB GI to enhance polyp detection

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Language Processing

AI-Based Language Processing:
Health Promotion and Chronic Disease Management

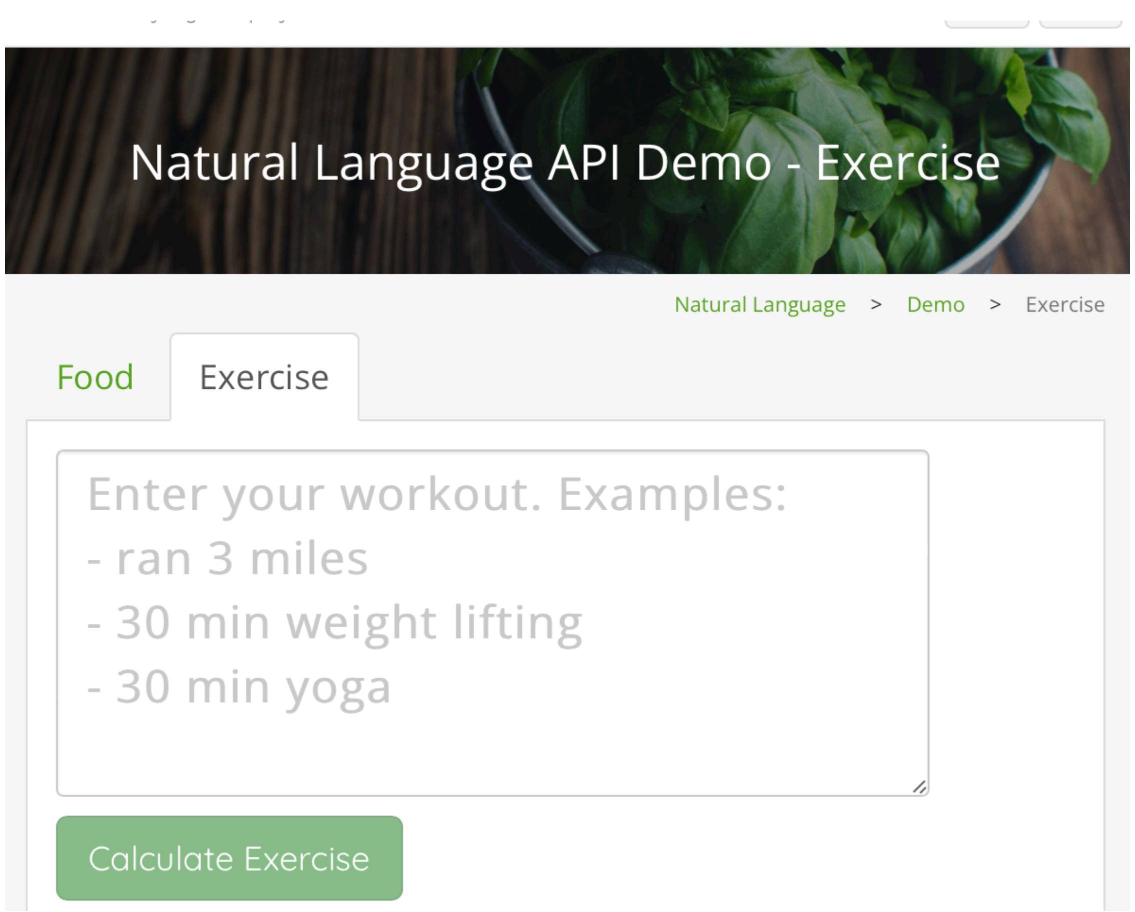
Tapan Mehta PhD
Vice Chair for Research
Family & Community Medicine

Erin Delaney, MD
Vice Chair for Clinical Affairs & Quality
Family & Community Medicine

Gamified Optimized Diabetes management with Artificial Intelligence-powered Rural Telehealth (GODART)

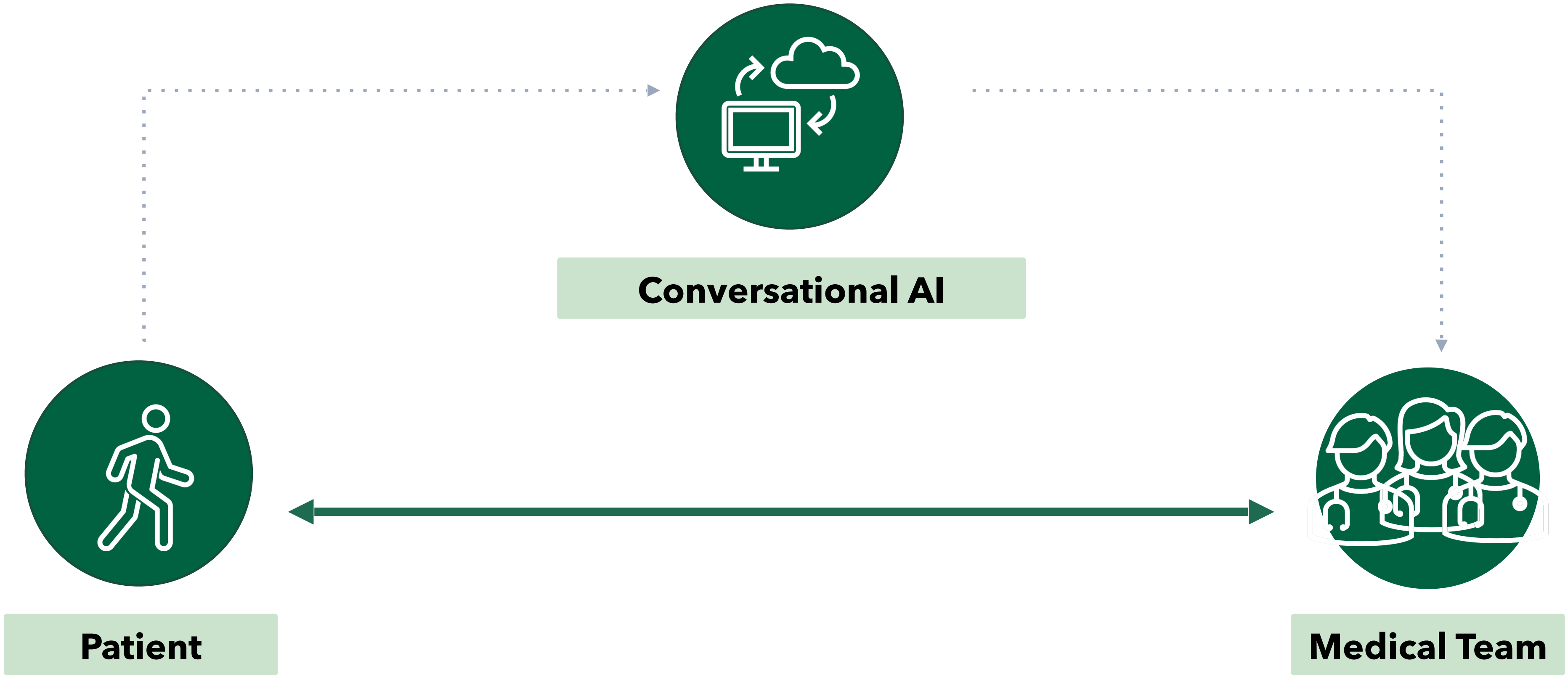
- AI-assisted individualized lifestyle modification for glycemic control
  - Smart phone
  - Landline phone

- Key Features
  - Interactive voice response
  - Natural language processing
  - Conversational features for motivational coaching



AI-Based Language Processing:

