

Smart Health: A path forward from today's reality to the vision

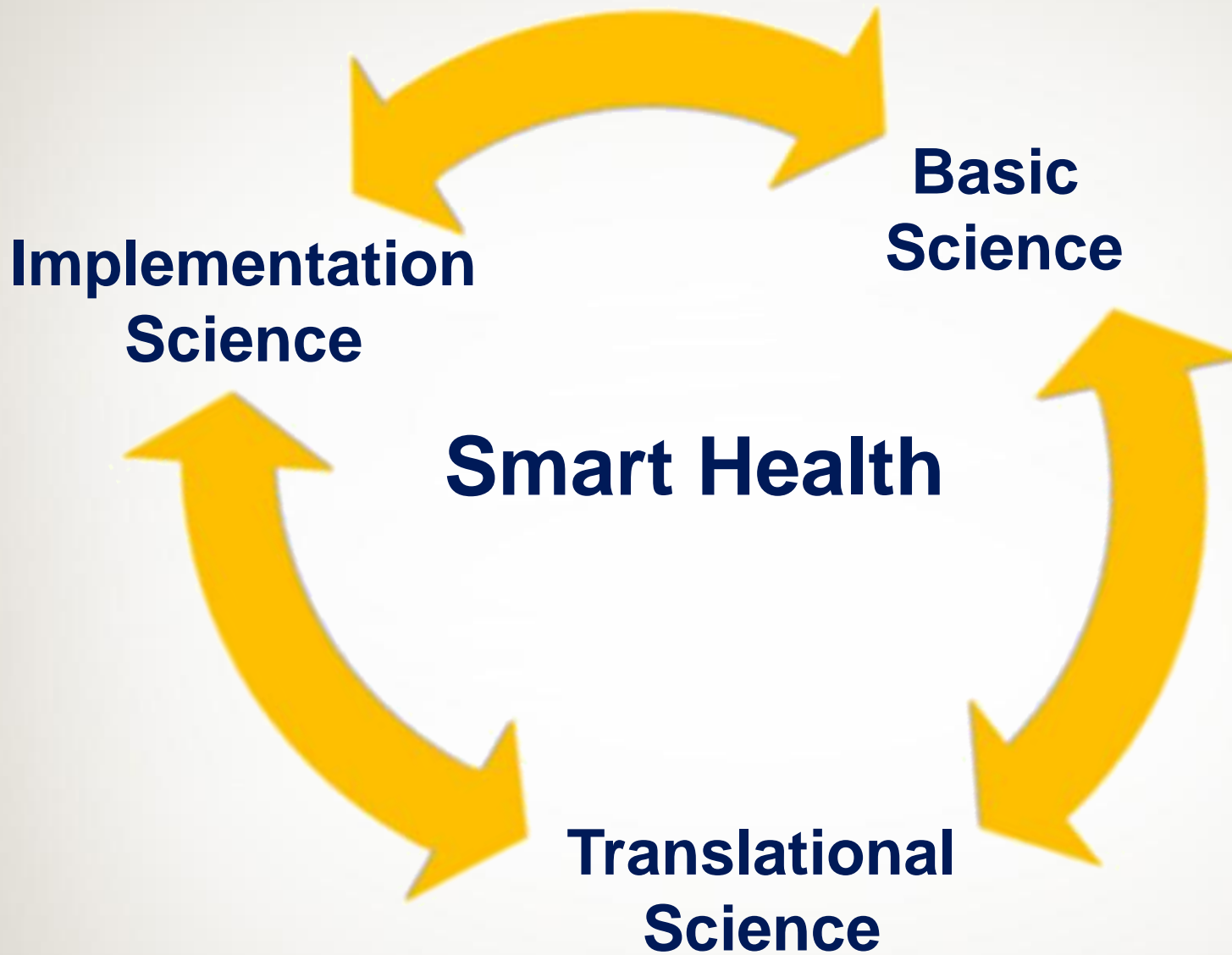
William W. Stead, M.D.

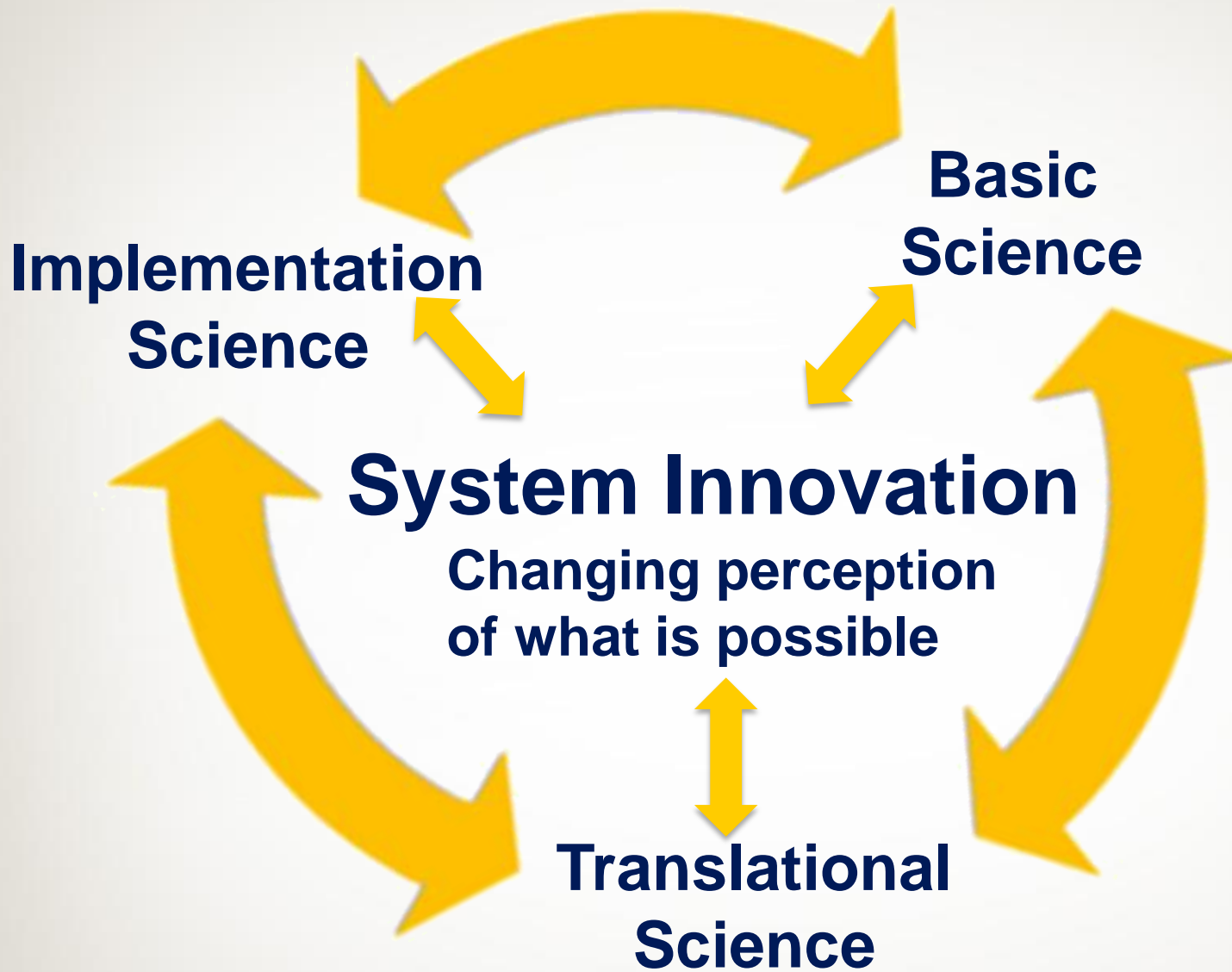
Associate Vice Chancellor for Health Affairs

Chief Strategy Officer

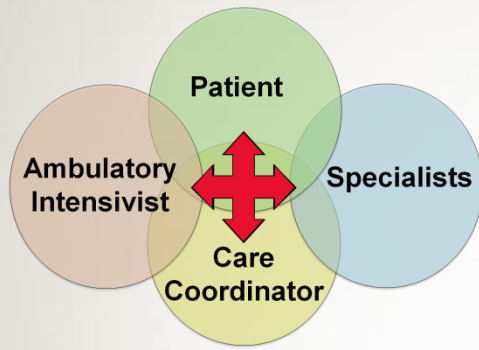
McKesson Foundation Professor of Biomedical Informatics and Medicine

Disclosures: I am a co-inventor of two patient medical record products — one licensed to McKesson, Inc., and one licensed to Informatics Corporation of America — from which I receive royalties through Vanderbilt University. I am a director of HealthStream, a public company, compensated by an annual option grant.





