The MURDOCK Study and Project Baseline: platforms for collaboration and discovery

Thursday, November 2, 2017
CIEMAS Building - Room 2240
12:00 PM - 1:00 PM

L. Kristin Newby, MD, MHS
Disclosures

- **Research**: NIH, Amylin/Bristol Myers Squibb, GlaxoSmithKline, Verily Life Sciences, Metanomics, Boehringer Ingelheim, Sanofi

- **Consulting/Honoraria**: BioKier, Roche Diagnostics, Philips Healthcare, NIH, Metanomics, Ortho-Clinical Diagnostics

- **Organizations**: Co-Chair, SCPC Foundation Board (part of ACC); Trustee, AstraZeneca HealthCare Foundation; Deputy Editor, *JACC: Basic to Translational Science*
Mortality in the 20th Century

Reduced infectious disease mortality (clean water, sewers, antibiotics, better nutrition)

Better treatment of cardiovascular disease, low birth weight infants
Global Projections for 2030

Source: WHO statistics 2008
Limitations of Current Approaches

• Therapies (drugs, devices and behavioral interventions) are developed to treat all patients with the same clinical diagnosis – “one size fits all”
  – Many therapies work in only a fraction of the patients for whom they are prescribed
  – Medical errors or adverse events from therapy remain limitations of treatment

• So, we still have room for significant progress in getting the right treatment to the right person at the right time (Precision Medicine)
Ideally We Would Reclassify Disease

- Cancer
- Excercise + Diet A
- Exercise + Diet B
- Exercise + Diet + Medication

Diabetes

Genetic & Genomic Profiling

Responder

Adverse event

Non-responder

Diet + Medication
The MURDOCK Study
What is the MURDOCK Study?

**Measurement to Understand the Reclassification of Disease Of Cabarrus / Kannapolis**

- **Overarching goal**
  - Integrate population data (participant-reported, clinical, and molecular) as well as publicly available data sources in a geospatial framework to
    - characterize health and disease, identify early signals of disease, risk for clinical events and response to treatment;
    - measure and predict population health outcomes;
    - provide a platform to conduct clinical and health services research
Details of the MURDOCK Study?

Distance from Durham to Kannapolis: 118 miles <2 hours, accessible by Amtrak

Fall 2007: Community education and engagement begin
February 2009: First participant enrolled
February 2016: 12,272 participants enrolled, registry recruitment ends
February 2016-present: Follow up phase; ancillary studies
Details of the MURDOCK Study

Distance from Durham to Kannapolis:
118 miles <2 hours, accessible by Amtrak

MURDOCK Leadership Team

Kristin Newby, MD, MHS  Erich Huang, MD, PhD  Geoff Ginsburg, MD, PhD  Julie Eckstrand, PharmD
Our Operations Team

**Director of Operations**

**Julie Eckstrand, RPh**

**Project Leadership**

**Doug Wixted, MMCi Strategic Services**

**Leah Bouk, CCRC, MBA, Clinical Operations**

**Perla Nunes, Community Engagement**

**Karen Johnson, Opportunity Development**

**Brooke Heidenfelder, PhD, Project Leadership**
Brief History of Duke in Kannapolis

- 2008: Duke opens its first office on the NC Research Campus, establishing its presence in Kannapolis.
- 2010: MS cohort enrolls its first participant.
- 2011: Nature publishes Duke MURDOCK Study research on the IL28B polymorphism in hep C virus. 5000th participant enrolled in MURDOCK Study.
- 2012: New studies, new cohorts, new publications, new collaborators, industry-sponsored study, growing number of participants, expanded catchment region, growth in operations and capabilities, new clinical operations space.