Patient Portal Assistance



Tapan Mehta PhD
Vice Chair for Research
Family & Community Medicine

Erin Delaney, MD
Vice Chair for Clinical Affairs & Quality
Family & Community Medicine

By the Numbers: UAB Primary Care Service Line

1/3
Overall patient calls at UAB

11.6%
Of Arrived Patients at UAB Medicine

173
(Days) Average Wait for New Adult Patient

75
(Days) Average Wait for New Child Patient

Clinical Full Time Equivalents

FY19	FY20	FY21
55.50	55.68	59.69

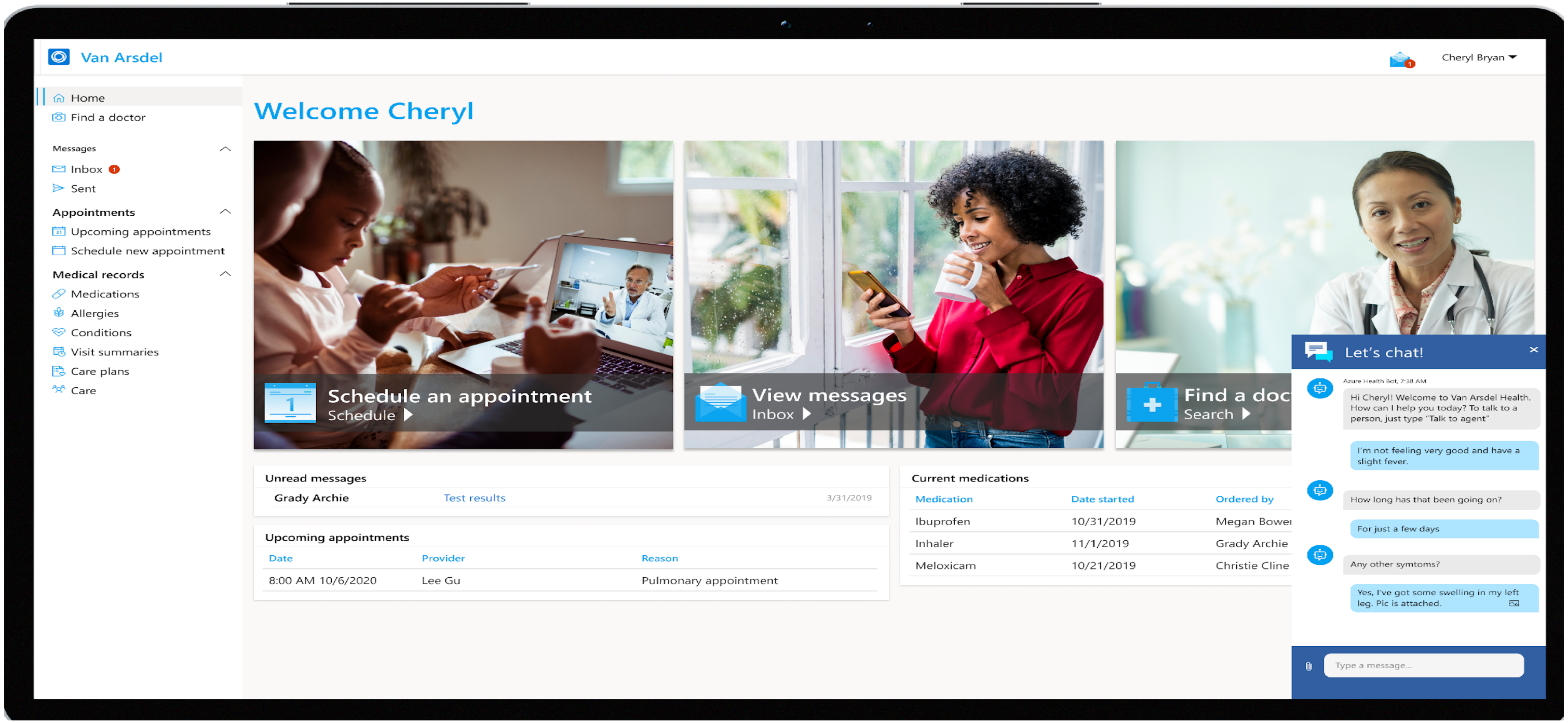
Messages	Quarter
55,364 Messages	Q4 FY21
54,609 Messages	Q4 FY20
34,269 Messages	Q4 FY19

>60%
Increase in Portal Messages

188,860
FY21 Arrived Patients

185,989
FY20 Arrived Patients

Conversational AI can aid in more meaningful patient engagement through the patient portal and help prioritize messages that may require a provider team (human) response.



- Lab, Imaging, and Result Retrieval
- Appointment Scheduling
- Message Routing
- Sentiment Analysis
- Health Query Response

Benefits

- Address major issues in current clinical practices
- Increased quality of care and potential to save time

Challenges

Benefits

- Address major issues in current clinical practices
- Increased quality of care and potential to save time

Challenges

- Need to develop clear workflows
- Provider/staff/patient education

Conclusions

- Imaging and language processing are 2 key areas where artificial intelligence will affect Family Medicine in the future

- Our role as a family physician will likely change
  - We may encroach on the territory of other specialties
  - Embrace our discipline's core ability to communicate to patient

Go Blazers and Thank You!

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VISION, VOICE, LEADERSHIP

AI and ML at Howard University

Mark S. Johnson, MD MPH

It started with one individual

Abiodun Otolorin, MD MS

-BS, Computer Science, Georgia Tech

-MS, Bioengineering, Georgia Tech

-MD, Eastern Virginia Medical School

-Howard Family Medicine Residency Program

It continues with training

- Grant Generating Project
- AIM-AHEAD Training
- Washington University PRIDE Program
- NIH Health Disparities Training Scholars

It’s supported with infrastructure

- Research Centers in Minority Institutions (RCMI)
- Georgetown-Howard University Center for Clinical and Translational Science (GHUCCTS)

Howard involvement in collaboratives

- NIH Artificial Intelligence/Machine Learning Consortium to Advance Health Equity and Researcher Diversity (AIM-AHEAD)
- Howard University Center for Applied Data Science and Analytics (CADSA)
- Georgetown University Massive Data Institute (MDI)

Grant funded

- Addressing Health Disparities via Development of a Geospatial Analysis Application for Visualization of Environmental and Social Determinants of Health: District of Columbia Pilot Study, $180,000

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Grants submitted

- Improving African American Health: Use of Artificial Intelligence and SMART on FHIR Application to Detect and Monitor Statin Nonadherence for Cardiovascular Disease Prevention, PI, Otolorin,
- The relative impact of biological factors and social determinants on reducing health disparities in COVID-19, PI Johnson
- Howard University Clinical Research Network for Health Equity, PI Johnson

Departmental research faculty

- TyWanda McLauren-Jones, PhD – clinical psychology
- Latita Kaul, PhD – nutrition
- Abiodun Otolorin, MD MS
- Finie Richardson, MPH PhD – health communication

