New Directions at the NIH
Office of Behavioral and Social Sciences Research

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NIH Associate Director for Behavioral and Social Sciences
International Society of Behavioral Nutrition and Physical Activity
Austin Texas
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Poll Question

- What is the name of the government agency that funds most of the medical research paid for by taxpayers in this country?
- Less than 10% can identify NIH.
- About as many people identify Harvard.
- More people identify CDC
  - about 1/6th of NIH budget
- Drug Companies commonly cited
We are 27 Institutes and Centers, many offices and programs.....
Small Subset of NHLBI Logos
Where are we going?

• We are all NIH
• Never forget to mention your grant in publications and discussions with the press
• Look for clearer branding in the future
NIH: Steward of Medical and Behavioral Research for the Nation

“Science in pursuit of fundamental knowledge about the nature and behavior of living systems and the application of that knowledge to extend healthy life and reduce the burdens of illness and disability.”
NIH Extramural & Intramural Funding
FY 2011 Enacted: $30.9 Billion

Spending at NIH
$5.0 B
16%

- $3.3 B Intramural Research
- $1.5 B Research Management & Support
- $0.2 B Buildings and Facilities, Other

Spending Outside NIH
$25.9 B
84%

- Supports over 325,000 Scientists & Research Personnel
- Supports over 3,000 Institutions
FY 2010 Percent Distribution of Basic and Clinical Research

- Basic Research: 52.0%
- Applied Research (Clinical): 34.6%
- Applied Research (Other): 10.5%
- R&D Facilities: 0.3%
- Training & Overhead: 2.6%
Impact of NIH-Supported Research On U.S. Economy

- In 2010, NIH research supported 488,000 jobs at 3000 institutions, small businesses nationwide.
- In 2010, NIH funding generated $68 billion in new economic activity—double taxpayers’ investment.
- NIH serves as foundation for entire U.S. medical innovation sector that:
  - Employs 1 million U.S. citizens
  - Generates $84 billion in wages, salaries
  - Exports $90 billion in goods, services

Source: An Economic Engine: NIH Research, Employment and the Future of the Medical Innovation Sector, United Medical Research, May 2011
Investing in Basic Research

The Nobel Prize in Physiology or Medicine 2011

Bruce A. Beutler
Jules A. Hoffmann
Ralph M. Steinman

NIH-supported Nobel Prize Winners: 135
Together these make up the majority of students and faculty at most research intensive universities.

We Cover a lot of Turf
A few behaviors explain almost half of all deaths

Mokdad, JAMA 2004 *corrected
Changing multiple risk behaviors is difficult

- Only 1 out of 7 U.S. adults practices the combination of dietary (fruit & vegetable) & physical activity behaviors recommended by the government
- Only 3% practice a combination of 4 heart-healthy behaviors
NIH support of BSS

FY 2010 non-ARRA
$3.53 billion
Some New Directions for OBSSR (preliminary)

- Planning for the next generation of behavioral and social sciences research
  - The next generation of measurement and data
  - Delivering services in a reforming health care system
  - Training the next generation of research investigators
Theme 1: The Next Generation of Data and Analysis Methods

- Primary focus of today’s talk
  - mHealth
  - Electronic Health Records
  - Systems science
  - Masses of data
  - Data Visualization
  - New methods for analysis
What is mHealth?

- Diverse application of wireless and mobile technologies designed to improve health research, health care services and health outcomes
Includes any wireless device carried by or on the person that is accepting or transmitting health data/information

- Sensors (e.g., implantable miniature sensors and “nanosensors”)

- Monitors (e.g., wireless accelerometers, blood pressure & glucose monitors)

- Mobile phones
Did We See It Coming?

• “This telephone has too many shortcomings to be seriously considered as a means of communication.”

Western Union internal memo
1876
Continuum of mHealth tools

Measurement
- Sensor sampling in real time
- Integration with health data

Diagnostic
- POC Diagnostics
- Portable imaging
- Biomarker sensing
- Clinical decision making

Treatment
- Chronic disease management
- Remote Clinical trials
- Disaster support/care

Global
- Service Access
- Remote treatment
- Dissemination of health information
- Disease surveillance
- Medication tracking and safety
- Prevention and wellness interventions
Measurement and Assessment
High Throughput Exposomics

NIH Genes, Environment and Health Initiative
Exposure Biology Program

Genes, Environment and Health Initiative: The Vision

EXPOSURE BIOLOGY PROGRAM
- Develop technology and biomarkers
  - Diet
  - Physical Activity
  - Environmental Exposures
  - Psychosocial Stress and Addictive Substances

GENETICS PROGRAM
- Identify genetic variants
  - GWA Studies
  - Data Analysis
  - Replication
  - Sequencing
  - Database
  - Function
  - Translation

(from Kevin Patrick, UCSD)
“At it’s most complete, the exposome encompasses life-course environmental exposures (including lifestyle factors), from the prenatal period onwards...”

