Behavioral and Social Sciences Research at NIH: Advancing Science, Redesigning Care, Reforming Education
My Personal Journey

Traditional

• Life Expectancy
• Infant Mortality
• Disability Days
Survival Analysis

Alive 1.0
Dead 0.0
Problem with Survival Analysis

Tennis player  1.0
Man in coma  1.0
Purpose of Quality Adjusted Survival Analysis

To summarize life expectancy with adjustments for quality of life
The concept of a Quality-Adjusted Life Year (QALY)

QALYs = 2x1 + 1.5x0.7 + 1x0.3 + 2.5x0.9 = 5.6
Using QALYs to measure the impact of a treatment

Without treatment:  \[\text{red}\]

With treatment:  \[\text{green}\]

From Peter Neumann, Tufts Medical Center
QUALITY-OF-LIFE PUBLICATIONS BY YEAR

Pubmed Publications Grew from Near Zero to Nearly 10,000/year
Our Primary Goal: Improve Quality-Adjusted Life

Overall Goals of DHHS Healthy People 2000, 2010, 2020

- **#1 Overall Objective for Healthy People 2000**
  - To increase the span of healthy life (quality-adjusted life expectancy)

- **#1 Overall Objective for Healthy People 2010**
  - Increase the quality and years of life

- **Healthy People 2020:**
  - 4 overall goals, including
    - Promote quality of life, healthy development, and healthy behaviors across all life stages
“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.”
Some New Directions for OBSSR

• 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

- mHealth
- Electronic Health Records
- Systems science
- Masses of data
- Data Visualization
- New methods for analysis
“At its most complete, the exposome encompasses life-course environmental exposures (including lifestyle factors), from the prenatal period onwards…”

-- Christopher Paul Wild
Together these lead to whether disease occurs or health is promoted...
The game is changing!

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

= Unprecedented opportunities for population-level sensing
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
**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
Theme 4: New Ideas

Exploring the Potential of Visualization for BSSR at NIH
HIV Prevalence and Estimated Number of Adults and Children Infected with HIV, 2009

This graphic depicts country size relative to the estimated number of its HIV-infected population. Sizes and shapes are distorted in this cartogram, which is presented for illustrative purposes only.


Courtesy of Nate Heard, U.S. Department of State
Agent – Based Model of Small Pox Epidemic

Courtesy of Josh Epstein, Johns Hopkins University
Los Angeles model airborne toxic pollution dynamics are modeled by Computational Fluid Dynamics (CFD) and visualized in a 3D.

Courtesy of Josh Epstein Johns Hopkins University
Home health based on unobtrusive, continuous monitoring

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

Sensor Events
Private Home

- Bedroom
- Bathroom
- Living Rm
- Front Door
- Kitchen

From Holly Jimison
OBSSR & OHSU
Summary: Data and Analysis

• Harmonization of Data
  • PROMIS
  • Toolbox
  • EHR

• New Approaches to Data Collection
  • mHealth

• New Approaches to Data Analysis
  • Visualization
  • Big Data - Data Mining
Theme 2

Understanding the Determinants of Population Health
The health of the nation: poor value for money

Figure 1. There are large differences in life expectancy and health care spending across OECD countries 2008.

Life expectancy at birth, years

Total expenditure on health per capita, US $ PPP

1. Or latest year available.
Source: OECD Health Data 2010.
Disease and Disadvantage in the United States and in England

James Banks, PhD
Michael Marmot, MD
Zoe Oldfield, MSc
James P. Smith, PhD

The United States has a considerably greater expenditure on medical care (US $5274 per capita) than in the United Kingdom (US $2164 adjusting for purchasing power). To determine whether this expenditure translates into better health outcomes for the adult US population, data on the degree of morbidity in each country beyond the childhood years are needed.