The language of research

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FIU | THRIVE

Social Determinants of Health Machine Learning Use Case

David Brown, MD; Troy Stefano, PhD; Cynthia LeRouge, PhD; M. Hadi Amini, Phd, DEng; Rachel Clarke, PhD; Staci Morris, PsyD; and Nana Aisha Garba, MD, PhD

drbrown@fiu.edu

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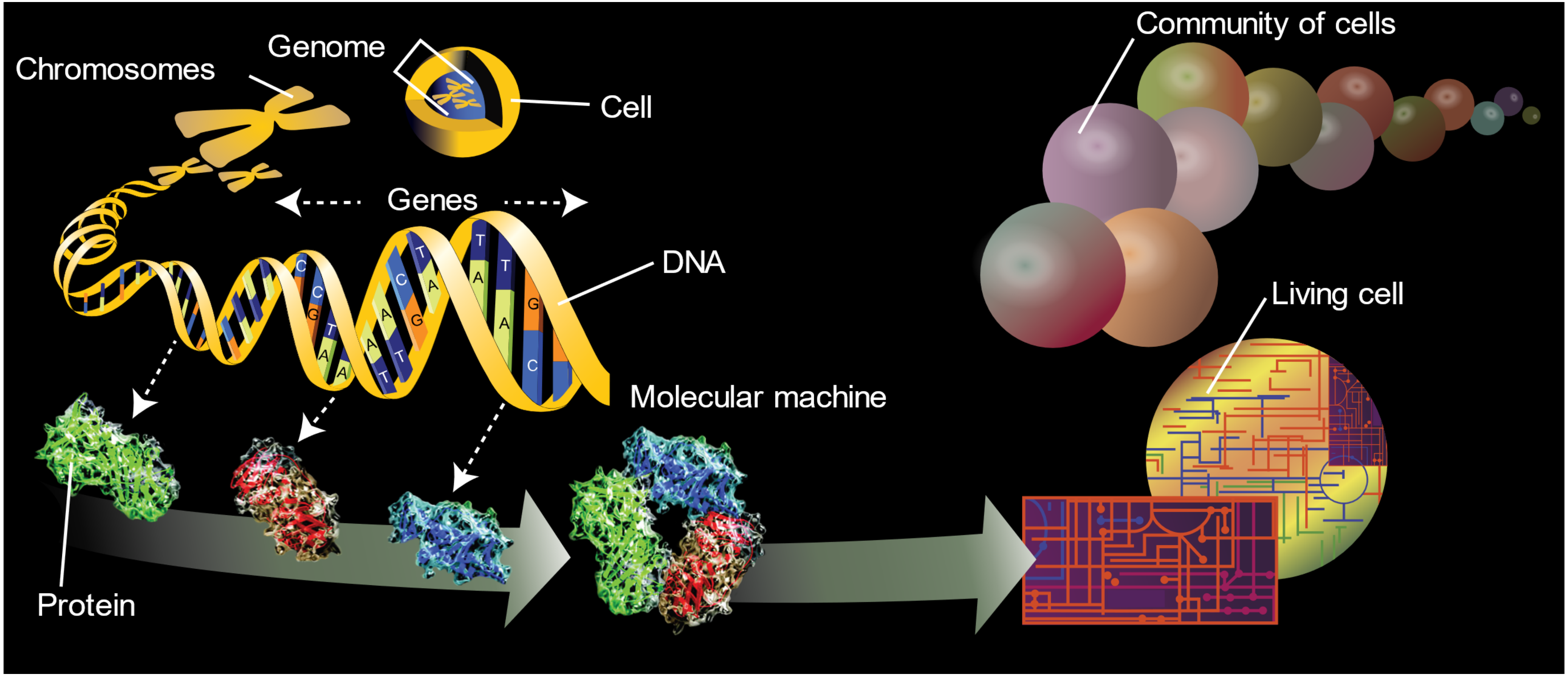
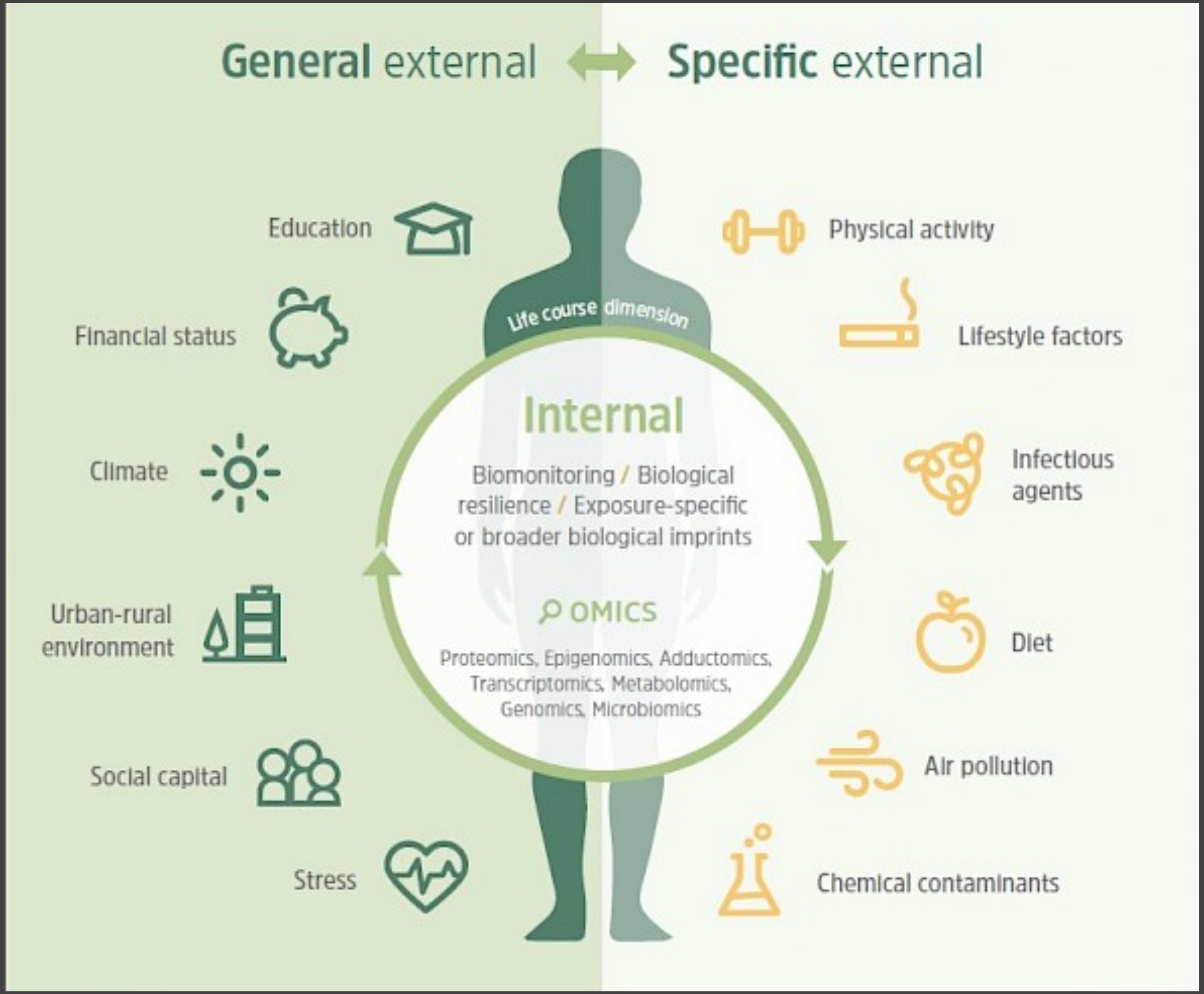
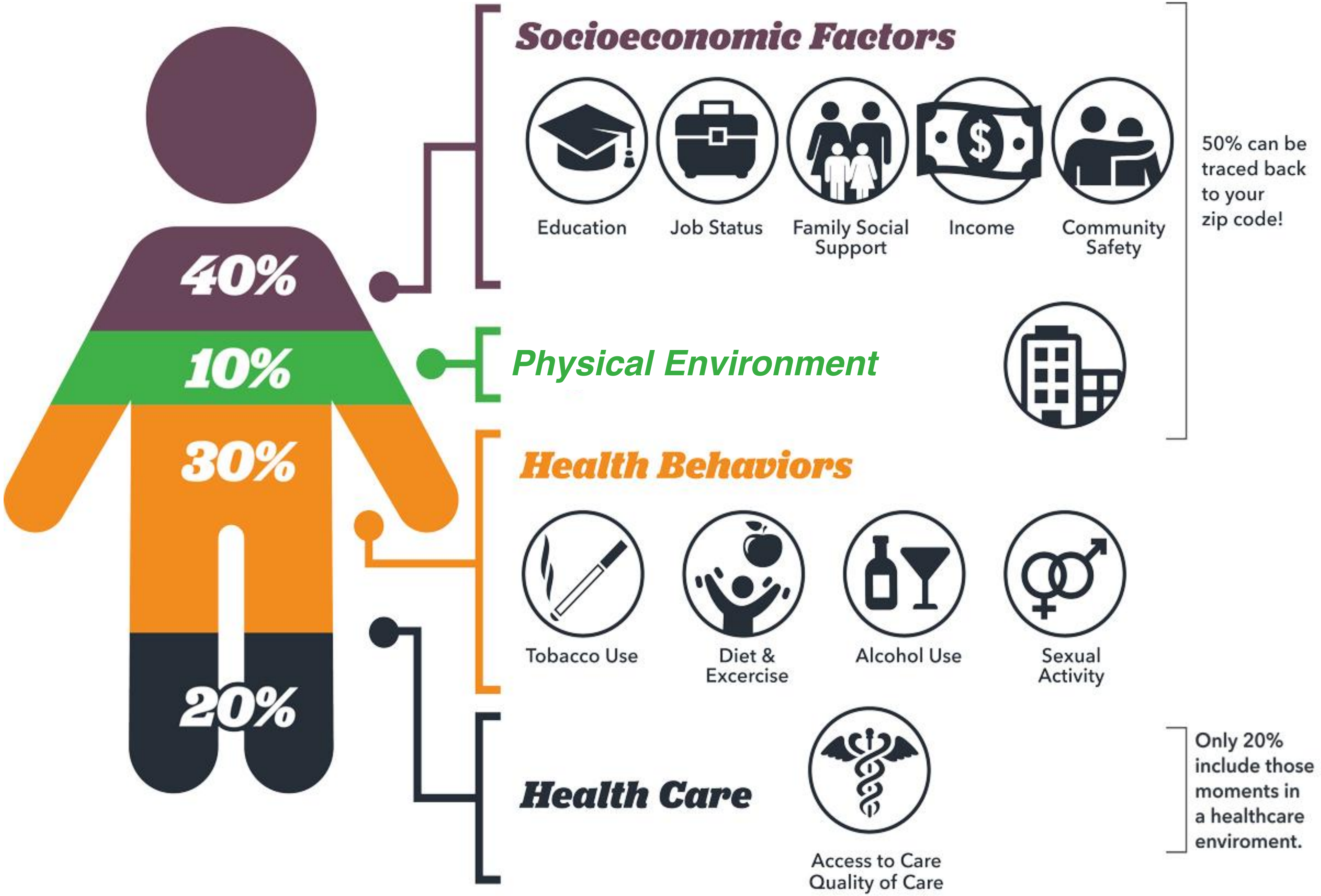
Myth of Simple Genetic Associations