-- Christopher Paul Wild

(from Kevin Patrick, UCSD)
Together these lead to whether disease occurs or health is promoted…

(from Kevin Patrick, UCSD)
“Unlike the genome, the exposome is a highly variable and dynamic entity that evolves throughout the lifetime of the individual...”

-- Christopher Paul Wild
Genome

Exposome

In utero…

(from Kevin Patrick, UCSD)
In childhood…

(from Kevin Patrick, UCSD)
Genome

Exposome

In adolescence…

(from Kevin Patrick, UCSD)
Genome

Exposome

In adulthood...

(from Kevin Patrick, UCSD)
In old age...

(from Kevin Patrick, UCSD)
“The imbalance in measurement precision of genes and environment has consequences, most fundamentally in compromising the ability to fully derive public health benefits from expenditure on the human genome...”

“There is a desperate need to develop methods with the same precision for an individual’s environmental exposure (and behaviors) as we have for the individual’s genome.”

-- Christopher Paul Wild

(from Kevin Patrick, UCSD)
The game is changing!

Billions of mobile devices
+ Billions of sensors
+ Billions using social networks

= Unprecedented opportunities for population-level sensing
Epidemiology

• The study of the distribution and determinants of disease
Detect Bouts of Activity

Research Question: Are small, low quality neighborhood parks better than large regional parks for continuous minutes of MVPA?

How long do participants engage in periods of intense physical activity?

Where are participants getting sustained activity?

Light
Moderate

(from Kevin Patrick, UCSD)
SenseCam

- **Microsoft Research Prototype... now the Vicon Revue**
  - Contains a camera, accelerometer, light color/intensity, temperature, infrared motion detector, compass
  - Takes about 5,500 photos per day
  - Pending: incorporation of GPS and Bluetooth

(from Kevin Patrick, UCSD)
Food Intake Recording Software System: Version 4 (FIRSSSt4)

PI: Tom Baranowski, Baylor College of Medicine

- Uses Web-based software to assess 24-hour recalls
- Adapts the NCI Automated Self Administered 24-hour Recall (ASA24) for children ages 8-13
- Calculates nutrient and food intake
- English and Spanish
- Utilizes alternative phonetic spell check algorithms
- Freely available Web-based tool
Improving Dietary Assessment Methods Using the Cell Phone and Digital Imaging

PI: Carol Boushey, Purdue University

- Uses a mobile phone as a food record
- Image processing to identify food in real time
  - Supplement with search list
  - Calculates volume to estimate portion size
- Calculates nutrient and food intake
Population Scale Activity Measures

- **Problem:** Population-scale measurement of physical activity
- **Solution:** Miniature, low-cost devices that measure human motion using redesigned accelerometers in a user-friendly format

Stephen Intille, PhD, Northeastern University NHLBI, U01HL091737
Implantable Biosensors

- **Problem:** Measurement of analytes (glucose, lactate O2 and CO2) that indicate metabolic abnormalities
- **Solution:** Miniaturized wireless implantable biosensor that continuously monitors metabolism
  - Inserted by needle subcutaneously
  - Operated remotely using a PDA
  - Multi-analyte sensor
  - One month continuous monitoring

Diane J. Burgess, University of Connecticut
NHLBI, R21HL090458
Participant’s evening commute with measured CO levels and traffic conditions
**LUCAS- Mobile Microscope**

**Problem:** Create a low-cost quality microscope to use in low resources settings.

**Solution:** A specially-developed lens fits to a cell phone to create a microscope

**Field testing:** Malawi, Mozambique and Brazil

LUCAS images of CD4+ and CD8+ T cells compared to a regular microscope image

Karin Nielsen, UCLA, FIC, R24TW008811
High-resolution fiber-optic microendoscope

- **Problem:** Methods to detect cancer from traditional biopsies are invasive for patients and require lab facilities.
- **Solution:** A scientific charge-coupled device camera and a laptop computer for under $4,000 (clinical trials in China, Botswana, Guatemala)

Rebecca Richards-Kortum, Rice Univ.
NIBIB RO1 EB007594
Necessity for Global Health

- Lack of providers in developing world
- No wired infrastructure
  - Well-developed and rapidly growing wireless
- Healthcare needs to be provided through low-cost and immediate, scalable services
- Potential for reverse technology transfer
  - Knowledge from developing world informs domestic research and practice
Adherence Monitoring (Uganda)

**Problem:** Adherence to chronic disease medications is poor. In resource-poor settings, getting people medication is only part of the solution.