Example 1: Care process - My Health Team



Team-based, informatics-enabled, management for targeted chronic co-morbid conditions (Hypertension, Congestive Heart Failure, Diabetes) to improve process reliability, physiologic control, resource utilization & evaluation

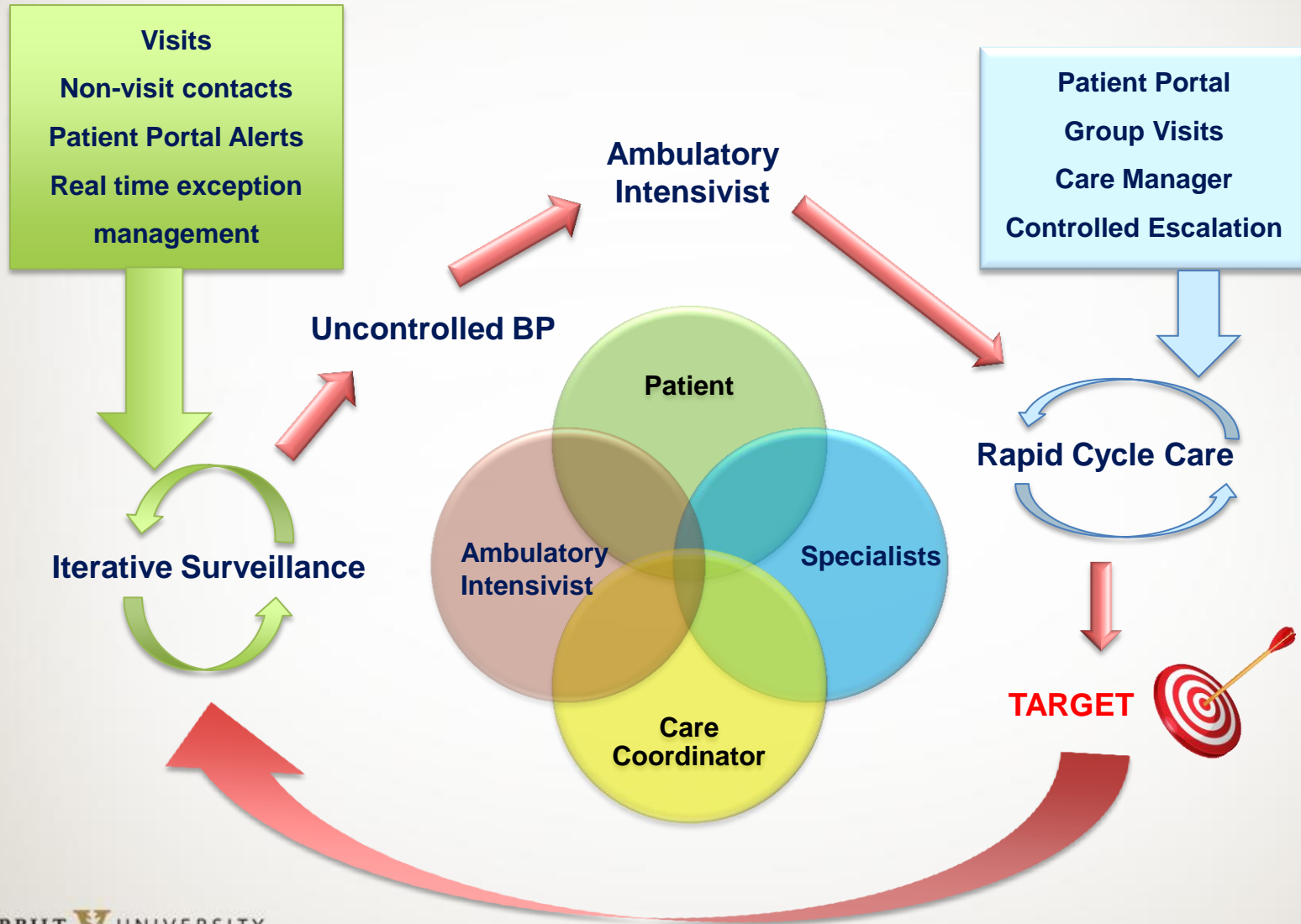
Innovation

- Stratification algorithm triggers enrollment, process intensity & escalation
- Inter-disciplinary team personalizes & manages to care plan
- Process control & iterative design cycles support reliability & improvement

Conventional Patient Centered Medical Home

- Every patient has a medical home
- Primary care coordinates with specialists
- Transparent metrics support accountability & improvement

My Health Team (microsystem view)



Common plan of care

ACTIVE Plan of Care - Last Modified by **greggns** on]2012-04-19 14:25:12

View Only Mode, Switch to [Edit](#)

Disease/Issue	Stratification	Disease POC Status	Target	Medication Goals
Hypertension	2b [Since 2012/03/22] <input type="checkbox"/>	Active	2012/01/20* BP: <= 140/90 <input type="checkbox"/>	2012/04/19 Increase lisinopril to 40 mg dai

Lifestyle	
Diet	2012/01/20* DASH-No
Activity	2012/01/20* increase w

Risk level + status to target

Patient specific target

Misc.	
Misc. Social Info.	2012/04/19 Lives with husband who has dementia <input type="checkbox"/>

Blood Pressure Journal

Use this journal to record your blood pressure readings. Take your blood pressure each morning and evening, in the time (ex: 8:30), systolic reading, then diastolic reading. Then click submit.

Read more about blood pressure and symptoms to watch for [here](#).

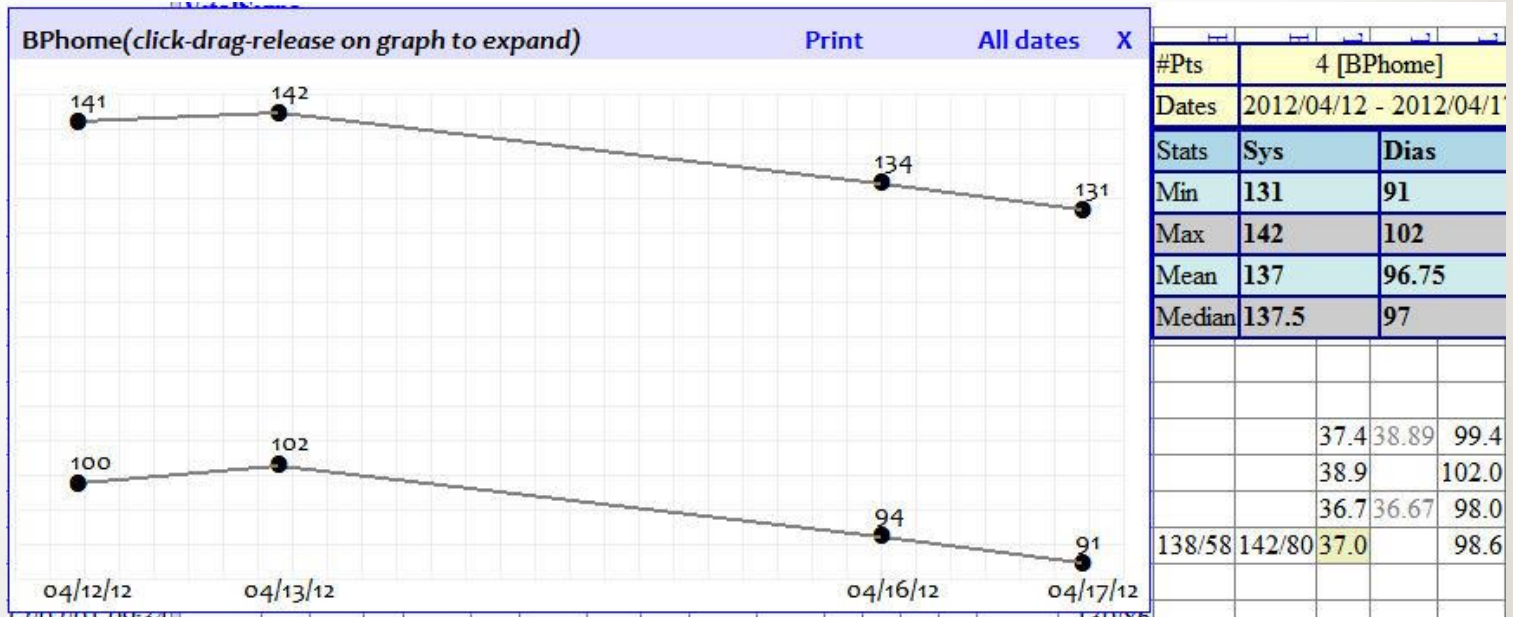
Target this week: 140/100

Long-term goal: 130/90

Date >	Time (A.M.)	Reading	Time (P.M.)	Reading
04/02/2012	08:00	142 / 82	18:00	128 / 76
04/03/2012	08:00	130 / 70	17:00	126 / 80
04/04/2012	08:00			

Data from Home

To Clinic



Process control dashboard

Patient Status: Active Patient Location(s): SUITE IV Active Diseases: Hypertension

Summary Statistics

HTN Statistics				
HTN POC Cycle Status	■ 95.7%	■ 0.3%	■ 4%	Total: <u>984</u>
HTN CC F/U Status	■ 87%	■ 3.9%	■ 3%	■ 6.1% Total: <u>984</u>
HTN RiskLevel <u>1</u> Distr (engaged >= 8 wks)	a: 83.1%	b: 13.3%	c: 3.6%	Total: <u>556</u>
HTN RiskLevel <u>2</u> Distr (engaged >= 8 wks)	a: 72.2%	b: 25.8%	c: 2%	Total: <u>299</u>
HTN RiskLevel <u>3</u> Distr (engaged >= 8 wks)	a: 42.9%	b: 42.9%	c: 14.3%	Total: <u>14</u>



Process Control Detail View



	Hypertension	LifeStyle	HomeBP	PCP	Next PCP Visit	Alerts
2-b	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	■	■	Habermann, Ralf C	2012-09-20 10:00:00	
1-b	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	■ ■	■	Habermann, Ralf C	2012-06-14 15:00:00	
1-a	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	■	■	Habermann, Ralf C	2012-08-23 14:45:00	
1-a	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	■ ■	■	Karlekar, Mohana B	2012-04-25 08:20:00	PCPv:(04/25)
1-a	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	■ ■	■	Habermann, Ralf C	2012-05-24 13:45:00	
1-b	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	■ ■	■	Denny, Joshua C	2012-10-23 09:00:00	
1-b	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	■ ■	■	Griffin, Marie R		
1-a	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	■ ■	■	Jirjis, Jim N	2012-05-21 15:00:00	