Present Day:

New studies, new cohorts, new publications, new collaborators, industry-sponsored study, growing number of participants, expanded catchment region, growth in operations and capabilities, new clinical operations space.
The MURDOCK Study Design

**HORIZON 1**
Used legacy samples and associated data to generate molecular biosignatures

Generated hypotheses to reclassify disease
- Cardiovascular disease
- Liver disease
- Obesity
- Osteoarthritis

**HORIZON 2**
Prospective cohort studies underway
- Multiple sclerosis
- Memory & Cognitive Health
- Healthy Aging
- Severe Acne
- Type 2 diabetes
- Medical records

Analyses using samples/data
- Prostate cancer
- Vascular/Alzheimer’s

**HORIZON 3**
New molecular data from diverse patient populations

New cohort studies

New meta-analyses

International collaborations

Measurement of public health impact

**Horizon 1.5:** Community registry of adults in Kannapolis/Cabarrus County and surrounding region of North Carolina.
- More than 12,000 participants
- Nearly 450,000 annotated samples
**Associated Data Available from Horizon 1 by Platform**

<table>
<thead>
<tr>
<th>Platform</th>
<th>Targeted Metabolomics</th>
<th>Proteomics</th>
<th>GWAS</th>
<th>Gene Expression</th>
<th>Imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Proteomics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Discovery</strong></td>
<td><strong>Targeted</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CVD</td>
<td>2023 plasma</td>
<td>60 plasma (30+30)</td>
<td>500 plasma (250+250)</td>
<td>2023</td>
<td>500 PaxGene RNA (250+250)</td>
</tr>
<tr>
<td>HCV</td>
<td></td>
<td>96 serum</td>
<td>96 serum</td>
<td>96 serum</td>
<td></td>
</tr>
<tr>
<td>OA</td>
<td></td>
<td>48 urine 14 synovial fluid</td>
<td>Pending 108 serum</td>
<td>1258</td>
<td>138 individuals (248 non-replaced knees)</td>
</tr>
<tr>
<td>Obesity</td>
<td>500 plasma 500 serum @ baseline</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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Study Inclusion Criteria and Consent

Inclusion criteria:
• Age 18 or older and reside in qualifying zip code
• Residential zip code requirement waived for:
  • All first responders who work in catchment area
  • Male healthcare workers who work in catchment area
  • People who work at the North Carolina Research Campus

Participants consent to:
• Health questionnaire (illness, PROs, activity, diet, lifestyle, meds and demographics)
• Brief exam (HR, BP, waist circumference)
• Blood and urine samples for unspecified future research
• Contact for annual follow-up
• Contact up to 4x/year for participation in other research studies
• Ongoing access to medical record
• Geospatial mapping
• Participation indefinite or until consent withdrawn
Eligible Zip Codes of MURDOCK Catchment Area

Includes Kannapolis and Cabarrus County, and portions of Mecklenburg, Rowan and Stanly Counties, all in North Carolina

* Duke opened clinical office space in Kannapolis in August 2015
* Multiple sites offer convenience for participants and access to diverse patient population for researchers
* Additional sites can be added for new study recruitment

Duke-Kannapolis operations live here

Enrollment Sites
1. Kannapolis Internal Medicine
2. CMC-NorthEast
3. Community Free Clinic
4. Logan Family Resource Center
5. Harrisburg Sleep Center
6. Bethesda Health Center
7. Lake Norman Community Health Clinic
8. Ada Jenkins Center
MURDOCK Study enrollment; Baseline data capture

Annual Follow-up leads to discovery of eligibility for new study

Enrollment in COPD cohort

Follow-up data capture

Age

0 15 30 58 59 60

Asthma

Depression

High Blood Pressure

Diagnoses of COPD
### Self-Reported Diseases

<table>
<thead>
<tr>
<th>Heart</th>
<th>Metabolic</th>
<th>Neurological</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronary artery disease</td>
<td>Diabetes</td>
<td>Alzheimer’s disease</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>High cholesterol</td>
<td>Depression</td>
</tr>
<tr>
<td>Heart attack or angina</td>
<td>Thyroid disease</td>
<td>Other mental illness</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>High blood pressure</td>
<td>Stroke</td>
</tr>
<tr>
<td>ICD or pacemaker placement</td>
<td>Obesity</td>
<td>Multiple sclerosis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cancer</th>
<th>Lung/Respiratory</th>
<th>Gastrointestinal/Renal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast cancer</td>
<td>Asthma</td>
<td>Crohn’s disease/UC</td>
</tr>
<tr>
<td>Colon cancer</td>
<td>Emphysema or COPD</td>
<td>Liver disease</td>
</tr>
<tr>
<td>Lung cancer</td>
<td></td>
<td>Kidney disease</td>
</tr>
<tr>
<td>Prostate cancer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cervical cancer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melanoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin cancer, not melanoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral cancer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other type of cancer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bone/Joint</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Osteoarthritis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rheumatoid arthritis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other autoimmune disease</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Osteoporosis/Osteopenia</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gout</td>
<td></td>
</tr>
</tbody>
</table>