Exposure to the environment is “embodied” through multiple complex “omic” pathways




40%
10%
30%
20%
Socioeconomic Factors
Education
Job Status
Family Social Support
Income
Community Safety
50% can be traced back to your zip code!
Physical Environment
Health Behaviors
Tobacco Use
Diet & Excercise
Alcohol Use
Sexual Activity
Health Care
Access to Care
Quality of Care
Only 20% include those moments in a healthcare enviroment.

NEIGHBORHOODHELP COMMUNITY INFRASTRUCTURE

Advocacy Organizations

Schools

Clinical

Outreach

Research

Administrative

Social Service Agencies

Clinical Partners

Cities and Counties

Faith Based Organizations

HEALTH RISK PROFILE Linked to Needs and Service Navigation

Food · Housing · Education · Employment · Technology

Daily Activities · Transportation · Healthcare · Income · Legal

Level	Food	Daily Activities	Housing	Transportation	Education	Healthcare	Employment	Income	Technology	Legal
5	Secure Nutrition	Easily Performs All Daily Activities	Stable Housing	Comfortably Gets Transportation	Graduate Degree	Active Prevention	Career	Savings and Planning	Digitally Engaged	Civic Engagement
4	Nutrition Quality Needs	Readily Performs Most Activities	Housing Needs Minor Repairs	Usually Gets Transportation	Bachelor's Degree or License	Engaged with Care	Stable Employment	Savings	2+ Sites/Apps for Health, Social Resources	Understands Rights
3	Enough Food Assistance	Stress or Discomfort with Daily Activities	Subsidized Housing or Significant Issues	Frequent Difficulty Getting Transportation	Associate's Degree or Vocational Training	Has Access, but…	Difficult Work Environment	Meeting Basic Needs	Has Access to Information, but…	Low Legal Literacy
2	Temp Need for Food	Difficulty Performing Daily Activities	Housing Insecurity	Hard Time Getting Transportation	HS or GED Only	Difficulty Accessing Healthcare	Underemployed	Inconsistently Meeting Basic Needs	Phone Internet Only	Legal Issues
1	Severely Short of Food	Unable to Perform Most Daily Activities	Homelessness	Can't Get Transportation	No HS Diploma or Vocation	No Access to Care	Unemployed	Unable to Meet Basic Needs	No Internet	Legal Barriers