**Solution:** Wireless medication canisters that signal medication timing, transmit adherence data and allow resources to target the non-compliant.

Jessica Haberer, Partners Healthcare NIMH K23MH087228
Visualization Provides New Ways of Seeing Complex Data

TRADITIONAL VISUALIZATIONS

NEW VISUALIZATIONS

- Mean Time (in seconds)
- Hospital Depression Scale

Age 70 neighborhood environmental quality
Exploring the Potential of Visualization for BSSR at NIH
Home health based on unobtrusive, continuous monitoring

Behavioral Markers = Continuous Monitoring + Computational Models
From Holly Jimison OBSSR & OHSU
Activity Monitoring in the Home

Sensor Events
Private Home

From Holly Jimison
OBSSR & OHSU

Oregon Center for Aging & Technology: www.orchtech.org
Among 19 trials, 12 (63%) failed to document a clear benefit of mHealth interventions. About half of the trials on smoking cessation achieved a benefit of text messaging. Record was less clear for weight loss. Most trials failed to show that text messaging improved diabetes outcomes. Results are positive for improving adherence to ART among adults with HIV in the developing world.
Abroms et al review of 47 iPhone applications designed to help people stop smoking.

  - Most popular apps did not apply the key guidelines recommended for control of tobacco use and nicotine dependence.
  - Few if any of the apps guided their uses to proven treatments including counseling, medical therapy, or the use of an established quit line

Breton et al reviewed 204 weight loss applications available on iTunes through September 2009.

Evaluated whether apps used 13 evidence based practices for weight control
- only about 15% of the available applications had 5 or more of the 15 evidence-based components.

Breton ER, Fuemmeler BF, Abroms LC. 2011. Weight loss…there is an app for that! But does it adhere to evidence-informed practices? Translational behavioral medicine: 1-7
Evidence that Nudges Work is Very Inconsistent, studies are equally as likely to refute as support nudges. (Marteau et al 2012)
Basic science discoveries used to develop new treatments

Testing use of proven therapies in clinical practice & community settings

**T1**
Translation

**T2**
Translation

**Bench** ↔ **Bedside** ↔ **Public Health**

Basic Research
Discovery
Mechanisms
Associations

Efficacy Trials

The whole point of the research enterprise
Basic science discoveries used to develop new treatments

Translation

Testing use of proven therapies in clinical practice & community settings

Translation

Basic Research Discovery
Mechanisms Associations

bBSSR

Behavioral Interventions

Efficacy Trials

Public Health

The whole point of the research enterprise
OppNet: OBBSR facilitated, co-managed

27 ICO members; $20 million annually - FY2014

Steering Committee
• Co-chairs: Drs. Richard Hodes (NIA), Robert Kaplan (OBSSR)

Coordinating Committee
• Co-chairs: Drs. Robert Kaplan (OBSSR), Santa Tumminia (NEI)

OppNet Facilitator: Dr. Bill Elwood (OBSSR)
OppNet Budget Coordinator: Ms. Nancy Vess (NIGMS)
OppNet accomplishments

- $21,533,410 for 106 extramural research projects
- 17 FOAs through FY2012
  - 13 RFAs
    - 3 FY2012 RFAs
  - 4 NOTs
- 4 on-Campus scientific symposia
- 1 widely-attended scientific conference

- Pleased stakeholders:
  - Academic, Advocacy
  - Congressional, NIH

**FY2012**
- 1 scheduled symposium
- 3 RFAs
  - 72 stress applications
  - 60 sleep applications
  - 85 decision-making applications
Agencies Rally to Tackle Big Data

John Holdren, the president’s science adviser, wasn’t exaggerating when he said last week that “big data is indeed a big deal.” About 1.2 zettabyes (10^21) of electronic data are generated each year by everything from underground physics experiments and telescopes to retail transactions and Twitter posts.

Holdren was kicking off a federal effort to improve the nation’s ability to manage, understand, and act upon that data deluge. Its goal is to increase fundamental understanding of the technologies needed to manipulate and mine massive amounts of information; apply that knowledge to other scientific fields; a decade within DOE’s Advanced Scientific Computing Research program. The Defense Department says it plans to spend $60 million this year on new awards for research on big data, but officials couldn’t say if that amount is more than what it has spent in previous years.