Results as of week of January 2013

- **5,081 patients with hypertension**
 - **78.5% control rate for patients after 8 weeks**
 - **Typical population control rate -- 45-55%**
- **Significant levels of engagement**
 - **72-87% of patients journaling BP values**
- **Patients per Care Coordinator ~ 900-1000**

Today's care process optimization

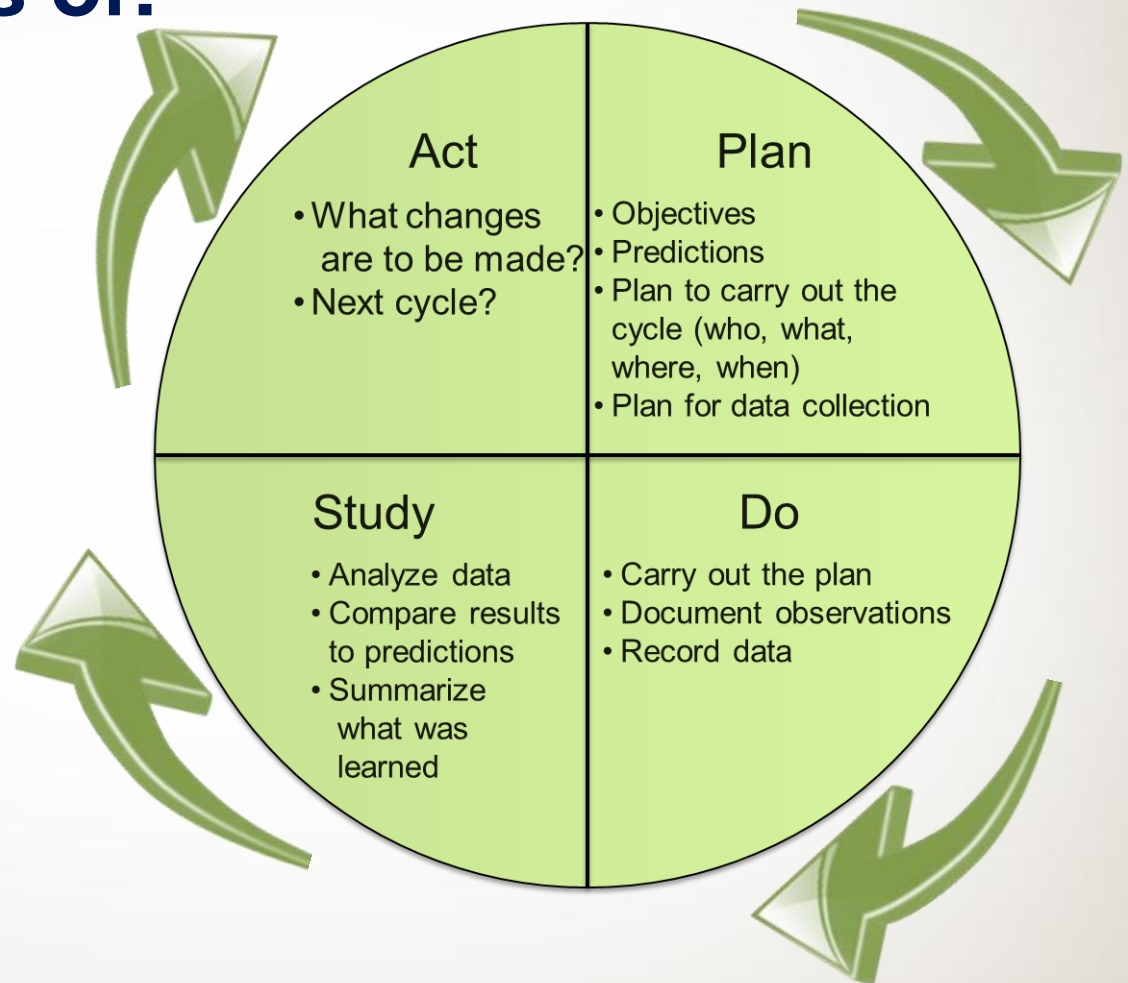
Iterative cycles of:

Plan

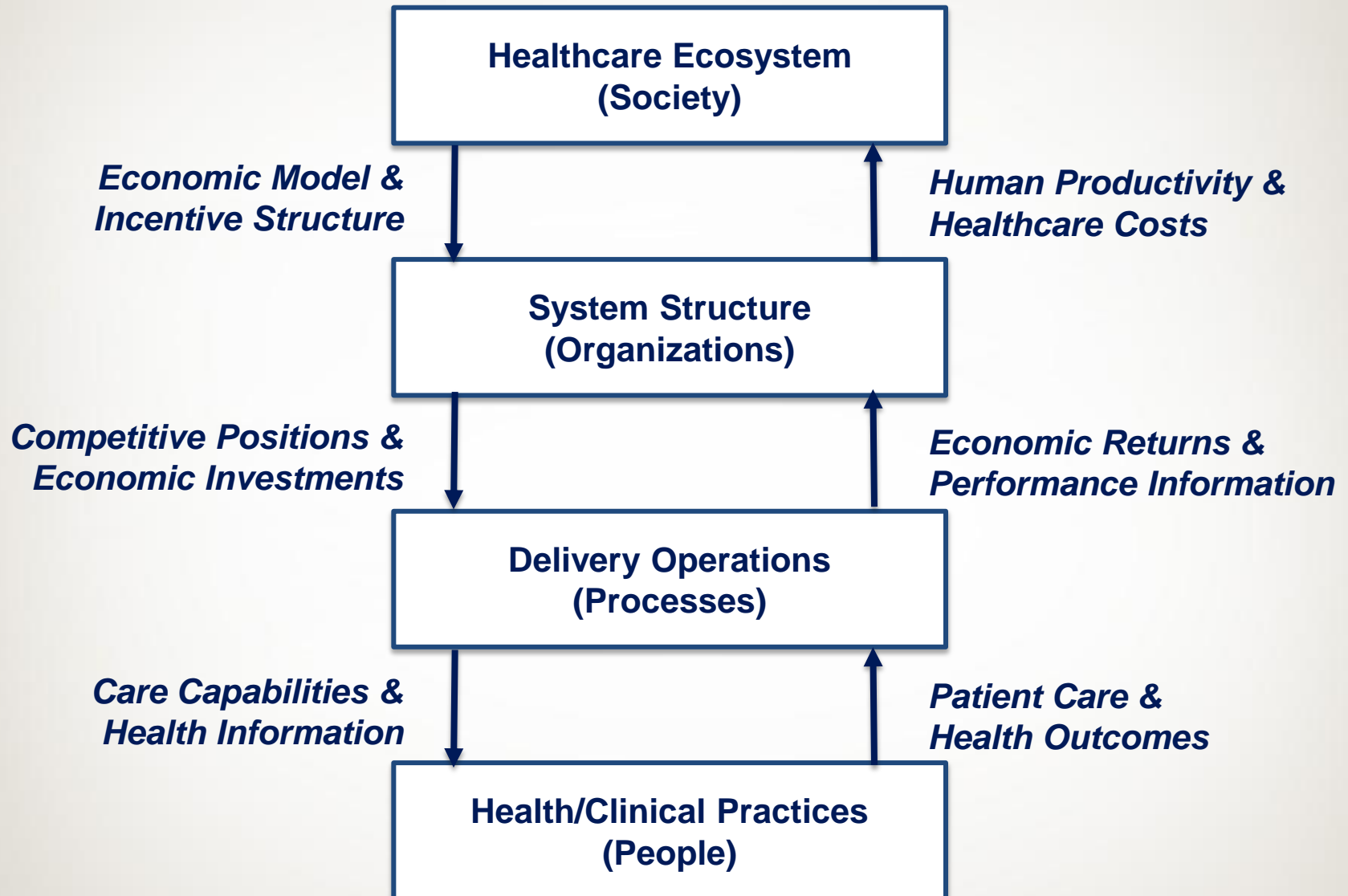
Do

Study

Act



Vision: Model-based system design & analysis



“What if” simulation of care process alternatives

My Health at Vanderbilt

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Tennenbaum Institut
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Site: Main Campus ECL Save Run As:

of patients: # of exam rooms: simulated duration (years):

(each type) MD: MDS: CC: MA: PSR: PCT:

Annual Salary (inc benefits) MD: MDS: CC: MA: PSR: PCT:

Visit Intervals (months) 1A: 2A: 3A: B:

Contact Int. (months) 1A: 2A: 3A: B:

Monitoring & Surveillance Int. (weeks) A: B:

Unsched. Contact Int. (days): Lifestyle Int. (days): Elig. Int. (days): New Cohort Size:

Provider Schedules:

Initial Risk Distribution:

Transition Probabilities:

Legend:
MD = Medical Doctor
MDS = MD Specialist
CC = Care Coordinator
MA = Medical Assistant
PSR = Patient Services Representative
PCT = Patient Care Technician