FIU | THRIVE

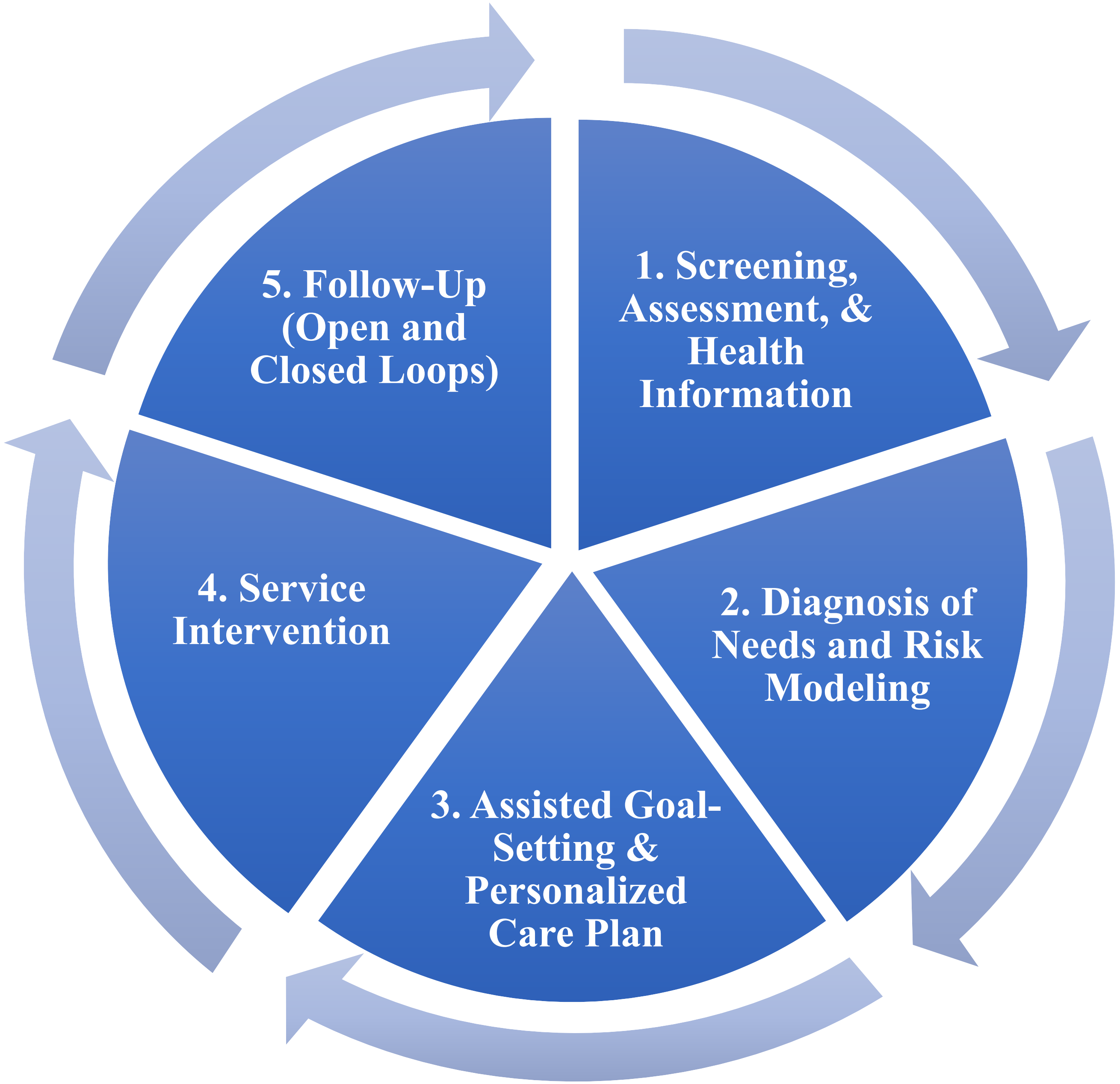
Social support for a healthier you

FIU Thrive helps connect people to accessible, valuable, and usable health and social care when and where it matters most.

SOURCE: CDC

Thrive Domains	Gravity Domains			Additional Concepts
Demographics				Veteran Status
Food and Nutrition	Food Insecurity			*Food Insecurity (accessibility, affordability); Nutrition (access, literacy, and health behaviors); structural barriers (food swamp)
Daily Activity				Physical Function, (Independence), Exercise
Education	Educational Attainment			Life Skills
Work	Employment Status			Retirement; Occupational Prestige
Financial Health	Financial Insecurity	Material Hardship		financial health and financial well-being;
Technology				Technological access, technological literacy, cell phone, technological adequacy, technological affordability
Transportation	Transportation Insecurity			
Housing	Housing Instability & Homelessness		Inadequate Housing	Housing security (housing affordability); housing safety; neighborhood safety
Neighborhood				GIS-Based Deprivation Index
Relationships	Social Connection	Intimate Partner Violence	Elder Abuse	Social Function, Household Composition, Support Structures, Social isolation
Wellness	Stress			Mental Health, Wellness, Substance Misuse
Healthcare	Health Insurance Status	Medical Cost Burden	Health Literacy	Engagement with Healthcare, Healthcare Access

Automated Care Plan Process

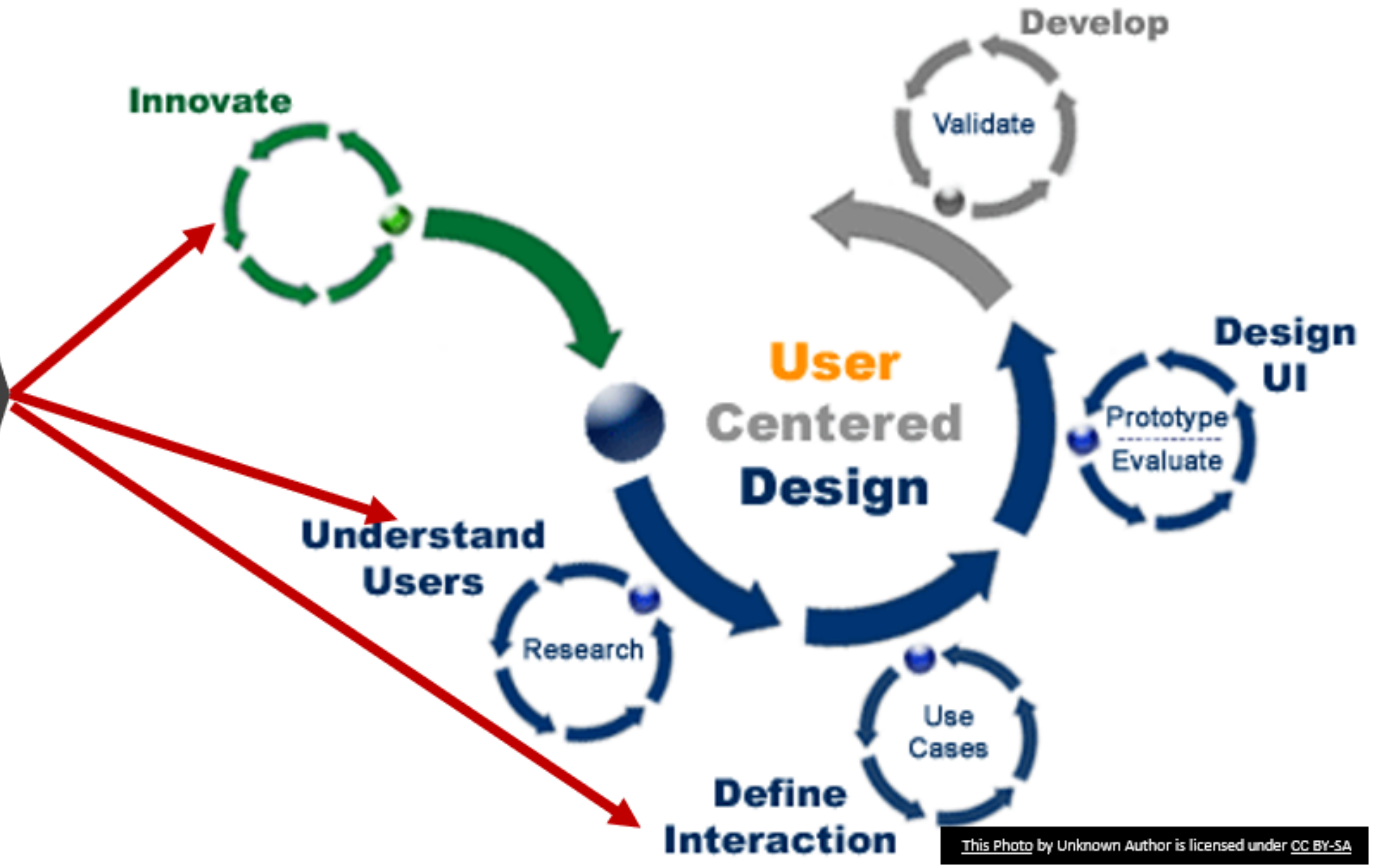


MI/SBIRT conceptual model for application design

- Engagement: assessing social needs
- Focusing/Evoking
  - sharing results for user to prioritize
  - user defines goals
- Planning/Directionality
  - Pre-set list of potential needs/goals
  - Offer a menu of options
  - Provide referral to services
  - Follow up

