

**National Institutes of Health  
Office of Behavioral and Social Sciences Research**

**Review of Behavioral and Social  
Sciences Research Opportunities  
Innovations in Population Health Metrics**

**March 26-27, 2014  
Bethesda, MD**

**MEETING SUMMARY**

FOR ADMINISTRATIVE USE

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## ABBREVIATIONS AND ACRONYMS

<b>Acronym</b>	<b>Definition</b>
AAAS	American Association for the Advancement of Science
AHRQ	Agency for Healthcare Research and Quality
AIDS	acquired immunodeficiency syndrome
ANS	autonomic nervous system
BDNF	brain derived neurotrophic factor
CARDIA	Coronary Artery Risk Development in the Young
CBA	cost-benefit analysis
CDC	Centers for Disease Control and Prevention
CEA	cost-effectiveness analysis
CISNET	Cancer Intervention and Surveillance Modeling Network
CPS	cyber-physical systems
CTSA	Clinical Translational Science Awards
CVD	cardiovascular disease
DARPA	Defense Advanced Research Projects Agency
DELPHI	Data e-Platform to Leverage Multilevel Personal Health Information
DHEA	dehydroepiandrosterone
DRG	diagnostic-related group
EITC	Earned Income Tax Credit
ELSA	English Longitudinal Study of Ageing
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
FKBP5	FK506 binding protein
FTO	fat-mass-and-obesity-associated
GIS	Geographic Information Systems
HHS	U.S. Department of Health and Human Services
HIA	health impact assessment
HIV	human Immunodeficiency virus
HRS	Health and Retirement Study
IOM	Institute of Medicine
MAOA	monoamine oxidase A
MBHC	managed behavioral health care

NCATS	National Center for Advancing Translational Sciences
NCCN	National Comprehensive Cancer Network
NCD	noncommunicable disease
NCI	National Cancer Institute
NHLBI	National Heart, Lung, and Blood Institute
NIH	National Institutes of Health
OBSSR	Office of Behavioral and Social Sciences Research
ODP	Office of Disease Prevention
PAA	Population Association of America
PALMS	Personal Activity Location Measurement System
PPS	Prospective Payment System
QALE	quality-adjusted life expectancy
QALY	quality-adjusted life-year
RCDC	Research, Condition, and Disease Categorization
RCT	randomized controlled trial
RWJF	Robert Wood Johnson Foundation
SCD	sickle cell disease
SEER	Surveillance, Epidemiology, and End Results Program
SES	socioeconomic status
SHARE	Survey of Health, Ageing, and Retirement in Europe
TANF	Temporary Assistance to Needy Families
U.S.	United States
U.K.	United Kingdom
WHO	World Health Organization

## EXECUTIVE SUMMARY

### Introduction

The National Institutes of Health (NIH) mission is “to seek fundamental knowledge about the nature and behavior of living systems and the application of that knowledge to enhance health, lengthen life, and reduce illness and disability.” The NIH Office of Behavioral and Social Sciences Research (OBSSR), through its programmatic development efforts and trans-NIH focus, coordinates and leads the mission of the NIH through its unique focus on the role of the social and behavioral sciences.

Recently, OBSSR has embarked on a series of activities as part of a current strategic planning process to review the contributions of behavioral and social sciences to population health. The Office plans to produce a publication that summarizes current evidence in the field and offers guidance for future research.

On March 26-27, 2014, OBSSR convened a meeting of select NIH awardees and scientific leaders to discuss the state of behavioral and social sciences and to identify the essential elements required to increase the contribution of the field to innovations in population health metrics and improved health.

### Exploring Causes for Trends in Disease

Understanding of the factors associated with disease trends and their causes continues to be a fertile area of research. A 2013 Institute of Medicine (IOM) Report, *U.S. Health in International Perspective: Shorter Lives, Poorer Health*, shows that life expectancy for both men and women in the United States is below average in comparison with other high-income countries.<sup>1</sup> The majority of deaths in the United States and worldwide are due to noncommunicable diseases (NCD) like cancer, cardiovascular disease (CVD), diabetes, and respiratory disease. The key causes are risk behaviors such as smoking, use of drugs and alcohol, poor diet, and lack of physical activity. According to the World Health Organization (WHO) World Health Assembly, eliminating these major risk factors would prevent 75% of diabetes and CVD and 40% of cancer and would reduce health inequalities by an estimated 50%.

Several presenters discussed causal links among behavioral and social factors and health. This association perhaps is most striking in the impressive overlay of the decline in smoking over

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<sup>1</sup> Institute of Medicine. 2013. *U.S. Health in International Perspective: Shorter Lives, Poorer Health. Panel on Understanding Cross-National Differences Among High-Income Countries*. Steven H. Woolf and Laudan Aron, Eds. Committee on Population, Division of Behavioral and Social Sciences and Education, and Board on Population Health and Public Health Practice, Institute of Medicine. Washington, DC: The National Academies Press.

time with declines in cancer and CVD. Aside from the important effects of tobacco, drug and alcohol use, and physical activity, many behavioral and social factors are implicated in disease. For example, educational factors, social engagement, level of income or socioeconomic status (SES), work environment, and early-life exposure to adversity or trauma all show causal effect. There is also a strong, linear relationship between health and social problems and levels of income inequality.

The intersection of biology and behavior in influencing health outcomes is apparent in the interaction among neurologic, genetic, and epigenetic variables with cellular and behavioral responses to chronic stress. Researchers are investigating the role of this complex set of social and biological interactions in the short- and long-term responses of children to early adversity and trauma.

### **Behavioral and Social Interventions for Health**

Several presenters discussed the magnitude of the impact that behavioral and social interventions could have on health. Nontrivial gains could be made in life expectancy in the United States if the trends in areas of declining health (e.g., caused by behaviors such as poor diet and physical inactivity, and by deaths from firearms and poisoning) could be reversed. Supportive work environments have a positive impact on health, physical activity improves health-related quality of life, and policy interventions to reduce injury are effective. For example, the Centers for Disease Control and Prevention (CDC) listed motor vehicle injury prevention among the 10 greatest public health achievements in the United States from 1900 to 2000.

Behavioral and social scientists are exploring which types of interventions will be most effective in improving health. A newer area of research is exploring the use of population-level, non-conscious interventions that work through a change in environment to affect the choices people make. Other research demonstrates that strategies to address risk factors for noncommunicable disease in youth should involve youth, families, schools, and communities in changing their behavior and their environment.

### **Areas of Emerging Methodologies**

Meeting participants discussed the changing paradigm of methodologies needed in behavioral and social sciences research. They noted that in addition to continued basic research, the field requires a move in the direction of systems modeling research and a shift from a focus on the individual to a focus on the community. Translational research opportunities may become available through NIH T4 awards and through interaction with the National Center for Advancing Translational Sciences (NCATS) to identify opportunities for clinical translational science awards (CTSA).

There is a critical need for an interdisciplinary approach that goes beyond epidemiology. Such an approach should incorporate sociology, psychology, environmental biology, neurology, developmental biology, genetics, epigenetics, anthropology, political science, engineering, computer science, etc. One obstacle to this collaboration is the tendency to under value behavioral and social sciences compared to biomedical science. Proactive communication among behavioral and social scientists and biologists is needed to spur collaboration.