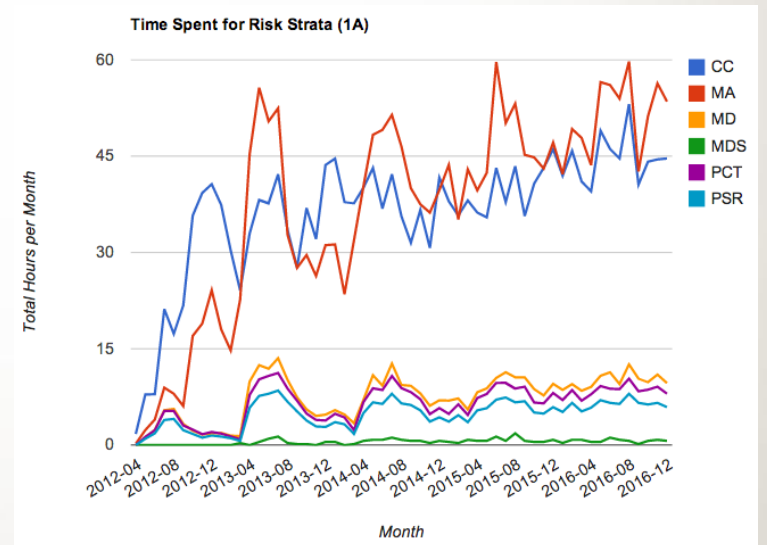
Dashboard

Ga Tech Contributors: Rahul C. Basole PhD, Dr. Mark Braunstein, Trustin Clear, Hyunwoo Park, William B. Rouse PhD

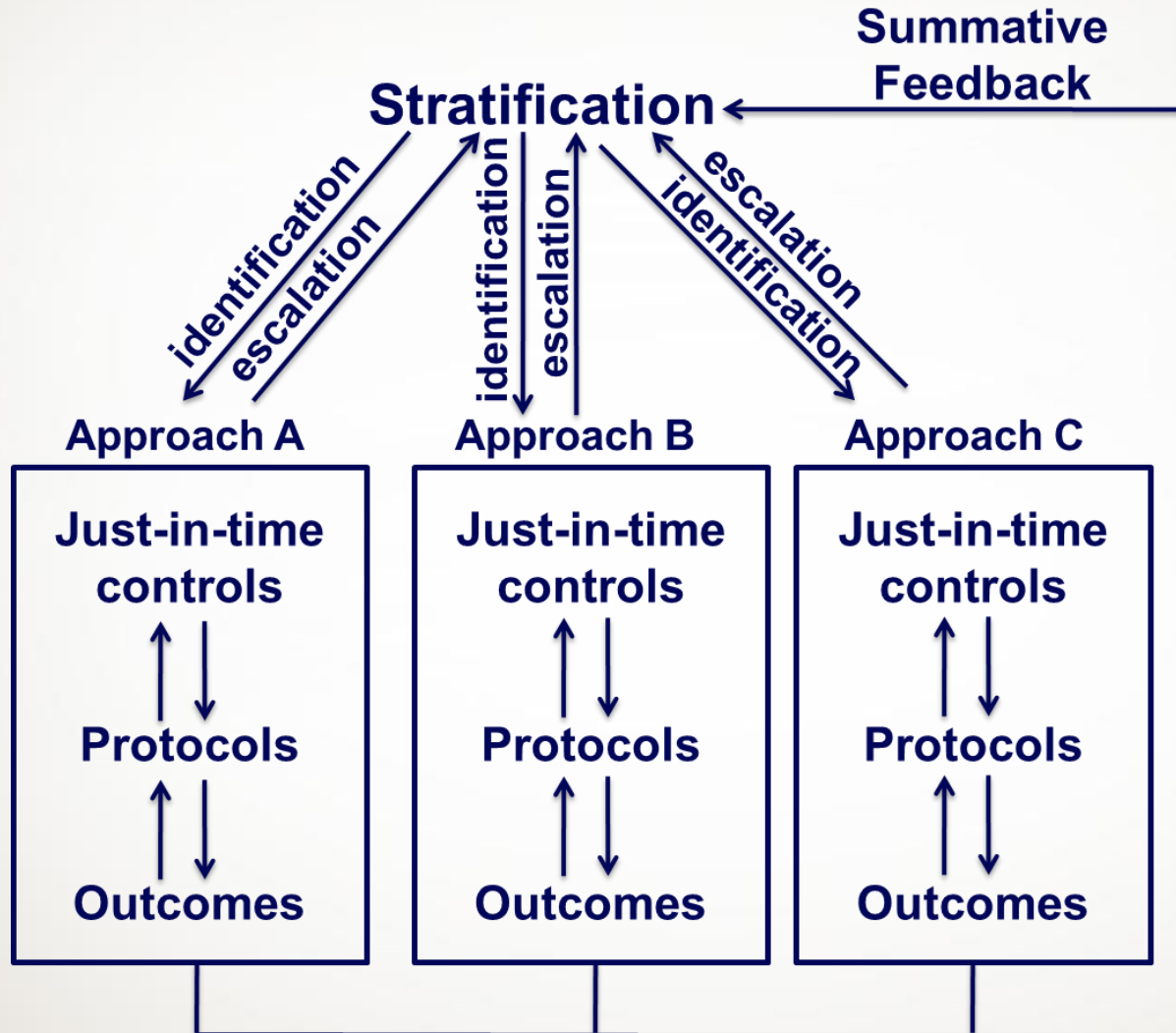
	1A	1B	2A	2B	3A	3B	C
1A	0.66	0.09	0.15	0.06	0	0	0.04
1B	0.52	0.11	0.2	0.09	0.01	0	0.07
2A	0.07	0.03	0.7	0.14	0.01	0.01	0.04
2B	0.14	0.04	0.54	0.19	0.01	0.01	0.07
3A	0.09	0.03	0.55	0.14	0.09	0.03	0.07
3B	0.11	0.04	0.51	0.16	0.07	0.03	0.08
C	0.38	0.1	0.27	0.11	0.01	0.01	0.12

Transition Probability Matrix

Sample Results



Vision: Adapting protocols to individual characteristics using control & feedback



Example 2: Patient Engagement



Today's approach is care-centric



Patient records data
to plan of care

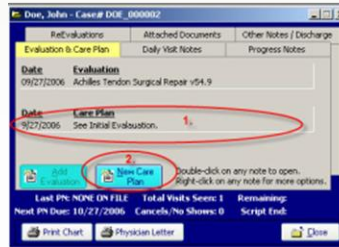
Clinician sifts &
interprets data as it
comes in



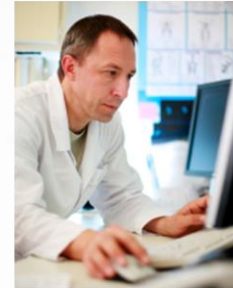
Today's Care-centric Patient Engagement



→
Patient records data to plan of care



→
Clinician sifts & interprets data as it comes in



Data

- Episodic and sparse data collection, limited to health information patient chooses to actively upload

Patient involvement

- Requires additional work from the patient to enter data into health journal or portal

Clinician interaction

- Requires additional work from clinician to interpret data entered by patient provides little incremental value in a vacuum

Vision – Individual Life Management



Aids improve quality of life & care plan adherence



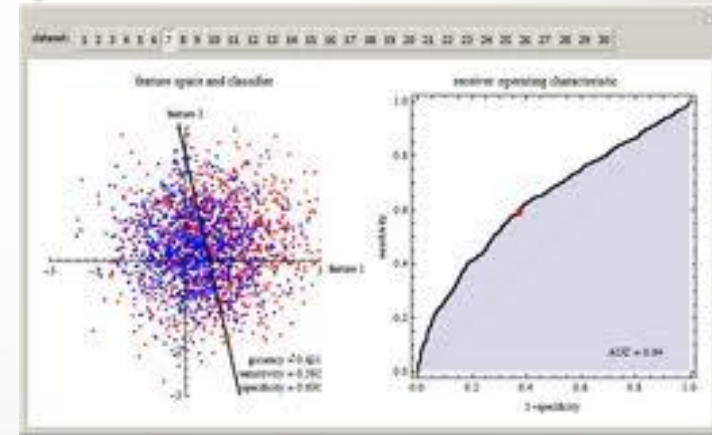
Sensors collect robust data continuously



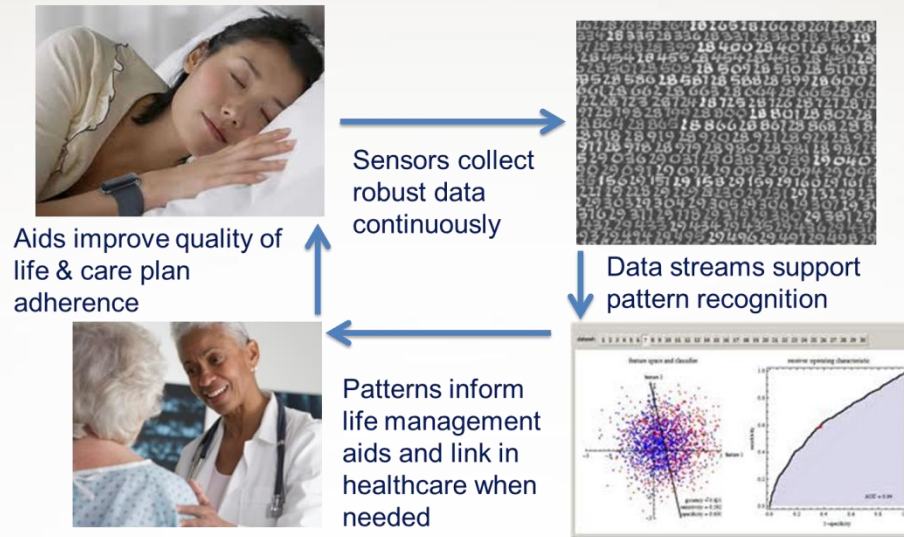
Data streams support pattern recognition