Given the strong link between socioeconomic position and health in both countries, cross-country comparisons of morbidity should examine variation of morbidity according to comparable measures of socioeconomic position. Cross-country comparison of social differences in illness provides some insight into potential causal explanations. Access to health care is a particular case in point. Although publicly funded health care is available in both countries to citizens older than 65 years, the UK National Health Service has no age criterion for eligibility. Thus, British households are more isolated from any financial impacts of out-of-pocket medical expenses. A similar argument applies to earnings and job losses, for which the more generous UK income maintenance system should mitigate any effects of health changes on income and wealth compared with what is available in the United States.

We compare measures of morbidity according to 2 salient measures of socioeconomic status (SES)—education and household income—in nationally representative samples in the United States and England. One common prob...
Trends in $e_{50}$, Females

Source: Glei et al. 2010

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

- Australia
- Austria
- Canada
- Denmark
- Finland
- France
- Germany
- Italy
- Japan
- Norway
- Portugal
- Spain
- Sweden
- Switzerland
- The Netherlands
- United Kingdom
- United States
Among the 17 peer countries, the US had 2\textsuperscript{nd} highest NCD mortality rate in 2008 (418:100,000)
Among the 17 peer countries:

- **US had 4th highest infectious disease mortality rate in 2008 (34:100,000)**
- **US had the highest incidence of AIDS (3rd highest in OECD, exceeded only by Brazil and South Africa).**
- **AIDS incidence in the US (122 per million) was almost 9 times the OECD average (14 per million).**
Among the 17 peer countries, the US had the 2nd highest injury mortality rate in 2008 (53:100,000).

US had the highest death rate from transport accidents in 2009 (3rd highest in OECD, behind Mexico and the Russian Federation).
Among the 17 peer countries, mortality from transport accidents decreased by 42% in the OECD between 1995 and 2009, but by only 11% in the US (OECD, 2011).
In 2007, 69% of US homicides (73% of homicides before age 50) involved firearms, compared with 26% in peer countries.

A 2003 study found that the US homicide rate was 7 times higher (the rate of firearm homicides was 20 times higher) than in 22 OECD countries.

Although US suicide rates were lower than in those countries, firearm suicide rates were 6 times higher.
### Life Expectancy at Birth, 2007

#### Males

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#### Females

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- **US life expectancy ranked last among males (75.6 years) and next to last among females (80.8 years)**
- **Difference from top-performing country = 3.7 years (males), 5.2 years (females)**
The problem is longstanding and worsening. In 1980, US life expectancy among females was about average, and was near the bottom for males, but by 2006 US life expectancy for both sexes had fallen to the bottom ranks.
For decades, American youth have been less likely to survive to age 50 than people in other rich nations.
US male and female newborns can expect to lose about 1.4 years and 0.8 years of life, respectively, before age 50.

The US losses before age 50 are double those of Sweden, the best performing country.
Ranking of US Mortality Rates by Age Group in 17 Peer Countries, 2006-2008

- US life expectancy is low at every age.
- In either sex, the US rank is never better than 15th out of 17 until age 75.
At no age below 55 do US non-Hispanic whites rank better than 16th out of 17 countries (for either sex).
MORBIDITY
Obesity: Average BMI in 17 Peer Countries, 2008

- The US has the highest prevalence of adult obesity among the 17 peer countries (and all other OECD countries) ...a position it has held for decades.

- As of 2009, the prevalence of obesity in the US (34%) was twice the OECD average (17%).
As of 2010, the US had the highest prevalence of diabetes (among adults aged 20-79) across all 17 peer countries (and all OECD countries except Mexico).
Among teens aged 15-19 in 2005, the US had the highest all-cause mortality rate among peer countries.

- Pattern is decades old: US mortality rates at ages 15-24 have been higher than the OECD mean since the 1950s for males and since the 1970s for females.

As of 2005, the prevalence of obesity among US teens aged 12-17 was more than twice the OECD mean:

- By 2011, one third of US children aged 5-17 were overweight/obese, the highest rate among peer countries.
- Obesity among US non-Hispanic whites aged 5-13 was higher than the OECD average for ages 5-19.

Among the 17 peer countries in 2010, the US had the 5th highest prevalence of diabetes among children ages 0-14.