*Collected at both baseline and follow-up timepoints*
Banked Sample Inventory

- Average number of aliquots stored per participant: ~35
  - Collected for all participants at baseline under MURDOCK Registry
  - Follow-up sample collection dependent on protocol
- Nearly 450,000 samples stored
  - Retrieved for variety of studies

<table>
<thead>
<tr>
<th>Stored as</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasma</td>
<td>0.5 mL</td>
</tr>
<tr>
<td>Serum</td>
<td>0.5 mL</td>
</tr>
<tr>
<td>Whole blood</td>
<td>3 mL</td>
</tr>
<tr>
<td>PAXGene RNA</td>
<td>2.5 mL</td>
</tr>
<tr>
<td>Buffy coat</td>
<td>not applicable</td>
</tr>
<tr>
<td>Urine</td>
<td>10 mL</td>
</tr>
</tbody>
</table>
**Snapshot of the MURDOCK Study Cohort**

N=12,272 participants

<table>
<thead>
<tr>
<th></th>
<th>% MURDOCK</th>
<th>% Region*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>66.0</td>
<td>51.3</td>
</tr>
<tr>
<td>African American</td>
<td>13.2</td>
<td>35.3**</td>
</tr>
<tr>
<td>Asian</td>
<td>0.7</td>
<td>3.5</td>
</tr>
<tr>
<td>Hispanic</td>
<td>12.3</td>
<td>10.9</td>
</tr>
<tr>
<td>Age (median)</td>
<td>56</td>
<td>—</td>
</tr>
<tr>
<td>Rural</td>
<td>—</td>
<td>12.5</td>
</tr>
<tr>
<td>≥ HS diploma</td>
<td>90.0</td>
<td>87.1</td>
</tr>
</tbody>
</table>

*Data based on U.S. Census tracts

**African Americans in Cabarrus County represent 17.1% of the County population (2014).**
## Selected Self-Reported Illnesses

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>% of Total Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oncology</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breast</td>
<td>343</td>
<td>3.1</td>
</tr>
<tr>
<td>Colon</td>
<td>105</td>
<td>0.9</td>
</tr>
<tr>
<td>Lung</td>
<td>58</td>
<td>0.5</td>
</tr>
<tr>
<td>Prostate</td>
<td>221</td>
<td>2.0</td>
</tr>
<tr>
<td>Cervical</td>
<td>141</td>
<td>1.3</td>
</tr>
<tr>
<td>Melanoma</td>
<td>368</td>
<td>3.3</td>
</tr>
<tr>
<td><strong>Diabetes</strong></td>
<td>1953</td>
<td>17.5</td>
</tr>
<tr>
<td><strong>Obesity</strong></td>
<td>2979</td>
<td>26.7</td>
</tr>
<tr>
<td><strong>High Cholesterol</strong></td>
<td>4795</td>
<td>43.0</td>
</tr>
<tr>
<td><strong>Hypertension</strong></td>
<td>4206</td>
<td>37.7</td>
</tr>
<tr>
<td><strong>Osteoarthritis (OA)</strong></td>
<td>2489</td>
<td>22.3</td>
</tr>
<tr>
<td><strong>Depression</strong></td>
<td>3030</td>
<td>27.2</td>
</tr>
<tr>
<td><strong>CAD</strong></td>
<td>1093</td>
<td>9.8</td>
</tr>
</tbody>
</table>

N=12,272 MURDOCK Study participants
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## Initial Horizon 2 Studies