Patterns inform life management aids and link in healthcare when needed



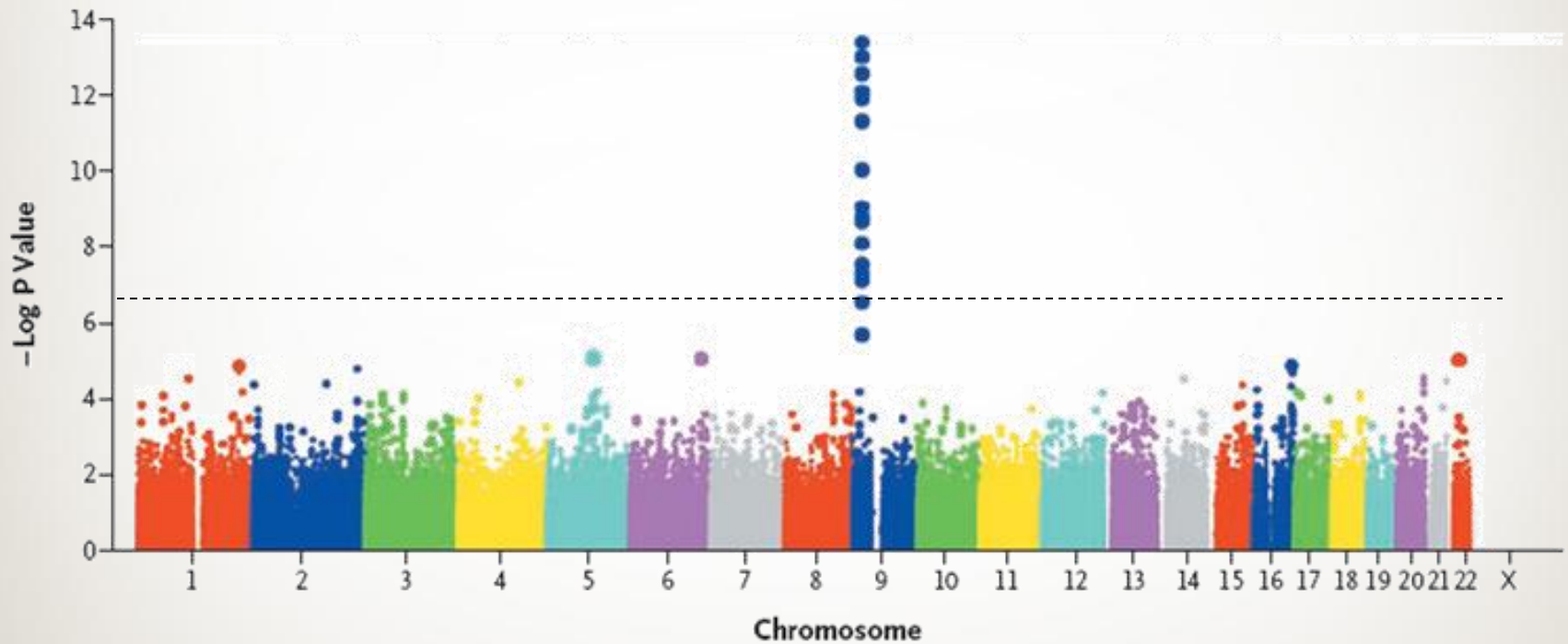
Vision – Individual Life Management



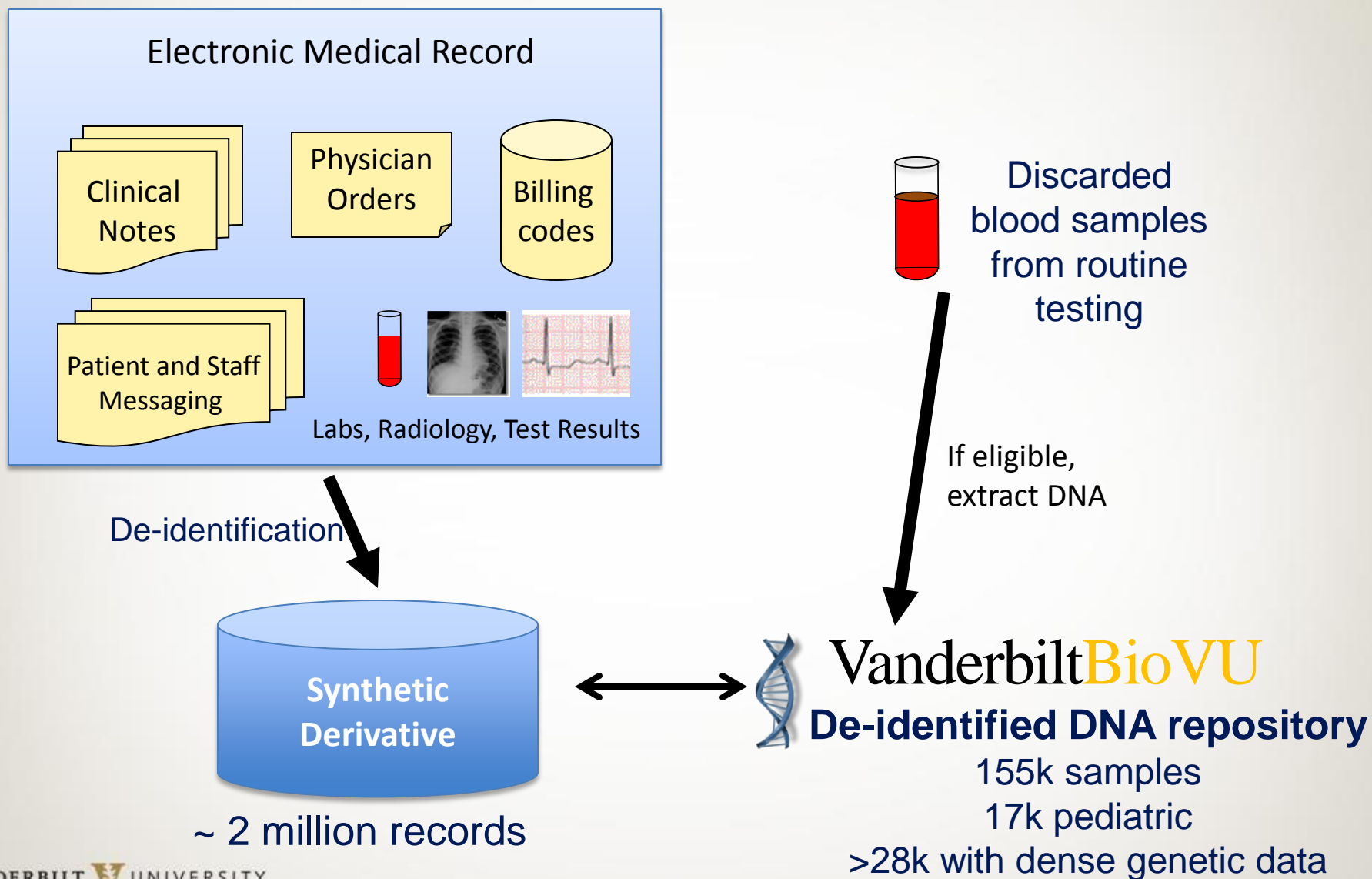
- Sensors gather a rich variety of data. Context sensitive “whole life” algorithms detect patterns and inform individual life management aids.
- Individual is supported in active life management, visualizing trends, potential for change, and actionable steps
- Individual is alerted to link in healthcare when appropriate, proactively targeting clinician interaction to areas of concern
- Privacy is protected by restricting access to summary interpretation/trends unless drill down is requested & permitted

Example 3: Harnessing healthcare for discovery

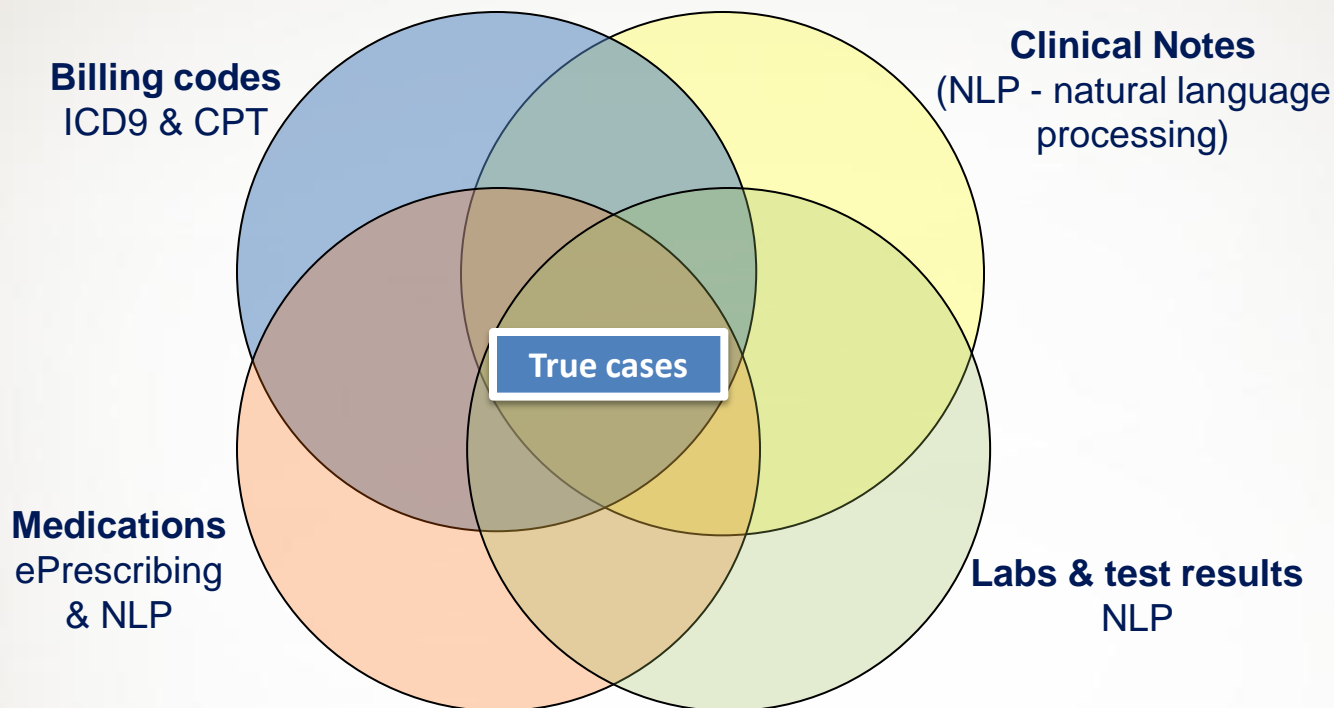
Today' standard: Genome-wide association study (GWAS)