Potential collaborators with OBSSR for supporting interdisciplinary research include the other NIH Institutes and Centers, CDC, the Agency for Healthcare Research and Quality (AHRQ), and the environmental health community. The National Cancer Institute (NCI) is providing tools to advance the interdisciplinary effort. For example, the NCI Team Science Toolkit is a website that serves to integrate and disseminate information and resources for engaging in tobacco science, as well as facilitating, supporting, evaluating, or studying team science.

Behavioral and social sciences research needs to embrace health economics to identify opportunity costs and return on value for public health interventions that target behavior and social changes. Health economic methods include cost-effectiveness analysis (CEA), cost-benefit analysis (CBA), and health impact assessment (HIA). The potential impact of this area of research was highlighted by the use of health economics research to spur the improvement of the behavioral health system and the advent of managed behavioral health care.

“Big data” and machine learning represent another critical area of research. The Personal Activity Location Measurement System (PALMS) project provides an example of big data research that is suitable for machine learning. The PALMS tracking device measures variables of physical activity, heart rate, and location in real time and can be used to track uptake of health-related behaviors. Another big data effort, emerging real-time point-of-sale visualization technology, will allow the U.S. Food and Drug Administration (FDA) to track and regulate every tobacco outlet in the country.

### **Communication and Public Policy**

Despite the major contribution of behavioral and social factors to disease and the tremendous need for research and interventions, few research funds are spent on behavioral and social science research compared with the investment in biomedical research. As a result, the knowledge network for evidence-based health, as it currently stands, is informed by biomedical science, and much less so by behavioral and social science.

The need to communicate the importance of behavioral and social interventions for public health was a major topic of discussion. Researchers need to learn how much, what type, and what quality of evidence is good enough to support public policy decisions. Efforts are required to better understand the type of methodologies, data, and communication strategies needed to inform public policy. The return on investment in behavioral and social sciences research and interventions must be communicated to policy makers and the public alike. The value of

behavioral and social sciences can be demonstrated by direct comparison of “value added” by interventions in areas such as diabetes prevention.

Generally, investigators are not trained to make data accessible to nontechnical audiences, such as policy makers and the general public. Those who may be interested in this undertaking should consider building those skills. Efforts are also needed to better communicate with regulatory agencies, such as FDA. NCI is spearheading an effort in this area to develop an inter-agency initiative with FDA to inform regulatory decisions about tobacco products and their marketing.

### **Next Steps**

The planned monograph will deal less with diseases and more with the broader topical groupings presented at the meeting, such as tobacco use, physical activity, and injury prevention. The monograph will also address the issue of how to maximize the impact of behavioral and social sciences research on public health. The monograph is expected to bring greater visibility for the field and to have a lasting impact.

## MEETING SUMMARY

### Introduction

The National Institutes of Health (NIH) mission is “to seek fundamental knowledge about the nature and behavior of living systems and the application of that knowledge to enhance health, lengthen life, and reduce illness and disability.” As one of four programmatically related offices in the NIH Office of the Director tasked with coordinating activities across the 27 NIH Institutes and Centers, the Office of Behavioral and Social Sciences Research (OBSSR) focuses on the latter half of the mission. Since its inception in 1995, OBSSR has twice undergone a strategic planning process to determine its long-term goals and best approaches for achieving those goals. The Office’s original strategic plan was implemented in 1997 and was updated in 2007.

More recently, OBSSR has embarked on a series of activities as part of a current strategic planning process to review the contributions of behavioral and social sciences research to health. The Office plans to produce a monograph that summarizes current evidence in the field and offers guidance for future research. OBSSR invited eminent scientists in the behavioral and social sciences to contribute papers related to “Innovations in Population Health Metrics” for inclusion in the monograph.

On March 26-27, 2014, OBSSR convened a meeting of the invited authors at the NIH campus to discuss the state of behavioral and social sciences and to identify the essential elements required to increase the contribution of the field to innovations in population health metrics and improved health (see appendices A for B for the meeting agenda and list of participants, respectively). The meeting focused on measuring determinants of health and emphasized research and interventions that occur outside the health care system. It also provided a venue for the authors to receive feedback on their contributions to the monograph and discuss major themes around which to organize the monograph.

### *Exploring Causes for Trends in Disease*

Understanding of the factors associated with disease trends and their causes continues to be a fertile area of research. Consider, for example, that the decline in heart disease is often attributed to medical advances such as the introduction of statins in the 1980s. However, such changes in health care cannot fully explain the sustained decline in heart disease beginning in the 1960s and continuing until today. The similarity of the downward trends in tobacco use and heart disease mortality since the 1960s suggests a strong role for behavior change in improved heart health.

Other findings should encourage further research about the role of behavioral and social determinants in population health. For example, a 2013 Institute of Medicine (IOM) Report, *U.S. Health in International Perspective: Shorter Lives, Poorer Health*, shows that life

expectancy for both men and women in the United States is below average in comparison with other high-income countries.<sup>2</sup>

Behavioral and social scientists must look beyond usual methodologies such as randomized controlled trials (RCTs) and consider the role of new methodologies to the field. Although the traditional model of mechanistic research works well for infectious disease and acute illness, it is less effective for chronic disease, which makes up the majority of the disease burden in the United States. Methods that take advantage of natural experiments are emerging as a promising area of research. One way to leverage natural experiments is to use available resources to create econometric models that link spending across different areas to life expectancy.

For example, the *Dartmouth Atlas of Health Care* looks at variations in cost and usage of medical care in different geographic areas. Researchers have used this type of resource to conduct various analyses that estimate the benefit of health care to life expectancy. The findings suggest that the money spent on medical care is disproportionately high compared to funds invested in behavioral and social interventions.

## Health and the Socioeconomic Environment

### *Causal Factors Linking Environmental, Economic, and Social Research*

Richard Wilkinson, Ph.D., University of Nottingham / Kate Pickett, Ph.D., University of New York

Dr. Pickett discussed her and Dr. Wilkinson's research on the relationship between income inequality and health and social problems. They have performed a causal review of the research literature on this topic. Income inequality is an important, politically relevant topic that has received attention from many world leaders.

There have been much confusion and debate about the strength of evidence needed to prove the link between inequality and health and to inform policy decisions.<sup>3</sup> Dr. Pickett discussed the strong, linear relationship between health and social problems and income inequality. Many factors are affected by inequality, including trends in life expectancy, infant mortality, and teenage births. The effect on crime is reflected by increases in the number of homicides and imprisonments. Health factors such as obesity, mental illness, and drug and alcohol addiction

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<sup>2</sup> National Research Council and Institute of Medicine. 2013. *U.S. Health in International Perspective: Shorter Lives, Poorer Health. Panel on Understanding Cross-National Differences Among High-Income Countries*. Steven H. Woolf and Laudan Aron, Eds. Committee on Population, Division of Behavioral and Social Sciences and Education, and Board on Population Health and Public Health Practice, Institute of Medicine. Washington, DC: The National Academies Press.