User Centered Design

Create for the user and and with the user



Spend Score: Save Score Borrow Score Plan Score

Core Validated Need-Based Assessment Instruments | Structural

Set 1: Income & Wealth | Set 2: Financial Health | Set 3: FWB

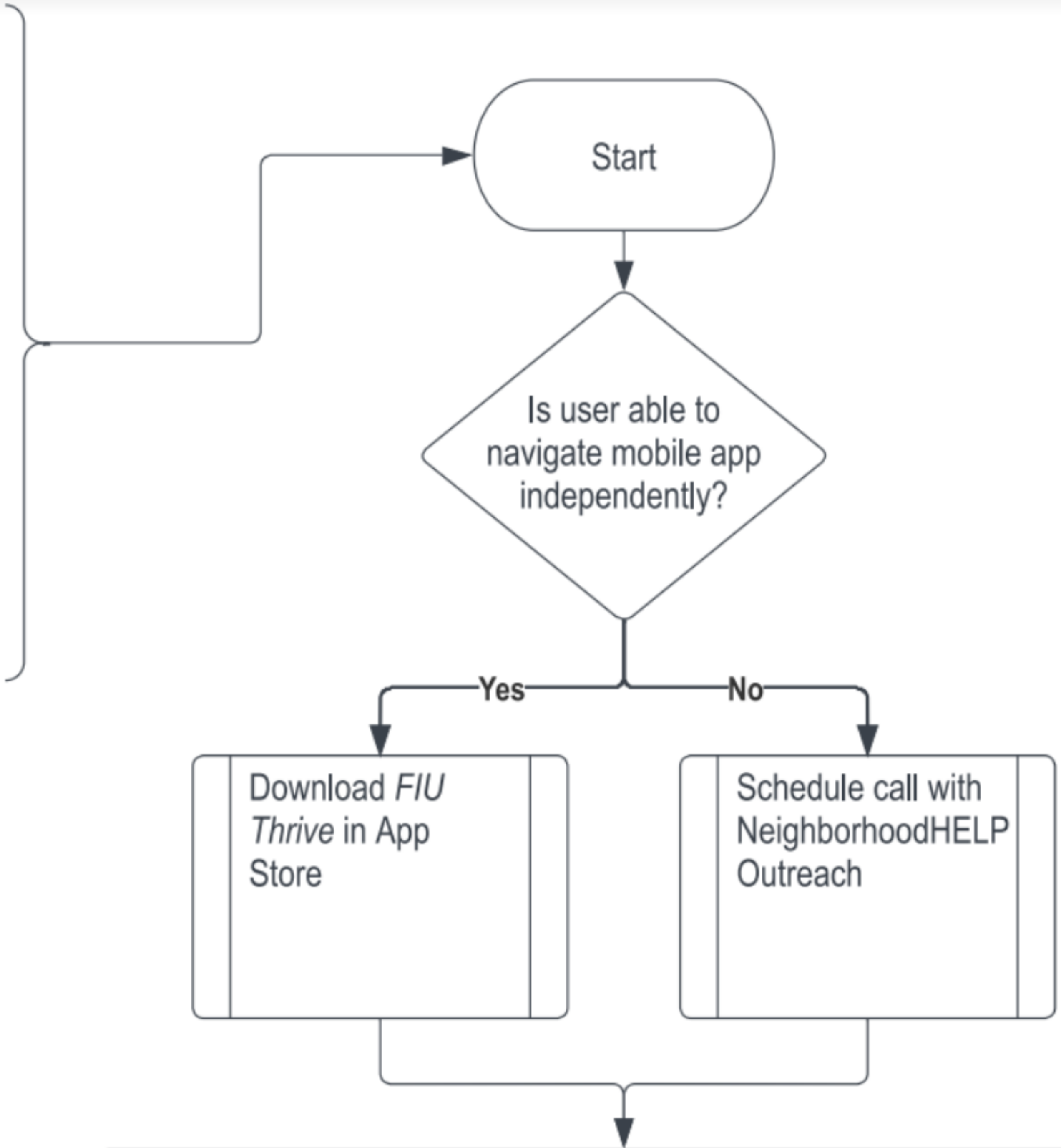
Core Validated Need-Based Assessment Instruments											Structural
Set 1: Income & Wealth		Set 2: Financial Health								Set 3: FWB	
Annual Family Income	Household Wealth	Spend Score:		Save Score		Borrow Score		Plan Score		Financial Well-Being	◀▶ Concentrated Poverty
		Indicator 1= spend less than income;	indicator 2= pay bills on time.	Indicator 3: Have sufficient liquid savings	Indicator 4: Have sufficient long-term savings	Indicator 5: Have manageable debt	Indicator 6: Have a prime credit score	Indicator 7: Have appropriate insurance	Indicator 8: Plan ahead financially		
National Health Interview Survey (NHIS) Family Questionnaire, 2020 (PhenX)	Panel Study of Income Dynamics (PSID), wealth supplement, 2019	Financial Health Network's FinHealth Score Toolkit		Financial Health Network's FinHealth Score Toolkit		Financial Health Network's FinHealth Score Toolkit		Financial Health Network's FinHealth Score Toolkit		CFPB Financial Well-Being Scale, Abbreviated Version	American Community Survey (ACS), 5-year estimates, Concentrated Poverty, 2009-2018
		2 Qs: Take Average Score of Qs 1A.-1.B.		2 Qs: Take Average Score of Qs 3-4		2 Qs: Take Average Score of Qs 5-6		2 Qs: Take Average Score of Qs 7-8		5 Q	
HH income is equal to or greater than 2 SD higher than median HH income [100]		[Q1.A.] Spending was much less than income [100];	[Q1.B] Pay all bills on time [100];	[Q2.A] 6 months or more of living expenses [100]	[Q2.B] Very confident of meeting longer-term goals [100]	[Q3.A] Do not have any debt [100]	[Q3.B] Excellent credit score [100]	[Q4.A] Very confident in HH insurance coverage [100];	[Q4.B] Plans ahead financially? Agree strongly [100]	[Q8] Thriving [Score < 62]	
HH income is a SD higher than median HH income [80];						[Q3.A] Have a manageable amount of debt [85]				[Q8] Focused [Score: 45-62]	
							[Q3.B] Very good credit score [80]			[Q8] Stable [Score: < 45]	
HH income is about equal to median HH income [75];		[Q1.A] Spending was a little less than income [75];	[Q1.B] Pay nearly all of our bills on time [60];	[Q2.A] 3-5 months of living expenses [75]	[Q2.B] Moderately confident of meeting longer-term goals [75]			[Q4.A] Moderately confident in HH ins. coverage [75];	[Q4.B] Plans ahead financially? Agree somewhat [65];	[Q8] Striving [Score > 52]	
HH income is above PL but below median HH income;		[Q1.A] Spending was about equal to income [50];	[Q1.B] Pay most of our bill son time [40];	[Q2.A] 1-2 months of living expenses [50]	[Q2.B] Somewhat confident of meeting longer term goals [50]		[Q3.B] Good credit score [60]	[Q4.A] Somewhat confident in HH ins. coverage [50];		[Q8] Tenuous [Score < 52]	
BPL [20]		[Q1.A] Spending was a little more than income [25];	[Q1.B] Pay some of our bills on time [20]	[Q2.A] 1-3 weeks of living expenses [25]	[Q2.B] Slightly confident of meeting longer term goals [25]	[Q3.A] Have a bit more debt than is manageable [40]	[Q3.B] Fair credit score [40]	[Q4.A] Not at all confident in HH ins. coverage [10];	[Q4.B] Plans ahead financially? Neither agree nor disagree [35]		
RBPL [0]		[Q1.A] Spending was much more than income [0];	[Q1.B] Pay very few of our bills on time [0]	[Q2.A] Less than 1 week of living expenses [0]	[Q42.B] Not at all confident of meeting longer term goals [0]	[Q3.A] Have far more debt than is manageable [0]	[Q3.B] Poor credit score [0] [Q3.B] I don't know [0]	[Q4.A] No one in my HH has any insurance [0]	[Q4.B] Plans ahead financially? Disagree somewhat [15]; Plans ahead financially? Disagree strongly [0];		

