Personal, Dense, Dynamic Data Clouds and the Future of Personalized Nutrition

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Institute for Systems Biology
Seattle, WA

Nutrigenomics and the Future of Nutrition
National Academies Food Forum Meeting,
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Disclosures

• Co-Founder and Board of Directors of Arivale, which partially funded and may license discoveries from the Pioneer 100 Wellness Project (to be described).

• Scientific Advisory Boards for Habit, Trelsys, Novo Nordisk Foundation Center for Biosustainability, Roche (personalized medicine division)

• Consultant, advisor, or received honoraria and/or grant funding from Genentech, J&J/Janssen Pharmaceuticals, Sera Prognostics, Nature’s Bounty, Just Therapeutics, Amgen

Founders

Clayton Lewis, CEO and Co-founder
Maveron, MarketLeader, Harborview Medical Center, Capitol

Lee Hood, MD, PhD, Co-founder, SAB Chair
ISB, Amgen, National Academies, Presidential Medal

Nathan Price, PhD, Co-founder, Board of Directors
ISB, University of Washington, University of Illinois, UCSD
Nutrition health effects...

Multiple studies demonstrate nutritional effects on disease
Nutrition health effects... are complex: Need context and personalization

Everything we eat both causes and prevents cancer

[Screenshot of a graph showing the relative risk of cancer for various foods, with each food item plotted on a scale from 0.1 to 10, indicating how each food item's consumption relates to cancer risk]

SOURCE: Schoenfeld and Ioannidis, *American Journal of Clinical Nutrition*
Determinants of Health in U.S.

Nutrition!

60% Behavior & environment

30% Genetics

10% Health Care
Proposing the 100K Wellness Project

Hood and Price, Clinical Omics, (2014)

Promoting Wellness & Demystifying Disease: The 100K Project

Leroy Hood, M.D., Ph.D., and Nathan D. Price, Ph.D.

Systems Biology

Demystifying Disease, Democratizing Health Care

Unsustainable cost increases threaten the global health care system, and further progress is stymied more by societal than technological factors. Only by engaging health care consumers (that is, patients) as pioneers who provide both health-related data and insights into pathophysiology can we meet these societal challenges and thus accelerate the pace of biomedical innovation.

In March 2014, the Institute for Systems Biology will launch a longitudinal Framingham-like study (www.framinghamheartstudy.org) of 100,000 (10K) healthy individuals that we believe will be instrumental in bringing predictive, preventive, personalized, and participatory (P4) medicine to patients. Participatory medicine means that patients, researchers, physicians, and the entire health care community join forces to transform the practice of medicine to make it more proactive than reactive—and, in turn, less expensive and more effective (1).

People Power

A systems approach is necessary for the effective management of complex diseases (1). This fundamental component of P4 medicine is built on two central features. The first is a conviction that, in 5 to 10 years, each patient will have a dynamic data cloud consisting of billions of diverse types of data points and that medicine will be informed by computational analyses that reduce high-dimensional data to actionable hypotheses designed with the intent of optimizing wellness and minimizing disease in individual patients. The second feature is that integration of patient data will reveal biological networks that specify health and are altered in disease, and that through an understanding of these differences, one can gain fundamental insights into disease mechanisms. Such insights are essential for developing more effective diagnostic and therapeutic approaches. Indeed, such an approach has already provided powerful new technologies and strategies (2) that have brought us to the brink of P4 medicine (3).

At its foundation, P4 medicine is about quantifying wellness and demystifying disease. Individual data clouds will let us predict future wellness and disease. The preventive element focuses on how well we can improve individual wellness and take actions to stop or de-
Pioneer 100 Wellness Project
PIs: Lee Hood and Nathan Price

Assays / Measurements—108 Pioneers

Creating personal, dense, dynamic data (PD3) clouds

**GENOME**
Whole Genome Sequencing.
SNPs Millions

**LABS**
Detailed lab tests 3x (blood, urine, saliva)
Clinical chem. 150
Metabolites 700
Proteins 400

**SELF-TRACKING**
Continual self-tracking & lifestyle monitoring

**MICROBIOME**
Gut Microbiome 3x

Database of actionable possibilities that will grow over time
Wellness coaching for participants

Wellness Coach

Sandi Kaplan, MS, RD

Study Physician

Craig Keebler, MD
Clinical Labs Discovery:
Improvements in blood health with behavioral coaching

- Cardiovascular: Improved by 6%
- Diabetes: Improved by 33%
- Inflammation: Improved by 12%
- Nutrition: Improved by 21%
Diet modification to reduce heavy metal toxicity