<sup>3</sup> Dr. Pickett recommended the following paper on this topic: Schrecker, T. 2013. Can health equity survive epidemiology: Standards of proof and social determinants of health. *Prev. Med.* (2013), <http://dx.doi.org/10.1016/j.ypmed.2013.08.013>

are relevant, as well as other societal factors such as trust, educational abilities, and social mobility.

Most past studies on inequality have been cross-sectional. However, emerging research takes a more longitudinal approach. For example, Kondo et al. (*BMJ*, 2009) recently performed a meta-analysis of multi-level studies that include almost 60 million individuals from several different countries. The results show an 8% increase in the risk of mortality in populations with high levels of income inequality. When considering the large numbers of people affected by inequality, this 8% increase will translate to millions of preventable deaths every year.

Dr. Pickett reviewed data showing a decrease in life expectancy in Eastern Europe in relation to inequality, with greater declines in inequality in the more unequal of those countries. Recent evidence from China, Latin America, Japan, and Chile shows a remarkable consistency in the relationship between inequality and health factors across the world.

The specificity of the link between income inequality and social impacts of health is demonstrated by the association of inequality with factors that exhibit a social gradient, but not with diseases such as breast or prostate cancer, which do not show a social gradient. One of the most important challenges in this research field is the need to address alternative explanations for health differences in populations with social inequalities. Alternative explanations include a compositional effect of income and education, neo-material factors, culture, and ethnic heterogeneity.

Some of the most exciting research on the causality of income inequalities has been from the field of psychology. For example, a recent study showed that people in countries with greater income inequality have higher levels of anxiety across the income spectrum compared with people in countries with greater income equality.

### *Work, Family, and Health: In Need of a Redesign*

Lisa Berkman, Ph.D., Harvard University

The United States ranks poorly in almost all health outcomes compared to other industrialized nations, and this trend is worsening with time. Although the United States spends the most on health care, life expectancy for both men and women ranks below the average for high-income countries.

Because social engagement is strongly related to health outcomes, major institutions related to family and work may influence the life-expectancy trend profoundly. The Work Family Strain Model developed by Dr. Berkman provides a possible explanation for why U.S. families fare so poorly. According to this model, the interaction of high demands, low control, and low social support will increase morbidity and mortality risk, especially for lower-SES women.

The number of women in the labor force with young children has increased dramatically from 1940 to 2000, while policies to protect workers have not kept pace. For example, the United States is one of the only high-income countries to provide no paid parental leave to workers.

Dr. Berkman and colleagues have shown that supportive work environments benefit both employees and employers. One study showed that employees who had work managers who were more open to work-family concerns have a lower risk of CVD and sleep more, compared with employees in less supportive jobs. In another study, employees in more flexible work situations reported fewer work and family stressors compared with workers in low flexibility jobs. Employers benefited from decreased turnover intention, increased job satisfaction, and increased organizational commitment.

Comparison of the Earned Income Tax Credit (EITC) and the Temporary Assistance to Needy Families (TANF) programs provides a natural experiment showing the benefits of supports for low-income working women. A study demonstrated that the EITC increased market wages, was associated with increased birth weight of infants, and decreased smoking among mothers with education less than a high school diploma. The TANF, which provides temporary cash assistance without respect to employment, showed no such benefits.

Preliminary data also suggest that continuing to work for pay after age 60 may help preserve cognitive performance. One study showed that cognitive performance was highest among individuals aged 60-64 years in countries that have the lowest rates of people in this age group not working for pay. Furthermore, analysis of data from the English Longitudinal Study of Aging (ELSA), the Health and Retirement Study (HRS), and the Survey of Health, Ageing, and Retirement in Europe (SHARE) shows a decline in cognitive performance as a function of decreasing employment rate among men aged 50-54 and 60-64 years.

In conclusion, work and family practices, the EITC, and retirement practices are examples of policies that have important impacts on health across the life course. Policies and practices, especially those related to work, have the potential to influence health in important ways and have unaccounted for benefits.

## Health Economics

### *The Science of Making Better Decisions about Health: Cost-Effectiveness and Cost-Benefit Analysis*

Louise Russell, Ph.D., Rutgers University

Health policy choices are as important to improving health as medical knowledge and technologies. These choices are as much in need of a scientific approach based on searching questions, empirical evidence, careful reasoning, and transparent presentation of that evidence and reasoning. Cost-effectiveness and cost-benefit analyses provide a tool for this type of

research. Such analyses are the main scientific methods of economic evaluation for policies that affect health.

Health policy choices must be considered in the context of high levels of spending on health care with poor outcomes as compared with other high-income countries. Decisions about health care involve public goods. This is what Nobelist Elinor Ostrom terms “social dilemmas” —situations in which cooperative solutions are better for everyone than individual choices based solely on self-interest.

The objective of a cost-effectiveness analysis (CEA) is to achieve longer, better lives by maximizing health for a given budget. Although CEAs suggest priorities, they do not control costs. CEA methodologies evaluate alternatives in the terms set by the goal (health) and the constraint (costs). CEA research ranks alternatives by their contribution to health and compares cost-effectiveness ratios.

Dr. Russell provided real-world examples of CEAs. One example focused on the timing of adult tetanus boosters. This CEA showed that the U.S. practice of giving tetanus boosters every 10 years costs nearly \$1 million to save 1 year of life, compared with about \$16,000 per year of life saved if only one booster were given at age 65.

The concept of opportunity cost considers whether more years of life could be saved by spending health care money in other ways. For example, many more years of life could be saved if the same amount of money spent on 10-yearly tetanus boosters were put toward total knee arthroplasty, screening for diabetes, diabetes prevention, or smoking cessation. For example, analysis shows that spending \$1 million on smoking cessation could save 161 years of life.

Scientific advances in CEA research include the concept of quality-adjusted life-years (QALYs), a scale that allows comparisons across a wide range of interventions. Another CEA concept, the reference case, consists of a standard set of methods, assumptions, and results that serves as a point of comparison across studies. CEA research also uses systematic reviews and meta-analyses, new methods of simulation modeling, and new methods of representing uncertainty. Use of CEA for health policy decisions has grown rapidly, except in the United States.

Cost-benefit analysis (CBA) is the main method of economic evaluation for social dilemmas outside the health sector. All benefits are valued in monetary terms. The U.S. Office of Management and Budget and the Environmental Protection Agency (EPA) both use CBA in decision making.

CBA estimates monetary values for benefits by assessing the tradeoffs of people affected by the choices, revealed through their actual choices (in markets) or when asked in surveys. For example, CBA shows that house prices reflect people’s value for quiet (houses in noisy areas sell for less, after controlling for other factors), and wages reflect people’s value for safety

(dangerous jobs pay higher wages, after controlling for other factors). Examples of CBAs used to inform government policy include a 1990 CBA of Clean Air Act amendments and a 1985 CBA of lead in gasoline.

It is important to view research and policy making related to health as a process. Changes in that process are needed to allow better decision making in health and medical care. CEA and CBA have a role in changing the structure of that process to improve decisions about health.