<table>
<thead>
<tr>
<th>Horizon 2 Studies</th>
<th>Lead Investigator</th>
<th>Current N</th>
<th>Enrollment Goal</th>
<th>Additional Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Sclerosis</td>
<td>Simon Gregory</td>
<td>691</td>
<td>1000</td>
<td>Dx of MS, MS-specific questionnaire</td>
</tr>
<tr>
<td>Primary Progressive MS</td>
<td>Simon Gregory</td>
<td>10</td>
<td>100</td>
<td>MS-specific questionnaire, serial sampling for 5 years</td>
</tr>
<tr>
<td>Memory and Cognitive Health</td>
<td>Kathy Welsh-Bohmer</td>
<td>1500+</td>
<td>1500</td>
<td>MoCa, CERAD, Trail Making Test, Part B; follow-up testing and sample collection at 3 years</td>
</tr>
<tr>
<td>Healthy Aging (Physical performance and cognitive assessment)</td>
<td>Miriam Morey Harvey Cohen</td>
<td>805</td>
<td>1000</td>
<td>Gait speed, 30-second chair stand, balance test, 6-minute walk test, 7-day accelerometry, MoCA, follow-up at 2 years</td>
</tr>
<tr>
<td>Severe Acne</td>
<td>Russell Hall (David Goldstein)</td>
<td>121</td>
<td>200</td>
<td>Current or previous dx of severe acne vulgaris and oral isotretinoin; acne-specific questionnaire</td>
</tr>
<tr>
<td>Centenarians</td>
<td>Liz Cirulli (David Goldstein)</td>
<td>20</td>
<td>20</td>
<td>None</td>
</tr>
</tbody>
</table>
# Current Projects, by PI and Sponsor

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Principal Investigator(s)</th>
<th>Sponsor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The Baseline Study</strong></td>
<td>Kristin Newby, Duke Clinical &amp; Translational Science Institute</td>
<td>Verily (Google)</td>
</tr>
<tr>
<td><strong>MURDOCK Study Physical Performance (Healthy Aging)</strong></td>
<td>Miriam Morey, Harvey Cohen, Duke Pepper Center</td>
<td>National Institute of Aging (NIA) Pepper Center renewal funding</td>
</tr>
<tr>
<td><strong>COPD Observational Study: The relationship between GOLD risk group and clinical outcomes in a community-based COPD cohort</strong></td>
<td>Scott Palmer, Jamie Todd, Duke Clinical Research Institute</td>
<td>Boehringer Ingelheim</td>
</tr>
<tr>
<td><strong>Assessing the Quality of EHR Data and Participant-Reported Data</strong></td>
<td>Carl Pieper, Duke Pepper Center</td>
<td>Patient-Centered Outcomes Research Institute (PCORI)</td>
</tr>
<tr>
<td><strong>Diabetes Self-Management &amp; Support LIVE (Learning in Virtual Environments)</strong></td>
<td>Constance Johnson, Allison Vorderstrasse, Duke School of Nursing</td>
<td>National Heart, Lung, and Blood Institute (NHLBI)</td>
</tr>
<tr>
<td><strong>Using Mobile Phones to Reduce Chewing Tobacco in Rural Communities: PACT Project</strong></td>
<td>Devon Noonan, Duke School of Nursing</td>
<td>National Cancer Institute</td>
</tr>
<tr>
<td><strong>IPF-PRO Biomarker Study</strong></td>
<td>Jamie Todd, Duke Clinical Research Institute</td>
<td>Boehringer Ingelheim</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Project</th>
<th>PI and Sponsor</th>
<th>Sponsor/Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reclassifying Primary Progressive MS</strong></td>
<td>Simon Gregory, Duke Molecular Physiology Institute</td>
<td>Herman Stone Foundation, internal funds</td>
</tr>
<tr>
<td><strong>Population-level interrogation of novel alternatively spliced genes in race-related aggressive prostate cancer</strong></td>
<td>Steven Patierno, Jennifer Freedman, Duke Cancer Institute</td>
<td>Duke Genitourinary Oncology Research Program and internal funds</td>
</tr>
<tr>
<td><strong>Metabolic Signatures Underlying Vascular Risk Factors for Alzheimer-type Dementias</strong></td>
<td>Rima Kaddurah-Daouk, Duke Psychiatry</td>
<td>National Institute of Aging (NIA)</td>
</tr>
<tr>
<td><strong>MURDOCK-NCRC Seed Funding Vouchers</strong></td>
<td>Saroja Voruganti, UNC NRI Manya Warrier, UNC NRI Mary Ann Lila, NC State Kevin Knagge, DHMRI Nowlan Freese, UNCC Renaud Warrin, NC A&amp;T</td>
<td>Duke-MURDOCK support for work at the DHMRI</td>
</tr>
<tr>
<td><strong>Profiling MURDOCK nutrition environment</strong></td>
<td>Matt Harding, Sanford-BECR</td>
<td>Internal; in progress</td>
</tr>
</tbody>
</table>
N=12,265 MURDOCK Study participants, percentage of total shared above.
### Duke-Kannapolis Engagement: At-A-Glance