Even small investments are welcome. The U.S. Geological Survey points to a tiny (annual budget of $650,000) synthesis and analysis center in Fort Collins, Colorado, that brings groups of scientists together for a week to crunch large data sets. The National Institutes of Health (NIH) is counting a
Theme 2

Behavioral and Social Science in an Evolving Health Care System
The Evolving Health Care System

The First Era (Yesterday)
- Focused on acute and infectious disease
- Germ Theory
- Short time frames
- Medical Care
- Insurance-based financing
- Industrial Model
- Reducing Deaths

Health System 1.0

The Second Era (Today)
- Increasing focus on chronic disease
- Multiple Risk Factors
- Longer time frames
- Chronic Disease Mgmt & Prevention
- Pre-paid benefits
- Corporate Model
- Prolonging Disability free Life

Health System 2.0

The Third Era (Tomorrow)
- Increasing focus on achieving optimal health
- Complex Systems - Life Course Pathways
- Lifespan/ generational
- Investing in population-based prevention
- Network Model
- Producing Optimal Health for All

Health System 3.0

From Neal Halfon, 2012
How Shifting the Health Curve can Shift the Cost Curve (from Halfon, 2012)
This year we will spend 17% of the GDP on Medical Care, but <0.4% on Public Health
FDR: A Preventable Death?
Blood Pressure Readings 1944-1945

10.1.40
Dedicated NIH Bethesda Campus

3.27.44
186/10
8

4.1.44
200/108

11.18.44
210/112

11.27.44
260/150

Feb 1945
260/150

DEATH: 4.12.45
300/190
The initial findings from the Framingham heart study were published 50 years ago.

By 1961, we knew that the **major risk factors** for CHD included:

- Tobacco smoking
- High blood pressure
- High serum cholesterol
- Diabetes
Public Health Impact: From NHLBI

- Death rates from heart disease have fallen since 1950
- ~30% reduction for all cardiovascular diseases combined
- Nearly ½ of decline due to prevention & treatment of CV risk factors (smoking, high BP, cholesterol)

Annual U.S. Deaths Per 100,000 People Of All Ages Over Time

Source: New York Times, April 24, 2009
Several models, developed in different countries and using different methods converge to suggest that reductions in cardiovascular risk factors (smoking, lipids, and blood pressure) contribute to at least half of the reduction in mortality in cardiovascular deaths.

- 23% to 46% of the decline was attributable to treatments.
- Primary prevention achieved an estimated fourfold reduction compared to secondary prevention.

Awareness, Treatment, and Control of Hypertension in 2004 NHANES

- **Control**
- **Treatment**
- **Awareness**

- **Latino**
- **Black**
- **White**
Even at Current Levels....

- **Awareness:** 80%
- **Treatment:** 70%
- **Control:** 50%

\[ 0.8 \times 0.7 \times 0.5 = 0.28 \]

Only 28% of people with high blood pressure are being successfully treated.
Non-Technical Solutions

Office reminders for cholesterol treatments are estimated to prevent $7X$ more deaths than replacing older cholesterol-lowering drugs with more potent medicines.

Source: Woolf & Johnson 2006
Global Health and International Studies
Trends in $e_{50}$, Females

Source: Chapter 2, Diverging Trends in Life Expectancy at Age 50: A Look at Causes of Death, D. Glei, F. Mesle, J. Vallin

Source: Glei et al. 2010
Land Mass
The Distribution of HIV/AIDS
Diabetes Prevalence
Scientific Publications
Theme 3: Training the Next Generation of Behavioral and Social Scientists

- K-12
- The undergraduate curriculum
- The PhD program of the future
- The 2011 AAMC report of the future of the medical school curriculum
- The 2015 MCAT
Building a Better Physician — The Case for the New MCAT

Robert M. Kaplan, Ph.D., Jason M. Satterfield, Ph.D., and Raynard S. Kington, M.D., Ph.D.

The Medical College Admission Test (MCAT), a prerequisite for admission to U.S. medical schools, currently consists of four sections: physical sciences, verbal reasoning, a writing sample, and biologic sciences. A 2004 Institute of Medicine report on “Improving Medical Education” and the section on perception considers the integration of sensory processes through attention, cognition, memory, and language and the roles of stress and emotions in sensory processes. Clinical applications are reserved for medical school instruction, but stu-
Summary

• The world is changing....
• Representative designs and representative sampling are now feasible
• Mobile technologies are likely to have a profound impact on health care and biomedical research
• We will soon be surrounded by more data than we can store, analyze, and interpret
• There will be opportunities to partner with
  ▫ Other government agencies
  ▫ Private industry
  ▫ Non-profits