### *Health Impact Assessments for Program Implementation*

Steve Teutsch, M.D., M.P.H., and Jonathan Fielding, M.D., M.P.H., Los Angeles County Department of Public Health / Brian Cole, Dr.P.H., University of California, Los Angeles

The United States fares poorly in health indices and costs compared with competitor nations. Furthermore, the relative research investment in social and environmental determinants of health is disproportionately low in the United States compared to basic biomedical and clinical science research. There is a need for timely, policy-relevant information on the health impact of social interventions to inform policy making. The Health Impact Assessment (HIA) is a tool for providing this information.

According to the National Research Council, “An HIA is a systematic process that uses an array of data sources and analytic methods and considers input from stakeholders to determine the potential effects of a proposed policy, plan, program, or project on the health of a population and the distribution of those effects within the population. HIA provides recommendations on monitoring and managing those effects.” The HIA includes six steps: screening, scoping, assessment, recommendations, reporting, and monitoring.

An HIA of menu labeling in Los Angeles, California, provides an example for discussion. Los Angeles’ interest in menu labeling was based on concerns that the increasing frequency with which Americans were eating out may be contributing to the obesity epidemic. In 2007 the California Senate for a second time was considering a bill to require menu labeling in many restaurants. Los Angeles County’s Department of Public Health conducted an HIA to determine the potential impact of menu labeling on obesity.

Investigators began the HIA by studying the trend of increasing obesity among adults in Los Angeles County from 1997 to 2011. Next, they formulated study assumptions related to the eating habits, level of physical activity, and resting metabolic rate of restaurant patrons. For example, they assumed that restaurant patrons who order reduced-calorie meals would not compensate by increasing their food and beverage intake at other times during the day.

Investigators performed a sensitivity analysis that considered economic factors such as the revenue of relevant restaurants, the number of meals served annually, and the cost of a meal. They also considered factors such as the number of calories in a meal and the estimated caloric reduction from menu labeling, etc. The results of the sensitivity analysis provided an estimate

of the average calorie reduction per percentage of restaurant patrons who purchased a lower-calorie meal as a result of menu labeling.

The HIA was published in the *American Journal of Public Health* and received media attention. In 2008, Department of Public Health staff testified about HIA findings before state legislative committees. Ultimately the menu labeling bill was passed and signed into law by the governor. One sponsor of the bill reported that the HIA was instrumental in negotiations with legislators and the governor. Two years later, a similar federal measure was passed as part of the Affordable Care Act.

There are three lessons from the menu labeling HIA: (1) Timing is important, which means the best possible data may not be available at the time of decision making. It is important to present the data that are available. (2) The study does not have to be perfect; it just has to be understandable. (3) It is important to take advantage of leverage opportunities.

### ***Behavioral Health and Behavioral Health Services***

Sherry Glied, Ph.D., New York University / Richard Frank, Ph.D., Harvard Medical School

Health economics research has proven useful in addressing the persistent challenges in behavioral health. These challenges include prevention of behavioral health conditions, limited use of effective treatments, institutional care and limitations on independence and autonomy, lack of adequate human services for recovery, and inadequate resources for behavioral care. Economic research has addressed these challenges, primarily by supporting policy changes to improve efficiency and effectiveness of delivery of care.

Three theoretical frameworks of health economics form the basis of health economic research: the Kessel/Friedman framework, the Arrow framework, and the Becker/Grossman framework. Modern health economics derives from the positive economic traditions of the Becker/Grossman framework, which considers health care as an investment and health behavior as input.

Health economics is based on empirical research grounded in economic theory and is centrally concerned with causal inference. The research uses RCTs, quasi experiments, and observational data. The results yield policy-relevant estimates of the magnitude of the effect of policy change.

Unequal health care coverage for mental health and substance use disorder, as compared with other medical care, was the rule from 1950 through 2010. Economic research helped to determine the causes behind the unequal coverage. For example, research has shown that under fee for service arrangements, demand response to cost sharing for ambulatory mental health was roughly twice that for general medical care.

Economic analysis also was instrumental in determining how to expand coverage while controlling costs. Studies showed demand side cost sharing (copayments) is not the only tool

for controlling access to care and cost. In fact, payment arrangements and copayments used in combination can be more efficient for attenuating moral hazard (i.e., discourage people from accessing health care when they do not need it) while maintaining coverage. This concept led to a fundamental policy shift and the development of managed behavioral health care (MBHC), which allows expanded coverage while controlling costs.

Economic research also led to a change in the payment system for behavioral health care. Analyses revealed problems with applying the traditionally used diagnostic-related group (DRG) classification system to inpatient mental health and substance abuse disorders. As a result of these findings, psychiatric hospitals and units were exempted from using the until-then mandatory Prospective Payment System (PPS), which based reimbursement rates on DRG codes.

MBHC proved to be of benefit to behavioral health in another way. It was the advent of MBHC that gave impetus to the lagging efforts, begun in the 1950s, to deinstitutionalize behavioral health patients.

Economic research also demonstrates the positive interaction between the provision of social services and behavioral health. For example, studies have demonstrated that the provision of supported housing improves clinical effectiveness of behavioral health services. Furthermore, this improved effectiveness led to cost savings in terms of health resources used.

These and other studies have been instrumental in shaping policies that have addressed fundamental issues in policy toward behavioral health.

### *Discussion of Presentations*

#### *Spending on Prevention*

The amount of money spent on prevention is much more than the 3% cited by Dr. Kaplan in his opening remarks. The figure is probably closer to at least 8-9%. The 3% figure is from a CDC report on government health spending through state agencies. It is difficult to accurately estimate a number for prevention spending. Estimates would have to include Environmental Protection Agency spending and money spent on water and sewage treatment, food inspection, building codes, highway safety, etc.

#### *The Impact of Menu Labeling*

Dr. Teresa Marteau and colleagues recently submitted a Cochrane review on menu labeling in the United Kingdom. It shows that menu labeling is not affecting what people buy regionally and that there can be adverse consequences of menu labeling if people over-consume to compensate for calories that they cut elsewhere. The estimates of the impact of menu labeling in the HIA described by Dr. Teutsch in his presentation may be high. Researchers are still determining the impact.

*Changing Population Behavior and Reducing Health Disparities: Exploring the Potential of “Choice Architecture” Interventions*

Theresa Marteau, Ph.D., University of Cambridge

The majority of deaths worldwide are due to cancer, CVD, diabetes, and respiratory disease. The key causes are risk behaviors such as smoking, use of drugs and alcohol, poor diet, and lack of physical activity. According to the World Health Organization (WHO) World Health Assembly, eliminating these major risk factors would prevent 75% of diabetes and cardiovascular disease and 40% of cancer and would reduce health inequalities by an estimated 50%.

The evolving science of behavior change can be traced back to the Framingham Study in 1961, the first study to mention risk factors for disease. During the early 2000s, interventions targeting individuals, such as behavioral change communication and behavioral cognitive therapy, came into focus.

These and other interventions targeting the individual, or the reflective system, are based on goals and values and aim to strengthen self-regulation. This avenue for risk reduction has its limitations. Health education, for example, has enjoyed a modicum of success but also has served to increase inequalities with greater benefit to those with the most social resources.