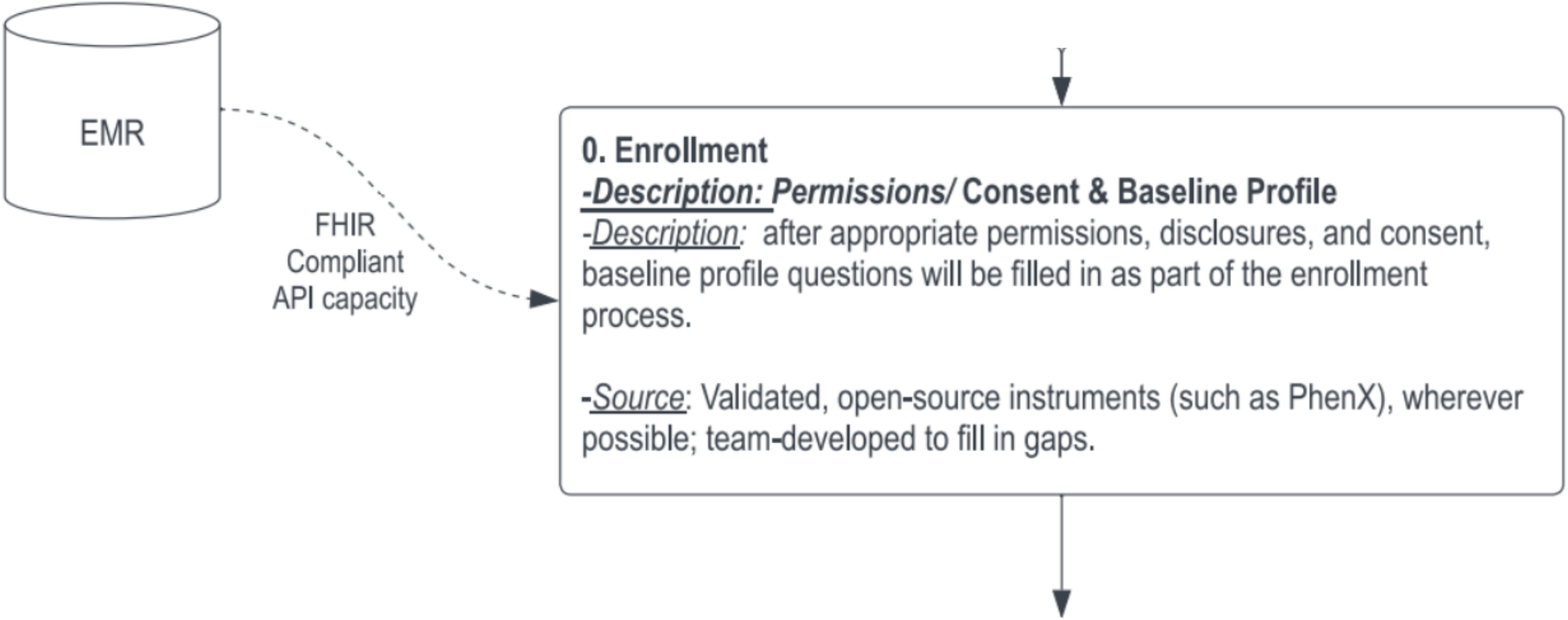
Risk-Based Framework (Life Course View: Risk to Resiliency)

Description (Needs to be fine tuned in light of changes)	Sub-Segments	Status (3-Segments)
	Thriving (FWB Subjective Score: < 62)	Healthy (FinHealth Score: 80-100)
	Focused (FWB Subjective Score: 45-62)	
	Stable (FWB Score: < 45)	
	Striving (FWB Subjective Score > 52)	Coping (FinHealth Objective: Score 40-79)
	Tenuous (FWB Subjective Score < 52)	
	Unengaged	Vulnerable (FinHealth Objective: Scores 0-39)
	At risk	

Healthy (FinHealth Score: 80-100)
Coping (FinHealth Objective: Score 40-79)
Vulnerable (FinHealth Objective: Scores 0-39)
Risk-Based Framework (Life Course View: Risk to Resiliency)
[Q4.A] No one in my HH has any insurance [0]
At risk

User Journey




EMR
FHIR Compliant API capacity
0. Enrollment
-Description: Permissions/ Consent & Baseline Profile
-Description: after appropriate permissions, disclosures, and consent, baseline profile questions will be filled in as part of the enrollment process.
-Source: Validated, open-source instruments (such as PhenX), wherever possible; team-developed to fill in gaps.

1. Screening/ Assessment

-*Description:* screening questions with conditional flows for 12 domains of SDOH. Questions and conditional flows are built into the database design and software.

-*Source*: Validated, open-source instruments wherever possible.

v1: expert-based look-up tables for filtering relevant needs based on conditional logic of assessment

v2: ML-based risk modeling and need identification

2. Need Identification

-*<u>Description</u>:* assessment results lead to a need identification (per subdomain) from a pre-set list of need identification options and a three-tiered risk designation (per domain); users then select priority needs from identified need list.

-*<u>Source</u>*: Gravity project (HL7's consensus-based standards), where possible; team-developed to fill in gaps.

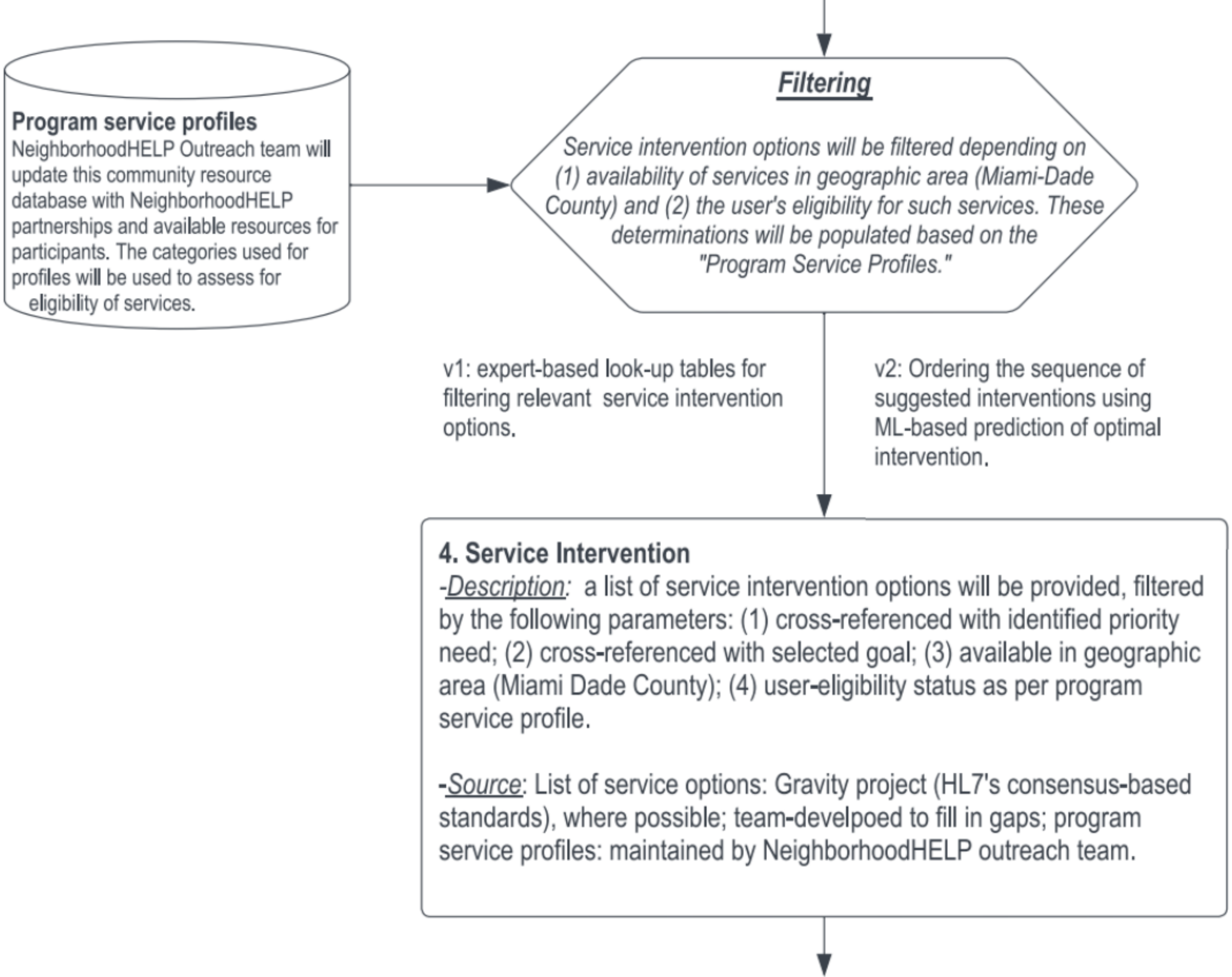
Look-up tables for filtering relevant goals based on selected priority needs.