<table>
<thead>
<tr>
<th>Metric</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of collaborations</td>
<td>&gt;68</td>
</tr>
<tr>
<td>Number of Duke faculty engaged</td>
<td>&gt;47</td>
</tr>
<tr>
<td>Number of Duke departments / institutes / centers engaged</td>
<td>28</td>
</tr>
<tr>
<td>Number of non-Duke faculty engaged</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Number of institutional agreements</td>
<td>4</td>
</tr>
<tr>
<td>Number of federal grant submissions utilizing Duke-Kannapolis infrastructure*</td>
<td>26</td>
</tr>
<tr>
<td>Number of awarded federal grants to which Duke-Kannapolis contributed</td>
<td>11</td>
</tr>
<tr>
<td>Number of industry-sponsored studies executed or under development</td>
<td>7</td>
</tr>
</tbody>
</table>

*This count includes number of grants that promoted assets of the Duke-Kannapolis site and the MURDOCK Study in support of their applications.
- Based on reporting from November 2016.

### Breakdown of Current and Pending Awards by Sponsor Type

- **Federal**: 53.8%
- **Industry**: 25.9%
- **Foundation**: 7.4%
- **Other**: 14.8%
MURDOCK Integrated Data Repository (MIDR)

- Geospatial/environmental Data
- Clinical Data / CRF
- Electronic Health Records
- Biospecimen Data
- Omics, Imaging Metadata
- Study Metadata
- Consent Data

Data mining, disease stratification, predictive algorithms, pathway modeling, systems biology

Metadata queries, cohort selection, administrative reports

Discovery
Information Retrieval
Collaboration with Duke-Kannapolis
Collaborators share their experiences in their own words

“Simply put, interaction with the MURDOCK study team has driven the success of my MURDOCK-MS sub-study…They have been responsive and proactive during the 5+ years of recruitment, and have set us up for future success with the study.”
—Simon Gregory, PI, MURDOCK Horizon 2 MS Study

“We are truly grateful to receive [sample] shipments that are so well-organized, packed, and documented. ... Your team’s careful maintenance of sample provenance and control of the chain of custody meet the highest standards in the profession. Analysis of certain metabolites clearly shows that MURDOCK plasmas were processed promptly and with care. ... Our DMPI lab looks forward to further collaborations with MURDOCK-CTSI.”
—James Bain, Faculty Co-Director, Metabolomics Laboratory, Duke Molecular Physiology Institute

“MURDOCK leadership and staff worked closely with me on multiple aspects of a large 5-year NIH proposal on smoking cessation and provided substantial value to the proposal by offering recruitment through existing relationships with the MURDOCK study population, access to comprehensive environmental data on participants through geospatial mapping datasets and correlational analysis with genomic and longitudinal health outcomes data. Access to this kind of nuance and sophistication profoundly expanded the scope and impact of the proposal. The MURDOCK research infrastructure was thoughtfully designed to enable researchers to more effectively test the boundaries of our current understandings of human behavior.”
—James Davis, Director, Duke Smoking Cessation Center
Collaborating is Easy

1. Investigator has new idea and consults with CTSI TransPop leadership

2. Complete online submission via MURDOCK Study website Proposal Concept Form: murdock-study.com

3. Proposal concept form to MURDOCK Leadership with budget

4. MURDOCK Leadership reviews form

5a. Proposal approved to proceed

5b. Proposal changes are requested for re-review

6. Proposal concept evolves into proposal submission to funding agency/sponsor

Contact:
Melissa Cornish, CTSI
(919) 622-2254
melissa.cornish@duke.edu
Why Join?

Am I Eligible?

What’s Next?