Researchers are now considering something different—nonconscious interventions. These interventions are targeted not to individuals, but to populations. They target the automatic system and work through a change in environment or through “choice architecture.” These interventions alter the properties or placement of objects or stimuli within microenvironments with the intention of changing health-related behavior.

A nonconscious intervention might target the physical environment through changes to the built environment or through the presentation of food, alcohol, and tobacco products. Social environments might be modified through social norms and the economic environment through pricing changes. Further research is needed to determine whether a nonconscious approach to behavior change will be effective.

Dr. Marteau has completed a scoping review and mapped the evidence for behavior change through choice architecture. She identified nine types of choice architecture. Four types primarily alter properties of objects or stimuli, namely sizing, presentation, labeling, functional design, or ambience. Two types primarily alter the placement of objects or stimuli through proximity or availability. Finally, two types alter both properties and placement via prompting and priming.

The potential of choice architecture to reduce health disparities is based on the observation that those who are most deprived face two influences that make less healthy behavior more likely. First, they are exposed to more environments that cue unhealthy behaviors. Second,

early years spent in poverty and insufficient material resources are associated with reduced cognitive resources that could be used to resist environmental cues.

The hypothesis is that the targeting of nonconscious processes through the removal of cues for unhealthful behaviors and the addition of ones for healthful behaviors will have the potential to change the behavior of all those exposed, regardless of their cognitive resources.

The scientific challenges to this work relate to the building of the evidence base and the primary research and evidence synthesis. There are two political challenges. The first is the economic tradeoff of health versus wealth—improving health requires less consumption in economies built on overconsumption. The second is the ethical debate over the freedom to choose versus protection of the public.

### *Discussion of Presentation*

Policies that raise taxes are an important lever for tobacco and alcohol control. However, this strategy would not be as appropriate or publicly tolerated for changing food choices. This is an area where nonconscious interventions that change the environment may come into play.

## **Behavioral Choices, Public Health, and Education**

### *The Contribution of Behavior Change and Public Health to Improved Health*

David Cutler, Ph.D., Harvard University / Susan Stewart, Ph.D., University of California, Davis

The leading causes of death in the United States involve behavioral risk factors that are not addressed by the medical system. In their research, Drs. Cutler and Stewart asked two questions pertinent to this situation: (1) Has behavior change related to public health contributed to an improvement in health over time or a reduction in health over time? (2) If we made progress on the areas where we have not, how large would the gains be relative to what has been achieved in the past?

Medical contributors to health improvement consist of technology for saving people and for preventing the occurrence of disease. Everything else falls into the domain of behavior and public health. Drs. Cutler and Stewart examined several data sources to assess the impact on life expectancy of behaviors related to tobacco, poor diet and physical inactivity, alcohol consumption, motor vehicle deaths, and illicit drug use.

They found marked improvements over time in smoking behaviors, alcohol consumption, and motor vehicle fatalities.<sup>4</sup> For example, there has been a dramatic and continuing decline in the number of cigarettes smoked since the 1960s. The percentage of people consuming more than 15 alcoholic drinks per week declined from about 10% to below 8% of the population from

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<sup>4</sup> Data for motor vehicle fatalities assumes a 75% behavioral/public health component to the change.

1970s to 2009. Motor vehicle deaths per 100,000 of population declined from about 20 to about 15 from 1960 to 2010, despite the increase in miles driven over this time period.

Areas of declining health over time include worsening behaviors for diet and physical activity, and deaths from firearms and poisoning.<sup>5</sup> Levels of obesity and extreme obesity in the United States increased for both men and women, especially since the mid-1970s. The rate of firearm deaths has decreased somewhat after a dramatic rise during the 1960s and 1970s, but remains elevated above 1960 levels. The increased rate of poisoning deaths is mainly attributable to drug overdose fatalities.

Drs. Cutler and Stewart accessed data from the National Center for Health Statistics period life tables, the Medical Expenditure Panel Survey, and the National Health Interview Survey to calculate the contribution of measured health behaviors on life expectancy. They calculated quality-adjusted life expectancy (QALE) by valuing each year of life at \$100,000 and using a 3% discount rate.

Drs. Cutler and Stewart calculated the contribution to health improvement at age 18 for areas of improving and declining health. They found that areas of improving health increased life expectancy by 1.87 years (1.93 years QALE) for the period 1960 to 2010. Set against that gain is a decline in life expectancy of 1.30 years (1.78 years QALE) caused by areas of declining health. The overall net gain was 0.57 years for life expectancy (0.15 years QALE). For comparison, overall life expectancy increased by 6.9 years over the same period. Calculations for the value of health improvement showed a net gain of \$17,594 for life expectancy (\$1,946 for QALE).

Drs. Cutler and Stewart calculated potential gains that could be achieved in life expectancy if improvements were made in the areas of diet, physical activity, and deaths from firearms and poisoning. Their estimates suggest that nontrivial gains could be made if the trends in these areas of declining health could be reversed. Calculations of potential gains assumed that improvements in firearm deaths would be comparable to the decline in mortality from seat belt use. Calculations for potential declines in obesity and poisoning assumed changes comparable to rates of smoking decline. It will be important to identify behavioral interventions to make progress in these areas.

***Understanding the Relationship between Education and Health: A Review of the Evidence and an Examination of Community Perspectives***

Steve Woolf, M.D., M.P.H., and Emily Zimmerman, Ph.D., Virginia Commonwealth University

Drs. Woolf and Zimmerman and colleagues are conducting the Education and Health Initiative funded by the Robert Wood Johnson Foundation (RWJF). The initiative focuses on raising awareness in policy makers about the link between education and health. The first product of

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<sup>5</sup> Data for poisoning assumes a 25% benefit from medical advances.

the initiative is the "[Education: It Matters More to Health than Ever Before](#)" campaign, which was released in January 2014.

The product includes a web version of information on education and health and a 5-minute documentary video. An accompanying scientific report reviews posited causal factors based on the literature. The report also presents a model for engaging the community to blend insights from the literature with lived experience. This approach considers the sociologic framework and life course perspective of the relationship between education and health.

Although there has been increasing engagement of stakeholders in health research, efforts aimed at involving community members in conceptualization and modeling are less common. In their research, Drs. Woolf and Zimmerman posed two key questions: (1) Would community stakeholders develop a causal model that differed from pathways and mechanisms already hypothesized in the literature? (2) Would the lived experiences of participants elucidate new descriptions and nuances about pathways?

Drs. Woolf and Zimmerman utilized an existing community-university partnership, *Engaging Richmond*, which includes residents of a low-income, primarily African American area of Richmond City, Virginia. The investigators facilitated a three-step model development exercise. In the first step, community participants individually identified factors that might be influential in the relationship between education and health. Next, they worked on model development as a group. The last two steps involved training in pathway design and group development of a pathway design showing causality of the impact of education on health.