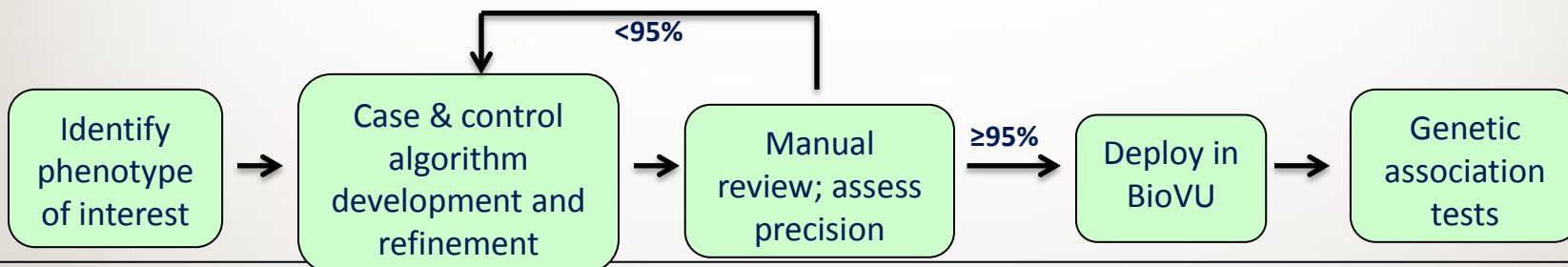
The electronic medical record as a platform for research



Finding phenotypes in the EMR

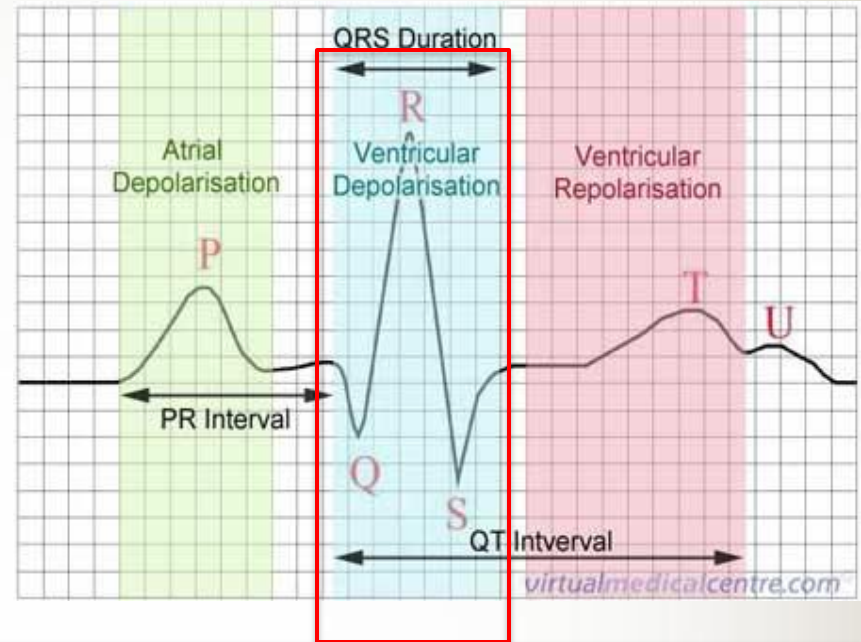


Algorithm Development and Implementation

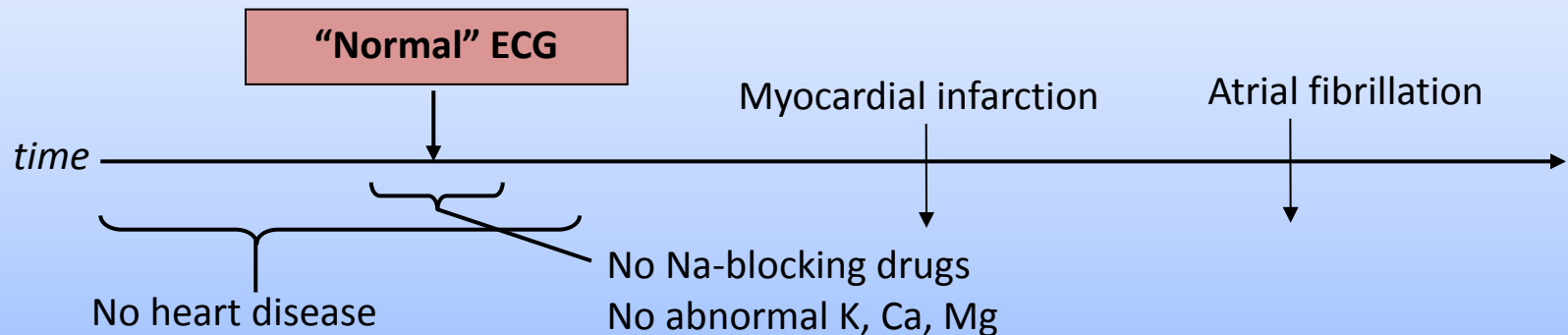


Proof of concept: normal cardiac conduction

- Find individuals with normal cardiac conduction
- Find genetic variants associated with **QRS duration**