Prevalence of overweight (including obese) children in 17 peer countries.
The US has the highest teen pregnancy rate among peer countries:
- The 2010 US teen pregnancy rate was nearly 3.5 times the average of peer countries.
- In 16 developed countries, the prevalence of syphilis, gonorrhea, and chlamydia among teens age 15-19 was higher in the US than in other high-income countries that provided comparison data.
- Among high-income countries, the US has the highest prevalence of HIV infection at ages 15-24.
Age 50 and Above

Disease and Disadvantage in the United States and in England

James Banks, PhD
Michael Marmot, MD
Zoe Oldfield, MSc
James P. Smith, PhD

Context: The United States spends considerably more money on health care than the United Kingdom, but whether that translates to better health outcomes is unclear.

Objective: To assess the relative health status of older individuals in England and the United States, especially how their health status varies by important socioeconomic position.

Panel on Understanding Divergent Trends in Longevity in High-Income Countries

EXPLAINING DIVERGENT LEVELS OF LONGEVITY IN HIGH-INCOME COUNTRIES

Eileen M. Crimmins, Samuel H. Preston, and Barney Cohen, Editors

Differences in Disease Prevalence As A Source Of The U.S.-European Health Care Spending Gap

Americans are diagnosed with and treated for several chronic illnesses more often than their European counterparts are.

by Kenneth E. Thorpe, David H. Howard, and Katya Galactionova

Health Disadvantage in US Adults Aged 50 to 74 Years: A Comparison of the Health of Rich and Poor Americans With That of Europeans

Mauricio Avendano, PhD, M. Maria Glymour, ScD, James Banks, PhD, and Johan P. Mackenbach, PhD

Differences in health between Americans and Western Europeans: Effects on longevity and public finance

Pierre-Carl Michaud, Dana Goldman, Darius Lakdawalla, Adam Gailey, Yuhui Zheng

A Tale of Two Countries—the United States and Japan: Are Differences in Health Due to Differences in Overweight?

Sandra L. Reynolds, Agon Hagedorn, Jihye Yeom, Yasuhiko Saito, Eise Yokoyama, and Eileen M. Crimmins

University of South Florida, Tampa, FL, USA
University of Southern California, Los Angeles, CA, USA
National University, Tokyo, Japan

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

OFFICE OF BEHAVIORAL AND SOCIAL SCIENCES RESEARCH (OBSSR)
NATIONAL INSTITUTES OF HEALTH
Conditions more prevalent in the US among those age 50 and older

- Overweight/obesity
- Diabetes
- Hypertension
- Heart disease
- Myocardial infarction
- Stroke
- Chronic lung disease
- Asthma
- Cancer
- Arthritis
- Activity limitations
The Good News: Some US Health Advantages

- Cancer mortality
- Stroke mortality
- Control of blood pressure and cholesterol levels
- Suicide
- Elderly survival
- Self-rated health
Americans die younger and have higher rates of disease and injury than people in other wealthy nations.

The problem is not new. It has existed for decades, especially for women.

The problem is pervasive. It affects both sexes, young and old, and multiple areas of health, from infant mortality to traffic fatalities, from teen pregnancies to heart disease.

Earlier reports highlighted the US health disadvantage after age 50. This report finds as large a disadvantage among younger Americans. US infants, children, and teens die younger and have greater rates of illness and injury than youth in other countries.

The problem is not limited to the poor or uninsured. Even Americans with health insurance coverage, higher incomes, a college education, and healthy behaviors seem to be sicker than counterparts in other countries.