Help us improve the health of the community one person at a time.
Be one of the 50,000 people in our community who will help us better understand health and disease.

Enroll Now
Be one of 50,000 people in our community to help us improve the understanding of health and

In the Community
The success of the Duke-MURDOCK Study correlates directly to the engagement of

Partner With Us
The MURDOCK Study offers a breadth of assets and capabilities that have been

Publications
The MURDOCK Study is committed to informing participants about all of the latest research findings

Duke Translational Research Institute
Where Are We in 2017?

Dawn of the Era of “Big Data” in Science and Healthcare
Big Challenges in Biomedicine

• Lack of significant information over time dimension
  – Measurements to assess biology and human health are made periodically in visits to healthcare or for research

• Missing systems biology
  – When developing concepts of human biology or drug development we make limited measurements focused on specific mechanisms —we look “under the lamppost”

• Missing the opportunity to measure interactions of biology, sociology, environment and decision-making that could enable optimization of individualized and population health
  – Although we know that health and disease are the product of the interactions of genes, multiple derivative biological systems, environment, social context and personal decisions, we tend to look at one part of the time
A quest to map human health
The first study is a collaboration among teams at Verily, Duke University School of Medicine, Stanford Medicine, and Google
Learn about Project Baseline - Join the Registry

To participate in the Project Baseline Registry, individuals must be:

- 18 years or older
- Able to speak and read English or Spanish
- Willing to share contact information and answer questions about their health and personal history

www.projectbaseline.com
Project Baseline Registry

Project Baseline registry or “online community”

Project Baseline study
N=10,000
Who can participate in the study?

Participants in the Project Baseline study must be:

• 18 years or older
• Able to speak and read English or Spanish
• Not allergic to nickel or metal jewelry
• Able to travel to a Baseline study site

N=10,000
Stratified by age and sex within risk groups
High risk groups are not disjoint; a single participant may be considered at elevated risk for both CVD and multiple cancers.
A comprehensive study of human health and the transition to disease

A longitudinal cohort study to extensively characterize participants at baseline and serially using clinical, molecular, imaging, sensor, self-reported, behavioral, environmental, and other health-related data.
Project Baseline Study Participants and Timeline

N=10,000

*In-person visits for participants at high risk for breast or lung cancer or CVD
Human Health and Transition to Disease

Baseline

Unhealthy

Amyloid Plaques

Cancer Mutations

Aberrant Blood Work

Correlation to family disease history
Project Baseline Study
Biospecimen Collection and Analysis

Sample Types
• Blood
• Urine
• Tears
• Saliva
• Microbiome
  - Stool and nasal, oral, retroauricular swabs

Create unique capabilities to process complex phenotypic, biochemical, and genomic data
Project Baseline Study
Imaging and Other Testing

- Cardiology
  - Echo, stress echo, CT for coronary calcium, ECG
- Ophthalmology
  - Retinal photos, OCT, corneal topography
- Pulmonary
  - PFTs, chest X-ray
- Audiometry
  - TBD
Project Baseline Study
Wearable Devices and Sleep Monitoring

Study Watch — Cardiac and Activity Monitor

Sleep Sensor
Project Baseline Study
Geospatial Mapping

Place Matters
Project Baseline Study—Data Flow
Novel Predictive Models of Health and Disease

Gene Expression Data

Clinical Data (EHR)
- Treatments, Family history, Demographics

Environmental Data

Physiologic Data
- mHealth Data

Signatures
- Models

Genome Data
- SNPs and CNVs
- Genome-scale sequence

Metabolomic Data

Proteomic Data

Imaging

Predictions:
- Risk
- Individualized Prognosis and Diagnosis
- Drug Response
- Environmental Response

Envisioning a Healthcare Ecosystem of Big Data

Ultimate Goals

• Integrate personal (clinical and biological) and external information to enable individuals, neighborhoods and populations to:
  – Optimize health, prevent disease, monitor treatment
  – Enable people to be as functional as possible

• Provide physicians and healthcare systems with continuously updated estimates of individual risk and the health and health behaviors of neighborhoods and populations
  – Enable directed education, prevention and treatment programs

• Use a more profound understanding of health and disease to inform development of new therapeutics and diagnostics
  – Early detection
  – Enable “precision medicine”