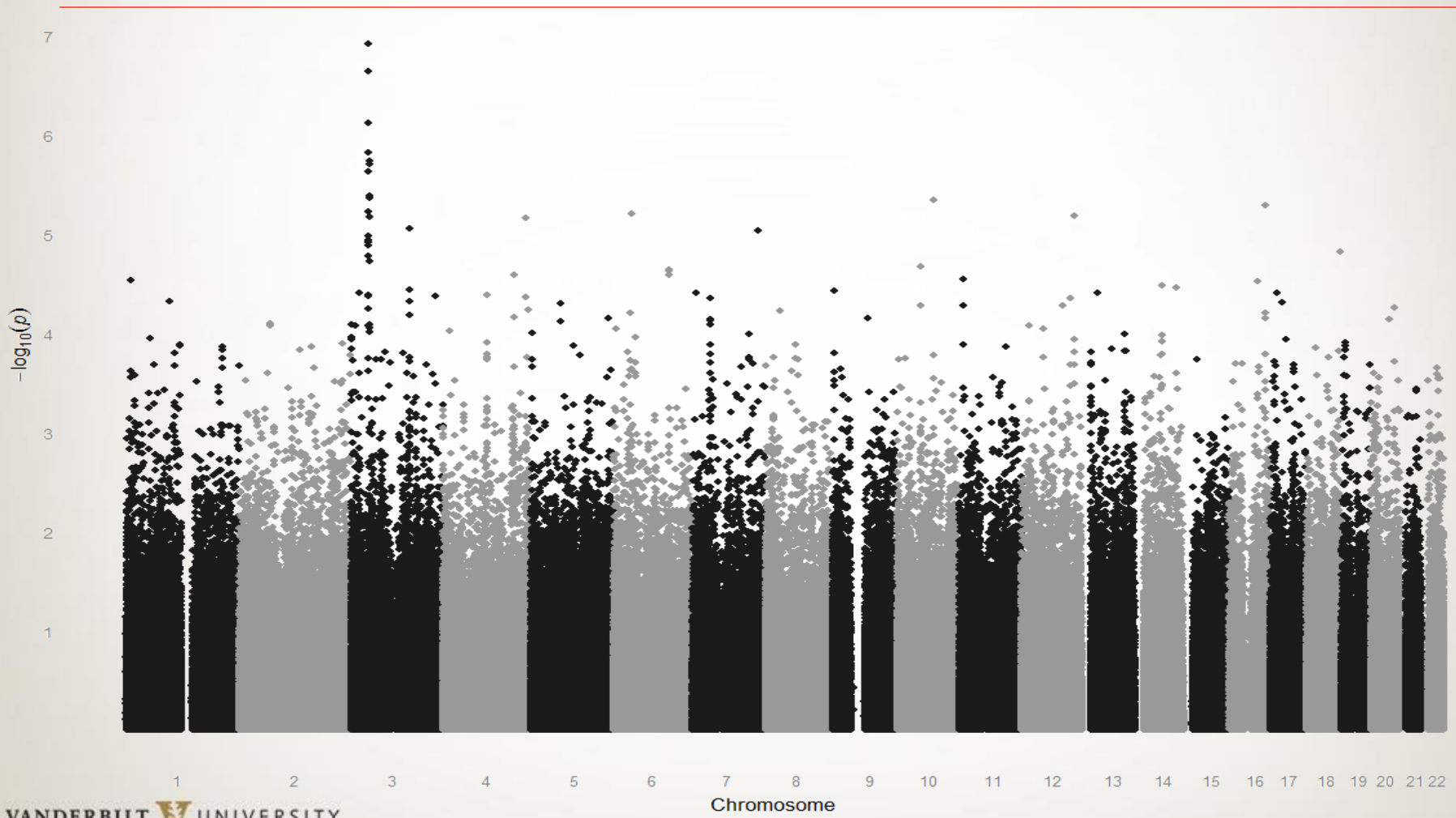
Hypothetical Record



GWAS of QRS duration

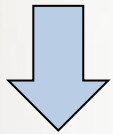
SCN5A/SCN10A

n=5,272

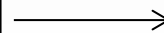
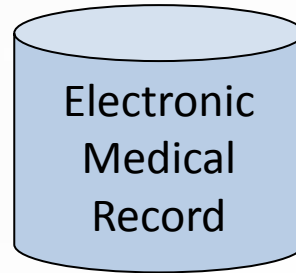
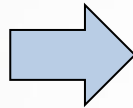


“PheWAS” – Phenome-wide association study

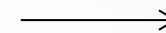
Genotype of interest
(e.g., *SCN10A*
rs6795970)



PheWAS



Phenotype
mapping



~1,400 Clinical
phenotypes (&
controls)



Compare with genetic loci

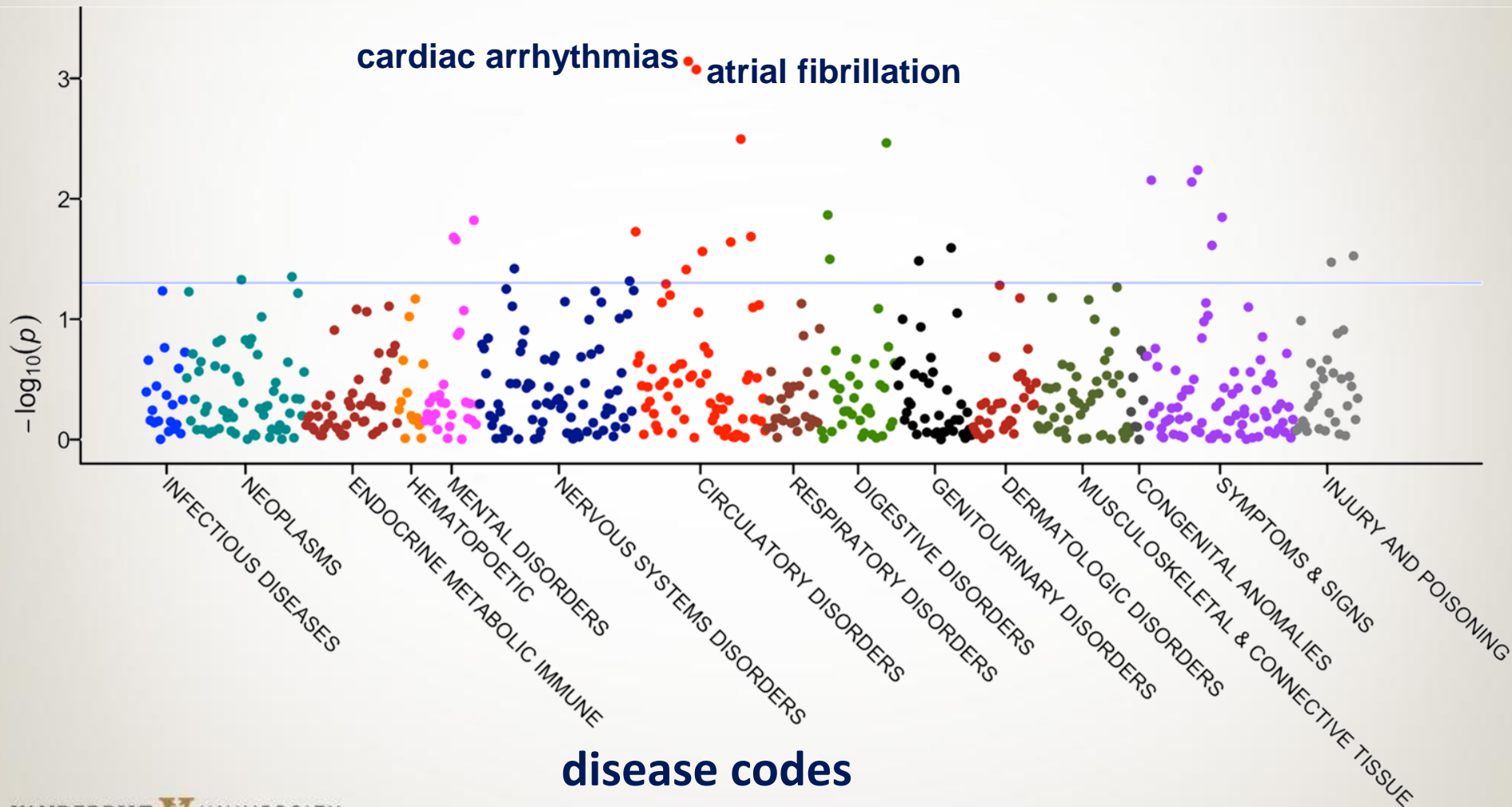
VanderbiltBioVU

The eMERGE Network
electronic Medical Records & Genomics

A consortium of biorepositories linked to electronic medical records data
for conducting genomic studies

PheWAS of rs6795970 (*SCN10A*) (associated with longer QRS duration in normal hearts)

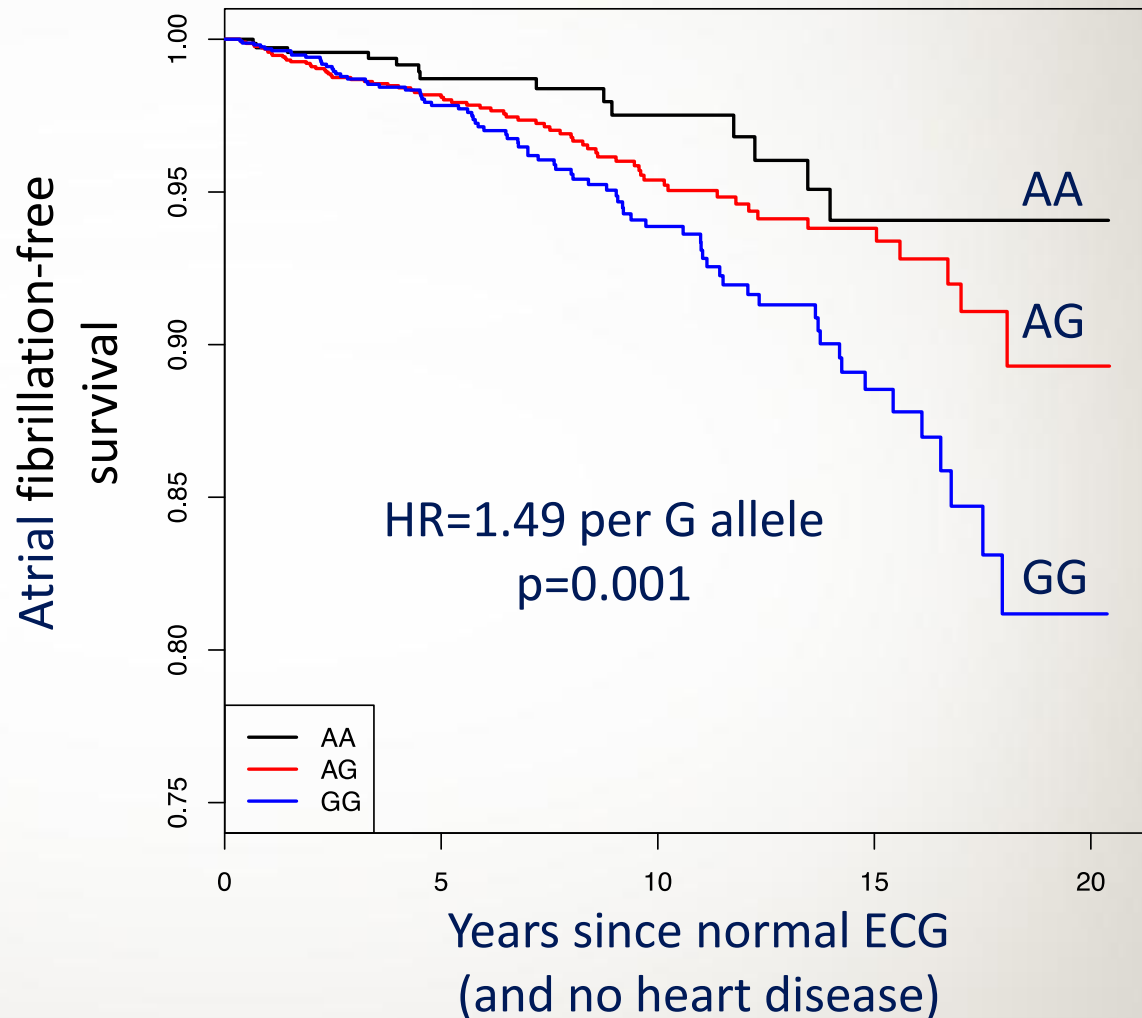
N=13617 subjects



In silico “trial” of what happens in the “heart healthy” population?