The problem claims lives and dollars. It threatens US workforce productivity and economic competitiveness.
Nine Areas of US Health Disadvantage

- Infant Mortality & Low Birth Weight
- Injuries & Homicides
- Adolescent Pregnancy & STIs
- HIV & AIDS
- Drug-related Deaths
- Obesity & Diabetes
- Cardiovascular Disease
- Chronic Lung Disease
- Disability
US health system’s strengths
• Cancer screening
• Control of blood pressure and serum lipids
• Patient-centered communication and attentiveness

Why health care does not fully explain the US health disadvantage
• Some conditions responsible for the US health disadvantage (e.g., violence, car crashes) are only marginally influenced by health care.
• Direct evidence of worse health care outcomes in the US (e.g., higher case-fatality rates) is lacking.
• Even conditions that are treatable by health care have origins outside the clinic.
• Countries with better health outcomes lack consistent evidence of superior health system performance.
Individual Behaviors

- **Smoking**
  - Although the US had the highest smoking rates in the 1950s, it now has the lowest rates of all peer countries but Sweden.
  - Smoking could explain shorter life expectancy in older adults, but not the health disadvantages observed in younger Americans.

- **Diet**
  - **Americans consume more calories than people in any other country.**
Individual Behaviors (Continued)

• Physical inactivity
  – Evidence is inadequate to compare physical activity levels in the US and other countries.

• Alcohol and other drug use
  – Americans consume less alcohol than people in other high-income countries.
  – Use of illicit and prescription drugs may be more prevalent in the US.

• Sexual practices
  – Compared to teens in other countries, US teens appear to:
    • Become sexually active at an earlier age
    • Have more sexual partners
    • Not properly use contraceptives or effective barrier methods
Injurious behaviors

- There is limited cross-national evidence about injurious behaviors.
- Civilian possession of firearms is much common in the US (89 firearms per 100 Americans) than in peer countries.
- US motorists are less likely to fasten front seatbelts, and motorcycle helmet use may also be lower in the US than in other high-income countries.
- 32% of US road accidents are attributable to alcohol, a higher proportion than in other high-income countries.
Social Factors

- The US has the highest level of income inequality among peer countries, 4th highest in the OECD.
- Since the 1980s, the US has had the highest relative poverty rates among peer countries.
- Since the mid-1980s, the US has had the highest rate of child poverty among peer countries.
- As of 2008, 22% of US children lived in poverty, the 5th highest rate among 34 OECD countries.
US preschool enrollment is lower than in most high-income countries. Among adults of all ages, the US ranks well in educational attainment, but other countries (including emerging economies) are outpacing the US in the educational attainment of young people (e.g., graduation rates).

US grade school students score above average, but by age 15 US students have average or below-average scores on math, science, and reading.
California adult smoking prevalence by region, 1990 – 2002

Data from California Tobacco Survey
Long-term impact of a comprehensive approach:

Lung and bronchus cancer incidence rates in CA

Rates are per 100,000 and age-adjusted to the 2000 U.S. standard (19 age groups).

* The annual percent change is significantly different from zero (p<0.05).


California: A 15 year investment of $1.8 billion in tobacco control reduced health care costs by $86 billion
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
Most PhD Programs Prepare Students to be Professors, but...

- Every year, ~50,000 doctorates are awarded by US academic institutions.
- More than 50% of doctorate holders work in fields outside academia (discipline-dependent.)
## Full-time S&E graduate students primary source of support
*(2009 data: NSF 12-300)*

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<td>NSF</td>
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<td>2,625</td>
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<tr>
<td>NASA</td>
<td>2,423</td>
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Total Federal Investment: ~$3B (conservative est.)
After moving to silos, can we come back together?
Postdoctorates, by Field and Type of Support

Source: GSS
What should the PhD curriculum look like?

- **Current Curriculum**
  - Focused primarily on training professors
  - Disciplinary focused
  - Methods
    - Original small sample data collection
    - Non-harmonized measures
    - Emphasis on sample statistics (ANOVA, Regression)

- **Curriculum for Future**
  - Trains for a range of job opportunities
  - Team science, prepares for multidisciplinary work
  - Methods
    - Big data
    - Harmonized measures
    - Data linkage
    - Pattern recognition
    - Systems Science
Why do we need to do this?

In a dynamic environment, if you are standing still, you will be left behind.
"Somebody has to do something, and it's just incredibly pathetic that it has to be us."