This exercise focused on the residents' insights that add new perspectives or emphasized different aspects of causal factors, while highlighting certain specific aspects of the experiences of low-income and minority groups. The community added new ideas to the model originally developed by the scientist researchers. Community members provided additions in the areas of noncognitive skills, personal health behaviors, social networks, health care navigation, SES, and community resources. Community researchers were particularly interested in the contextual and policy factors linking education and health.

The limitations of this community engagement exercise pertain to the difficulty in training participants in model development in a short timeframe. However, the exercise was helpful for gaining the perspective of individuals who have lived through the experiences under study. This type of research is useful to inform the thinking of investigators.

### *Discussion of Presentations*

#### *Educational Attainment and Life Expectancy*

There is a behavioral component to the association between educational attainment and life expectancy, but the relationship is broader than that. For example, people lower on the SES scale have more difficulty with most health-related behaviors, whether it is quitting smoking,

taking medicine, or eating properly. Cognitive factors probably account for some of the association. In addition, stress, the impact of material need, behavioral health, and other factors likely come into play. Interdisciplinary research is needed to better understand the contribution of these factors.

### *Social Determinants of Obesity*

Obesity is an outcome not a behavior. Many potential determinants for obesity have been identified. Possible factors include diet, physical activity, use of antibiotics in livestock, stress levels, sleep patterns, and more. It is important to consider the social determinants of obesity rather than thinking of obesity as a social determinant.

## **Emerging Technologies in Behavioral and Social Science Research**

### *Tobacco Use Behavior: The Rise and Decline of the Greatest Behavioral Disease Epidemic of the 20th Century*

David Abrams, Ph.D., American Legacy Foundation

Dr. Abrams provided an overview of the past 120 years of tobacco use. He introduced the idea of electronic cigarettes as a potential disruptive technology to reverse the trend of combustible tobacco. E-cigarettes and other noncombustible forms of tobacco, such as Swedish snus, are less addictive and less disease-causing than smoked tobacco.

Combustible tobacco was one of two disruptive technologies of the 20th century that caused a large change in cancer rates. The other was the advent of refrigeration, which caused a marked decline in the rates of gastric cancer. Combustible tobacco, in contrast, caused large increases in the rate of cancer, especially lung cancer. Cigarettes increased the number of people using tobacco and changed the way they used it.

The number of people who smoke tobacco continued to rise until about the 1960s. Although the smoking rate has been declining since then, substantial numbers of people continue to smoke. The impact of smoking on lung cancer is evident from the marked similarity of the magnitude and timing of changes in the rates of smoking and lung cancer over time.

### *Systems Integration and E-cigarettes to Combat the Tobacco Problem*

Dr. Abrams suggested that a population-level impact that uses systems integration of prevention, treatment, and policy interventions is needed to end the tobacco problem. A social network view must consider not only the reach and efficacy of the intervention, but also externalities such as social contacts. For example, the efficiency of an intervention will depend on optimization of the quality of delivery, scalability, and cost-effectiveness for population impact. This will require use of science informed by modeling.

Dr. Abrams suggested that the E-cigarette may provide a new disruptive technology that could displace smoking with a safer, although not benign, alternative. E-cigarettes could be made

more attractive than combustible cigarettes through taxation policies. Another strategy would be to ban menthol in combustible cigarettes but allow it in E-cigarettes.

Dr. Abrams noted that before promoting E-cigarettes, it first will be necessary to determine that new users of E-cigarettes would not simply progress to smoking, which would be a disaster. Preliminary studies of the effect of snus on tobacco use behavior in Sweden suggest that noncombustible tobacco use will not necessarily lead to smoking.

#### *Real-time Point-of-Sale Technology*

Dr. Abrams and colleagues are creating real-time point-of-sale visualization technology for FDA. This technology will allow FDA to track and regulate every tobacco outlet in the country. For example, information can be obtained on price discounting, advertising, and compliance with FDA regulations. Importantly, these new systems are providing an unprecedented platform for analysis of the link between individual behavior and policy-related context. These methods provide a novel lens with which to study the link between individuals and their environment in real-time.

#### *Big Data: New Opportunities for Measurement, Analysis, and Intervention in the Behavioral and Social Sciences*

Kevin Patrick, M.D., MSPH, University of California, San Diego

According to Dr. Patrick, “Big Data” is a term that captures the opportunities and challenges in accessing, managing, analyzing, and integrating information within diverse datasets that are increasingly larger, more diverse, and more complex. This paradigm exceeds the abilities of traditional data management approaches. The value of data from social and behavioral measures can be significantly amplified by aggregating or integrating them with other data.

Dr. Patrick discussed the research and development of interventions that use big data to bring about behavioral change. Larry Smarr, Ph.D., of the California Institute for Telecommunications and Information Technology is a case in point for the use of big data. Dr. Smarr used a variety of emerging personal sensors and measurement of blood and stool variables to quantify his nutrition and exercise and drive behavior change.

#### *Big Data*

There has been a recent exponential growth in researchers’ ability to measure and track big data. Sources of big data for behavioral and social sciences research include mobile phones and wearable technology. Internet connectivity, social networks, and digital traces such as data from retail store discount cards also are relevant, as are cloud computing and machine learning.

The Personal Activity Location Measurement System (PALMS) project, undertaken by Dr. Patrick and colleagues, provides an example of big data research. The PALMS tracking device measures variables of physical activity, heart rate, and location. It provides extensive data on where

people are spending their time and what they are doing. The data are suitable for machine learning approaches to behaviors such as transportation usage or the uptake of E-cigarettes.

Dr. Patrick also discussed big data research using “smart” cyber-physical systems (CPS). Shyam Sunder, Ph.D., of the National Institute of Standards and Technology described CPS as integrated, hybrid networks of cyber and engineered physical elements, designed and engineered to create adaptive and predictive systems. They enhance performance, including safety and security, reliability, agility and stability, efficiency and sustainability, and privacy.

CitiSense is an example of an always-on, participatory CPS sensing device for air quality. Investigators attached the CitiSense device to the mobile phones of participating individuals in San Diego County, California. The current air quality monitoring system in this county uses 10 monitoring sites to define the general quality of air in broadly defined regions. In contrast, CitiSense allows the construction of much finer grained air quality maps.

#### *Machine Learning*

Dr. Patrick also highlighted the Data e-Platform to Leverage Multilevel Personal Health Information (DELPHI). The goal of DELPHI is to enable personalized population health through the creation of a “Whole Health Information Platform” that takes into account everything from the genome to the “exposome”—essentially all health-relevant data. The project will integrate heterogeneous data into a “single” uniform database within a geospatial context. Investigators will implement a machine learning analytics layer on top of the data and open up the data and analytics to third party developers of apps and services.

The advancement of these and other big data undertakings will require transdisciplinary research merging medicine, behavioral and social sciences, engineering, public health, computer science design, and other disciplines. New methods are needed for data fusion, synthesis, and comprehension. The field will require a new generation of health data analysts. Furthermore, researchers must develop new approaches to handling privacy, security, and sharing of health information.

#### *Discussion of Presentations*

Participants expressed concern about the possibility of encouraging public use of E-cigarettes and the possible priming effect they might have on regular cigarette users. If E-cigarettes are to be used as a disruptive technology to displace smoking, then it will be necessary to minimize unintended consequences and discourage dual usage. The potential impacts on users and non-users must be explored.

