The NIH Pipeline in Digital Technologies

FNIH Remote Digital Monitoring Workshop

Jill Heemskerk, Ph.D.
Deputy Director
National Institute of Biomedical Imaging and Bioengineering
NIH Structure

27 Institutes & Centers
~$40 Billion Annually
~$1.2B commercialization

>300,000 researchers
>2700 institutions
>55,000 applications

Office of the Director

Office of Research Infrastructure Programs

http://www.nih.gov/icd
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NIH Clinical Center
Center for Information Technology
Center for Scientific Review

No funding authority
Engineering the Future of Health

National Institute of Biomedical Imaging and Bioengineering

Office of the Director

NIBIB tech

Clinical Center

NIBIB: ~$400M, ~1000 grants
NIBIB: Bioengineering Impact at NIH

- NIBIB ~1% total NIH Budget
- ~13% NIH Budget to Bioengineering

Bioengineering $ (Billion)

NIH Budget $ (Billion)


78% increase
26% increase
13%
NIBIB: Bioengineering Impact at NIH

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Bioengineering will be >90% of NIH budget in 30 years
NIBIB Impact: Partnerships

Add ~ $50M/yr since 2014
(~12-20% of appropriated budget)

NIBIB
Creating Biomedical Technologies to Improve Health

SCGE
BRAIN Initiative
HEAL
DSI-Africa
POCTRN
SPARC
Alzheimer’s Supplements

NIH
National Institute of Biomedical Imaging and Bioengineering
NIH BRAIN Initiative

$5.2B  Projected total for lifetime of BRAIN

~67% Bioengineering

Base Funding  FY 2020 increase  21st Century Cures Funding
2020: NIBIB Expanding Mission

Engineering and Physical Science in Biology and Medicine

- **Human Health a top priority of Engineering Schools**
  - Adding ~1600 UG BME students, ~70 BME faculty/year*
  - ~30 ABET BME depts when NIBIB started, 119 in 2019*

- **Medicine-Engineering partnerships: "Physicianeers"**
  - University of Illinois Urbana-Champaign
  - Texas A&M University

- **Drive Human and Economic Health**

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*R. Hart, Annals BME, 2015
** R. Pettigrew, TAMU
Engineering Impact: *Patents*

**Impact**

All NIH: $1 → $6 downstream R&D investment

NIBIB: $1 → $33 downstream R&D investment

*Patents, Pasteur, and Productivity: A Model for Promoting Scientific and Economic Growth at the National Institutes of Health, M. Kalutkiewicz and R. Ehman (2017)*
Current Medicine: 
*Static “Snapshots”*
Future Medicine: Continuous Sensing Dynamics

Complex, Multi-parametric, Dynamic Data
NIBIB Mission: Technology & Innovation

Therapeutic Devices
Monteris Medical, Inc.

Engineered Biology
Cambridge University

Modeling, Computation & Machine Intelligence
V. Venugopalan, J. Spanier, UCI

Imaging Technologies
M. Garwood, UMN

Sensors and Point of Care
S. Xu, UCSD
Transcutaneous Glucose Detection

Oral Glucose Tolerance Test: N = 20

Non-invasive NIR Raman Fiber Probe
830 nm Diode laser

Sing et al. Analytical and Bioanalytical Chemistry (2018)
Wearable Ultrasound Patch for Blood Pressure

• Ultrasound measure of central blood pressure
• Flexible patch
• Continuous recording of blood vessel diameter
• Diagnostic for hypertension, heart disease, valve dysfunction

Wang, et al, Nature Biomedical Engineering, September 2018
Continuous measurement of analytes in blood

Electrochemical **aptamer** biosensors:

- Fully implantable and wireless
- Simultaneous measurement of multiple targets
- Platform technology – glucose and insulin underway; neurotransmitters and gut hormones are planned
- High sensitivity (pM-nM), spatial resolution (~10 µm), and temporal resolution (< 1 min)
Implantable ASIC
Measures hemoglobin in RGB images of nail bed
GAITS: Guidance and Impact Tracking System

10 Milestones

4 Deliverable Domains:
- Clinical/Workflow
- Market/Business
- Regulatory
- Technical/Science

Public version: www.GAITS.org
NIBIB Strategic Planning

NIBIB Strategic Plan working groups met Jan 22, 2020
>55 participants in 7 sub-groups

Data Science and Computation
Christine Cooper
Qi Duan
Maryellen Giger
Jay Humphrey
Lydia Kavraki
Kyle Myers
Grace Peng
Behrouz Shabestari
Hari Shroff
Andrew Weitz

Engineered Biology
Paula Hammond
Joshua Leonard
Jessica Meade
Robert Nerem
David Rampulla
Gordana Vunjak-Novakovic
Ron Weiss

Sensing Health and Disease
Samuel Achilefu
Nancy Allbritton
Zane Arp
Tatjana Atanasijevic
David Grainger
Amy Herr
Thomas Johnson
Tiffani Lash

Imaging Health and Disease
Richard Buxton
Shawn Chen
Vincent Ho
Elizabeth Jones
Randy King
Richard Leapman
Guoying Liu
Cynthia McCullough
Kathy Nightingale
Bruce Rosen
Daniel Sodickson
Patricia Wiley
George Zubal

Advanced Therapies/Cures
Kate Egan
Ranu Jung
Brian Pogue
Marjolein van der Meulen
Michael Wolfson

Technology Development Pipeline
Andrea Belz
Richard Leapman
Jack Linehad
Raymond MacDougall
Ed Margerrison
Todd Merchak
SoHi Rastegar
Greg Sorensen

Biomedical Imaging & Bioengineering Workforce
Gilda Barbino
Rashid Bashir
Zeynep Erim
Ilana Goldberg
Raphael Lee
Carolyn Meltzer
Julia Ringel

https://videocast.nih.gov
January 23 Advisory Council

NIBIB Organization: Kris Kandarpa, Kate Egan, Jackie Martinez, Saltant Satabayeva
Emergent Opportunities

Organ Simulators

Images

Computational Models


N Paoletti et al, CMSB 2017
Emergent Opportunities

**Sensors**


**Organ Simulators**

**Images**

N Paoletti et al, CMSB 2017

**Computational Models**

**Digital Twins**

Badano et al., JAMA Netw Open. 2018

**Virtual Clinical Trials**
Toward the Future

biobank.uk
Improving the health of future generations

- Lifestyle, medical history, sociodemographic
- Physical measures
- Environmental measures
- Urinary biomarkers
- Genetic data via the EGA (500,000)
- Imaging (15,000+)
- Cognitive function and hearing tests
- Health outcome data
- Genotyping & imputation (n = 500,000)
- Web-based questionnaire data (~200,000)
- Physical activity monitor (100,000)

500,000 participants

All of Us
The future of health begins with you

The future of health begins with you
The All of Us research program is a historic effort to gather data from one million or more people living in the United States to accelerate research and improve health. By taking into account individual differences in lifestyle, environment, and biology, researchers will uncover paths toward delivering precision medicine.

&gt;350,000 enrolled, 5/2018-11/2019

at least 1,000,000 subjects

&gt;350,000 enrolled, 5/2018-11/2019
Impact

• Significant NIH-wide growth in Bioengineering: now ~12% of the NIH budget
• NIBIB funding: high and growing demand, heavily leveraged, high ROI
Summary: Engineering the Future of Health

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Opportunities

• Explosion in technologies and biomedical knowledge
• AI/ML to understand and exploit complex, dynamic biology
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Future

• Continuous monitoring: Shift to prevention, optimize healthspan
• Reduce costs: democratize access