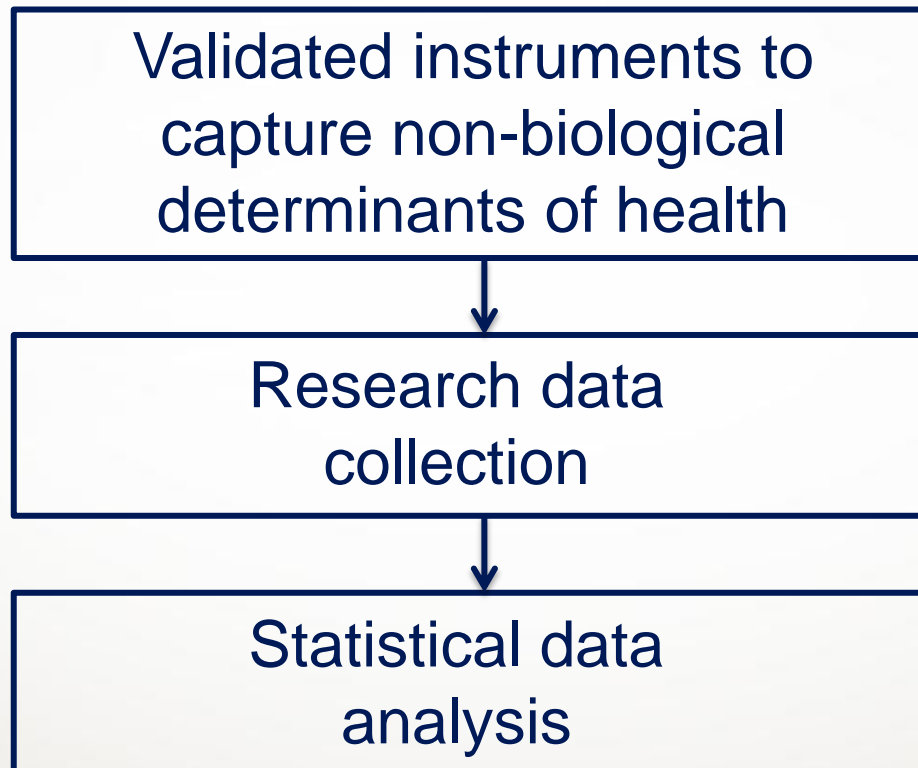
Examined the n=5272
“heart healthy”
population

Followed for
development of **atrial
fibrillation** based on
genotype



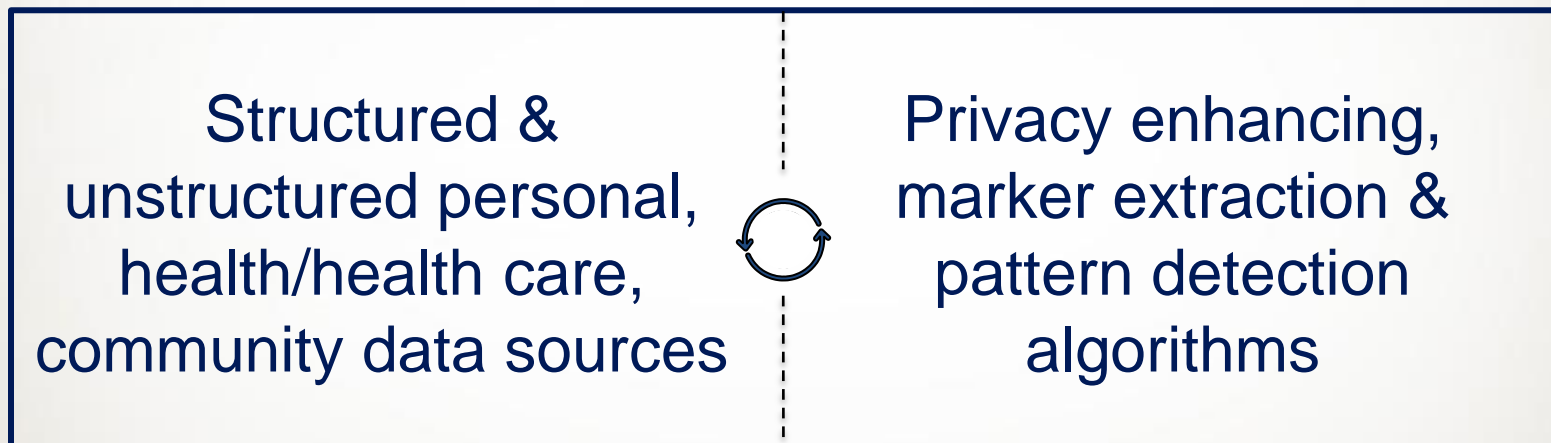
Vision: adding non-biologic determinants of health

Step 1: Health services & social science research

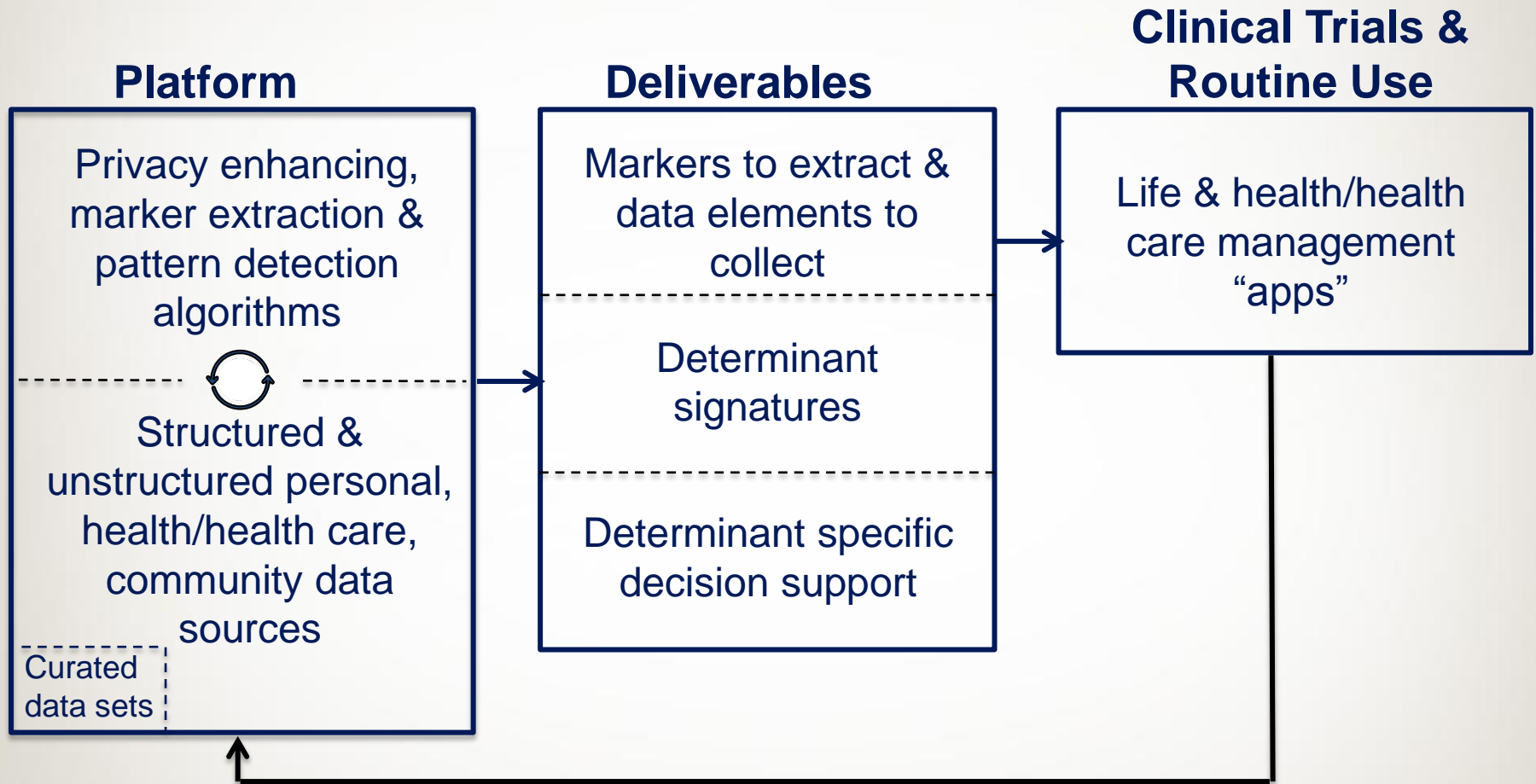


Vision: adding non-biologic determinants of health

Step 2: Population-scale “whole person” data for hypothesis generation & algorithm development



End game vision: executable knowledge to support “whole person” health/medicine



Smart Health: Path toward the vision

Harness Health/Healthcare as “real world” test beds:

- Adapt “non-system” to “system-based approaches” on a small scale to test approaches with potential to scale-up
- Use system engineering spiral development, feedback and control for proof of concept & optimization
- Aggregate data broadly for “population scale” pattern detection & visualization
- “And” computational awareness with human reasoning under uncertainty & judgment
- Use modeling to explore & formalize relationships