## Neurology, Genetics, and Epigenetics

### *Brain on Stress: How Behavior and the Social Environment “Get Under the Skin”—Biological Embedding over the Life Course*

Bruce McEwen, Ph.D., The Rockefeller University

Historically, there have been three eras of health science. In the past the focus was primarily on the biomedical model, which considered germs and the use of “magic bullets” such as antibiotics to combat disease. In the current era, researchers consider the biopsychosocial model, which assesses multiple risks stemming from stress, health behaviors, and the social environment. Health science is now moving into an era of life course health development and the exploration of epigenetics, context sensitive genes, and complex systems biology.

#### *Stress, Allostatis, and Allostatic Load*

Health stressors in the social environment include environmental stressors, major life events, trauma, and abuse. Stressors can be defined as positive, tolerable, or toxic. Toxic stress leads to the development of unhealthy brain architecture.

Stress leads to the release of cortisol, which has positive short-term but negative long-term effects on the brain. Acute elevations in cortisol act to enhance the immune system, memory, and cardiovascular function and also replenish energy. In contrast, chronically elevated cortisol results in suppressed immune function, poorer memory, bone and mineral loss, muscle wasting, and metabolic syndrome.

Other than cortisol, key mediators of stress and adaptations include dehydroepiandrosterone (DHEA) and inflammatory and anti-inflammatory cytokines. These mediators interact through a network of allostasis, impact sympathetic and parasympathetic function, and modulate levels of oxidative stress. The end result is changes in central nervous system function and metabolism.

Dr. McEwen discussed work by Teresa Seeman, Ph.D., on Coronary Artery Risk Development in the Young (CARDIA). Seeman and colleagues measured a battery of markers for allostatic load in young adults at four urban sites. They found that higher levels of education and social support, as well as several other social factors, were associated with lower allostatic load score. Dr. McEwen suggested the need for a battery test for allostatic load for research in children.

#### *Remodeling of Neural Architecture*

Stress leads to changes in neural architecture in adult as well as in developing brains. Epigenetics is an important area of research in this field of study. Epigenetic changes early in life appear to be involved. One mechanism of the epigenetic effect of stress involves the folding and unfolding of chromatin through the methylation of cytosines in DNA.

Dr. McEwan discussed the diverse mechanisms of adrenal steroid action in dendritic function. He noted that glucocorticoids are critical regulators of dendritic spine development and plasticity *in vivo*. Glucocorticoids also have been implicated in learning-dependent synapse formation and maintenance. Other mediators of structural plasticity and epigenetic change include sex hormones, growth factors, brain derived neurotrophic factor (BDNF), corticotropin-releasing factor, leptin, insulin, and ghrelin.

Whether the action of these mediators enhances or suppresses brain function depends largely on whether the stressor is acute or chronic. The interplay of different areas of the brain, including the hippocampus, the amygdala, and the prefrontal cortex is an important component to this research.

There is evidence that interventions can be effective in countering changes in brain structure and function caused by social factors. Effective interventions include regular physical activity, mindfulness-based stress regulation, and social support and integration. Pharmaceutical agents such as fluoxetine or valproate may be effective during windows of plasticity although there appear to be individual differences in treatment response.

#### *Exposure to Early Adversity and Life Course Health/Development*

W. Thomas Boyce, M.D., Ph.D., University of California, San Francisco

Dr. Boyce used a historical metaphor to provide context to present-day research on the effects of gene/environment interactions on health and development. He likened the contribution of epigenetics to this field of research to the revolution in neurology research caused by Camillo Golgi's methods for cellular imaging of the brain in 1889.

#### *Childhood Development and Early Adversity*

Research has shown a linear association between decreased SES and the development of chronic disease. Numerous childhood stressors show greater prevalence in low-income versus middle-income populations. Furthermore, childhood experiences of adversity and trauma predict leading causes of adult mortality from chronic heart disease, diabetes, sexually transmitted disease, drug use, and suicide. Studies have also identified SES differences in child-directed speech and language processing efficiency. Even social positions within peer hierarchies predict teacher-reported mental health and academic competencies.

Other research has highlighted the biological component of the effects of adversity. One study showed that the overall relationship between exposure to stressful, disadvantaged environments and poorer developmental outcomes is linear, but with much variability of effect. These types of findings led researchers to study why some children were better able to deal with stressful environments than others.

Dr. Boyce and colleagues determined that levels of autonomic nervous system (ANS) reactivity differ among children. The behavior of children with low ANS reactivity is not greatly affected

by changes in levels of stress in the family. In contrast, children with high ANS reactivity exhibit a marked increase in externalizing behavior problems when exposed to family stressors, such as marital conflict.

Although children with high ANS reactivity have more problems in stressful environments, in low-stress environments these children actually do better than peers with low ANS reactivity. A similar cross-over relationship is seen with variations in cortisol levels in response to family stressors, depending on which allelic variant of the *BDNF* gene the children expressed.

Research has determined that socially partitioned childhood adversities have potent, pervasive, and persistent linkages to health and development. These effects are age-linked, inter-generational, and highly variable. Furthermore, variation in health and developmental outcomes is an interactive product of biological susceptibility and environmental conditions.

#### *Mechanisms of Differential Susceptibility to Adversity*

The molecular origins of individual differences in susceptibility are less clear. Research is needed, therefore, to determine the basis of inter-generationality, or how epigenetic changes that originate in youth may affect phenotypic expression later in life. The source of the remarkable variability in the effects of genetic variation on health outcomes is an important area of research.

Preliminary research suggests that exogenous control of human gene expression is mediated by differential epigenetic DNA methylation that impacts transcription events. Studies have shown that individuals who are exposed to trauma in childhood have increased levels of DNA methylation through adolescence and adulthood. For example, allele-specific *FK506 binding protein (FKBP5)* gene demethylation mediates gene-childhood trauma interactions. The interaction of early trauma exposure and expression of the *FKBP5* risk allele is a significant predictor of post-traumatic stress disorder.

These and other research findings elucidate the increasingly untenable distinction between the biological and social sciences. In fact, there is a reciprocal interdependence of social and biological discovery. Social science research is able to illuminate the tremendous variability of genetic effects on important endpoints and outcomes. In turn, biological factors are illuminating the variability in the impacts of social factors.

#### *Discussion of Presentations*

Although high levels of stress reactivity was assumed for many years to be uniformly damaging, under the right circumstances this reactivity has protective affects, rendering children even better off than their low-reactivity peers. However, the modern high-SES lifestyle demands the ability to suppress impulses and plan for future rewards. Individuals with high levels of reactivity will have difficulty moving into such environments unless there are ways to reactivate the placidity of the brain to allow a decrease in level of reactivity. The period of vulnerability in

which treatments may be effective is not well defined and is probably epigenetically mediated. More research is needed in this area.

Epigenetic regulation can occur at several levels. For example, methylation occurs at the level of the nucleotide or the histone and causes changes in the folding and unfolding of the histones to affect DNA transcription. DNA methylation is easier to measure than histone methylation.