Look-up tables for filtering milestone options based on risk level, goals, and domain.

3. Goal-setting & milestones

-*Description*: user to select a goal from a list of goal-options that corresponds to selected priority needs. A milestone for follow-up is selected per goal.

-*Source*: Gravity project (HL7's consensus-based standards), where possible; team-developed to fill-in gaps. Milestones to be determined based on secondary literature.


Program service profiles
NeighborhoodHELP Outreach team will update this community resource database with NeighborhoodHELP partnerships and available resources for participants. The categories used for profiles will be used to assess for eligibility of services.
Filtering
Service intervention options will be filtered depending on (1) availability of services in geographic area (Miami-Dade County) and (2) the user's eligibility for such services. These determinations will be populated based on the "Program Service Profiles."
v1: expert-based look-up tables for filtering relevant service intervention options.
v2: Ordering the sequence of suggested interventions using ML-based prediction of optimal intervention.
4. Service Intervention
-Description: a list of service intervention options will be provided, filtered by the following parameters: (1) cross-referenced with identified priority need; (2) cross-referenced with selected goal; (3) available in geographic area (Miami Dade County); (4) user-eligibility status as per program service profile.
-Source: List of service options: Gravity project (HL7's consensus-based standards), where possible; team-develpoed to fill in gaps; program service profiles: maintained by NeighborhoodHELP outreach team.

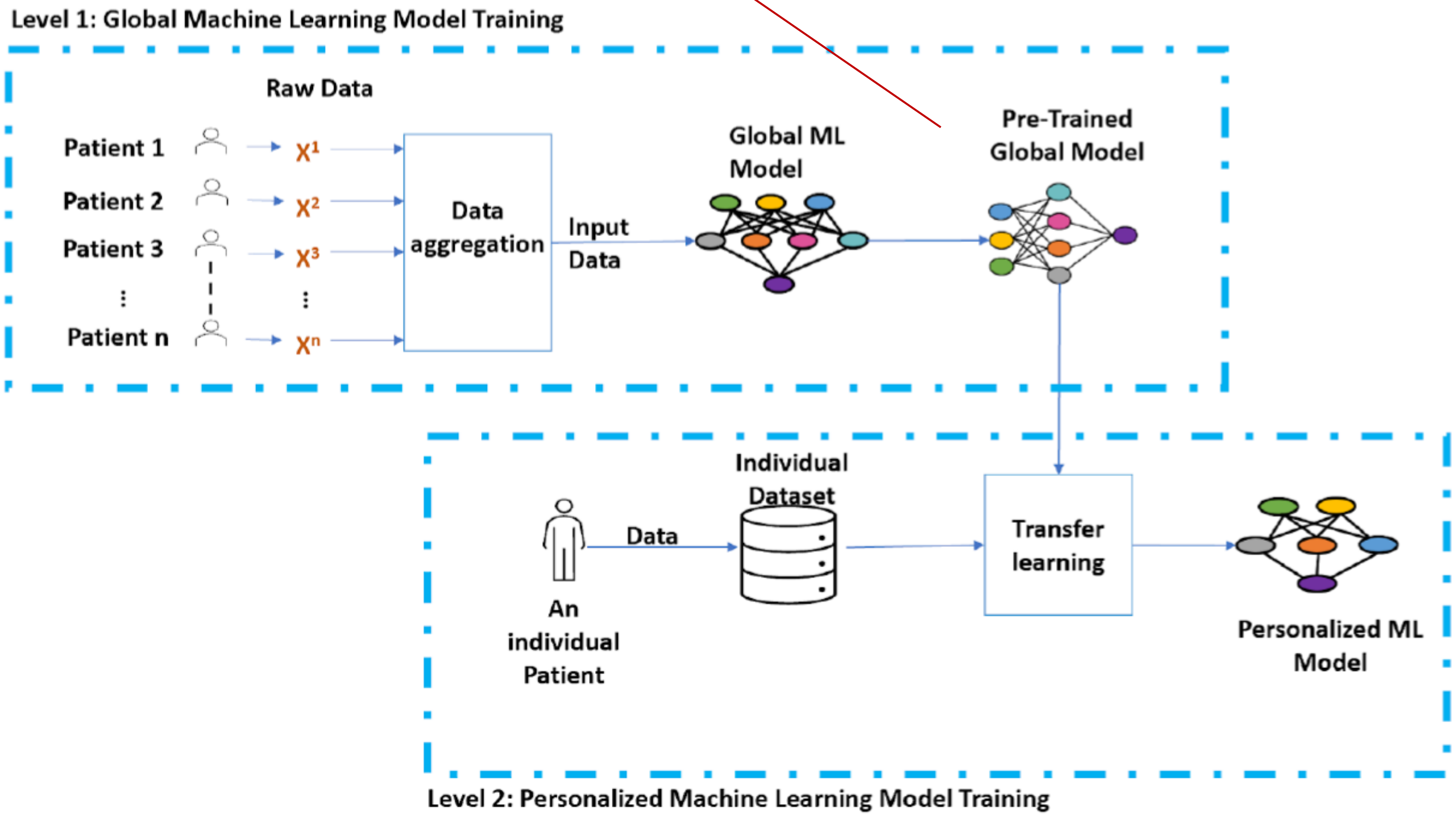
5. Follow-up

-*Description:* follow-up will take place at the time determined in the milestone selection (step 3). Questions would ask about other SDOH domain areas and would update the assessment accordingly.

-*Source*: Adapted questions similar to screening/assessment questions (i.e., validated, open-source instruments), wherever possible.

Artificial Intelligence (AI)

ML 0: Pre-Training for Functions 1-3 via Transfer Learning.



ML 1: Complex health risk modeling and simulation using data-driven tools

ML 2: Assisted Goal-Setting and Personalized Care Plan

ML 3: Personalized Intelligent Learning for Patient-users

Q&A