1. Baseline: High mercury levels in blood

2. Coached to modify diet - eight weeks of eating salmon sushi vs. tuna sushi (3x a week)

3. Reduced mercury levels in three months

<table>
<thead>
<tr>
<th>Toxic Elements</th>
<th>Reference Range</th>
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</thead>
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<tr>
<td>Element</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>0.027</td>
<td>&lt;= 0.048 mcg/g</td>
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<tr>
<td>Mercury</td>
<td>0.0180</td>
<td>&lt;= 0.0039 mcg/g</td>
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<tr>
<td>Antimony</td>
<td>0.002</td>
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<tr>
<td>Arsenic</td>
<td>0.019</td>
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<td>Cadmium</td>
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<td>&lt;= 0.001 mcg/g</td>
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<tr>
<td>Tin</td>
<td>&lt;dl</td>
<td>&lt;= 0.0009 mcg/g</td>
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Deriving Insights from Data: New Frontiers
Nutrient measurements correlate with genetic predisposition for IBD

Cystine (plasma) → Cysteine (cytosol) → Glutathione (cytosol)

<table>
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<tr>
<th>Activity</th>
<th>Cystine (μM)</th>
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<tbody>
<tr>
<td>Control (n=65)</td>
<td>61.3 (1.7)</td>
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<tr>
<td>Crohn’s disease (n=33)</td>
<td>42.8 (2.4) ***</td>
</tr>
<tr>
<td>Before surgery</td>
<td>47.3 (1.8) ***</td>
</tr>
<tr>
<td>10 days after surgery</td>
<td>56.0 (3.0)</td>
</tr>
<tr>
<td>3 months after surgery</td>
<td>52.7 (2.8)</td>
</tr>
<tr>
<td>Ulcerative colitis (n=33)</td>
<td>64.3 (2.4)</td>
</tr>
<tr>
<td>Before surgery</td>
<td>47.3 (1.8) ***</td>
</tr>
<tr>
<td>10 days after surgery</td>
<td>64.3 (2.4)</td>
</tr>
<tr>
<td>3 months after surgery</td>
<td>64.5 (3.6)</td>
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Personalized Nutrition in the Real World
Creation of a Consumer-Based Scientific Wellness Company

Arivale™

2015 LAUNCH
Members Value

Data + Coaching + Action = Results
Technology Amplifies Coach Relationship

Mobile App Amplifies Coach Engagement

Dashboard: Brings Data to Life

Action item tracking

Coach interaction

Food tracking

Food:

- I have a business trip coming up. Any advice?
- Sure thing! What action item are you most concerned about continuing during your trip?
- Getting the protein in at breakfast.
- I usually just grab a latte when traveling.
- Love that you’re so focused on this.
- Pack nuts and salmon jerky in your suitcase to eat with your latte.
- Great! I’ll try that.
- I’ll check in tomorrow. Text me a photo of your breakfast.

Photo:

- Meal type: Dinner

Heart Health

- HDL: Good Cholesterol
- Total Cholesterol

Genetics

- LPL: 115
- APOC: 175
- CETP: 270
- ACE: 481
- AGT: 689

Lifestyle

- First Activity

Focus On

- Triglycerides: 172 mg/dL
- HDL: Good Cholesterol
- Total Cholesterol: 229 mg/dL
Personalized Nutrition

NUTRITION JUST GOT PERSONAL

When your body’s unique biology gets just the right foods in the right amounts, something amazing happens – you thrive.

JOIN WAITLIST
Key inputs for your personalized nutrition blueprint

Your DNA
Your diet influences gene expression and your genes program the systems that process your food. Analyzing your genetic variations helps us give you evidence-based nutrition recommendations.

Your Phenotype
Biomarkers and body basics, like waist measurement, show us your phenotype—the unique interaction between your genes, food, and environment.

Your Phenotypic Flexibility
We help you understand how your body reacts to fats, carbs, and proteins by giving you a meal replacement drink and analyzing how your metabolism responds.

Your Habits and Goals
Your goals and habits contribute to revealing which foods are best for you right now. We even provide a coach to support you in achieving your goals and creating healthy habits.

Our Nutrition Intelligence Engine™
Our Nutrition Intelligence Engine™ uses decision trees based on your lab tests, activity level, goals, food preferences, and body basics to create a nutrition blueprint personalized just for you.
Personalized Nutrition From Test to Table™

Bio testing  Results  Coaching  Personalized Meals
Insights from PD3 clouds provide a data-rich foundation for the future of personalized nutrition
Enabling Individuals to take Responsibility for their Own Wellness (and Disease)

Individuals taking responsibility for their own health – with informed personalized nutrition – will dramatically reduce the cost of healthcare.
ISB Hundred Person Wellness Project: Team

Special thanks to our funders: Robert Wood Johnson Foundation and M.J. Murdock Charitable Trust

Project Leadership
- Leroy Hood, MD, PhD
- Nathan Price, PhD
- Sean Bell, Business Director

Data Analytics
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- Andrew Magis, PhD, Multi-omics
- John Earls, Data integration

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- Mary Brunkow, PhD, Project Coordinator

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**Special Assistant to the President**
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**Funding**

[Logos of funding agencies]