### **Behavior and Social Sciences Research Opportunities: Innovations in Population Metrics and the Burden of Noncommunicable Diseases and Injury in the Developing World**

Wendy Baldwin, Ph.D., Independent Consultant

Noncommunicable diseases (NCDs) are the leading cause of death globally, and 80% of NCDs occur in low- and middle-income countries. According to WHO, the four major NCDs are cancer, chronic respiratory disease, diabetes, and CVD. One-quarter of NCD deaths occur before age 60. It is estimated that by 2030, \$47 trillion in cumulative loss in global economic output will be lost because of NCDs. Among countries in the developing world, Latin America has the highest percentage of deaths due to NCDs.

The four major risk factors are all modifiable. They are tobacco use, harmful use of alcohol, insufficient physical activity, and unhealthy diet leading to overweight and obesity. Dr. Baldwin discussed adolescence as the “last best chance” to reach people with behavior modifications to lower their risk of NCDs. Seventy percent of premature deaths in Latin America and the Caribbean are the result of behaviors that start during this timeframe. Adolescence is the time of adoption of two major risk behaviors—tobacco use and alcohol use. It is a time when physical activity levels change and positive behaviors can be established and reinforced. Furthermore, the growing autonomy of youth gives them more control over personal behaviors such as diet. There is also value to a full life cycle approach to screening, diagnosis, and treatment.

Strategies to address the prevalence of risk factors for NCD in youth include enactment of public policy, collaboration of government and civil organizations with the private sector, and enforcement of laws and policies that promote healthful lifestyles. It will be important to involve youth, families, schools, and communities in changing their behavior and their environment. Dr. Baldwin and colleagues created a Youth Risk Data Sheet to communicate the level of risk for behavioral risk factors to policy makers. The data sheet uses color coding to show low, moderate, or high prevalence of risk factors in a range of countries. Efforts also should focus on improving and optimizing health care.

Dr. Baldwin suggested roles for NIH in research on youth and risk factors for NCDs. Opportunities include research in the areas of initiation of risk behaviors and protective factors; maintenance of healthful behaviors; roles for communities in understanding the needs of

youth; and creation of positive environments. Other possibilities include development of innovative programs, involving youth in their creation and function. NIH also might support behavioral economics or other research to elucidate the ways that people invest in their future wellbeing. Potential partners in this research include CDC, the United Nations, the United Nations Children's Fund, WHO, various foundations, and policy makers and program leaders.

In addition to supporting new research, NIH could highlight and continue current efforts in the area of youth risk behaviors, provide leadership to bridge silos of research, and support researchers to develop skills and tools to communicate with nontechnical audiences.

### **Social Determinants for Health**

Nancy Adler, Ph.D., University of California, San Francisco

The knowledge network for evidence-based health, as it currently stands, is informed by biomedical science, and much less so by behavioral and social science. The knowledge is drawn from understanding of “-omics,” such as the genome, epigenome, transcriptome, proteome, metabolome, and also by cellular processes and organ systems.

It will be important to incorporate behavior and social factors into this knowledge system. Analyses have shown that 50% of deaths are caused by behaviors, such as smoking, poor diet, inactivity, and alcohol use. Important factors to consider from behavioral and social science include social and economic policies, institutions, neighborhoods and communities, living conditions and social relationships, and individual risk.

### ***Linkages and Interactions between Behavioral and Social Sciences and Biomedical Research***

The point of intersection between behavioral and social sciences and biomedical knowledge systems occurs at the narrow intersection of organ systems and individual risk. Dr. Adler used the analogy of the tenuous meeting of stalagmites and stalactites in caves. She proposed that a better analogy to strive for would be a single column of knowledge supported by linkages and interactions.

An example of *linkages* between behavioral and social sciences and biology systems is the association between stress and telomere length, which links social factors to the cellular level. Shorter telomere length has been associated with several socioeconomic factors including lower educational attainment and lower income.

Telomere length also turns up in *interactions* between behavioral and social sciences and biological factors. Research has demonstrated that the decline in telomere length with increasing stress is attenuated by physical activity. A second interaction is seen in the lesser tendency of children with low *monoamine oxidase A (MAOA)* gene activity to develop antisocial behavior in response to maltreatment.

The need to consider behavioral and social sciences factors along with biomedical data is exemplified by the inability to find a genetic cause to account for obesity. For example, genetic research identified the *fat-mass-and-obesity-associated (FTO)* gene, which increases the risk for obesity, but only by 20-30%. Interestingly, the obesity risk associated with *FTO* is attenuated by physical activity. Furthermore, a genome-wide association study for body mass index was able to account for only 1.45% of genetic variance.

### ***Challenges to Integration of Behavioral and Social Sciences and Biomedical Research***

Dr. Adler reviewed six challenges to better integration of behavioral and social sciences and biomedical research and offsetting actions for meeting each challenge. For example the differences in the cultures of the two fields of research could be offset by team science and work at the intersection of epigenetics and the “exposome”—the measure of all the environmental exposures of an individual in a lifetime and how those exposures relate to health. The value of behavioral and social sciences, alongside biomedical science, can be demonstrated by direct comparison of “value added” by interventions in areas such as diabetes prevention.

The lure of the simple and concrete of biomedical science could be offset by new analytic methods for large data sets. Another challenge is the preference for greater leverage, or in other words, for single actions with widespread and long-lasting effects, such as vaccinations or drugs. In response, behavioral and social scientists could pay greater attention to easier “defaults” for behavior, highlight rare but valuable opportunities for leverage, and leverage upstream interventions that take people out of the risk pool.

The fifth challenge, the lack of market forces for scaling up interventions could be addressed by incentives for creating health, such as accountable care organizations, or by incentivized outcomes, such as avoiding hospital re-admissions. Finally, the lack of standard measures could be offset by identifying behavioral and social sciences variables that people could agree to include in electronic health records.

### **Physical Activity: Numerous Benefits and Effective Interventions**

James Sallis, Ph.D., and Jordan Carlson, Ph.D., M.A., University of California, San Diego

Physical inactivity is a major behavioral risk factor for death in the United States for both men and women. Between 6% and 10% of chronic diseases worldwide are attributable to physical inactivity. An estimated 5.3 million deaths per year worldwide might be avoided by eliminating inactivity.

Research also shows a strong association between physical activity and improved health-related quality of life, with big impacts on vitality, physical function, social function, and mental health. Physical activity improves cognitive function in people with dementia, in the general population, and in children. Physical activity appears to be the only lifestyle behavior that can

favorably influence such a broad range of physiological systems and chronic disease risk factors, which may also be associated with better mental health and social integration.

### ***Co-Benefits of Physical Activity***

Furthermore, there are co-benefits of physical activity, such as reduced levels of climate change as more people switch from driving to walking or bicycling. Financial benefits stem from lower health care costs leading to improved budgets. Research has also shown that the level of walkability of a neighborhood raises home prices in U.S. cities. The co-benefits of physical activity are not well studied, and this is a potential area for NIH collaboration.

The increasing use of labor-saving technologies over the decades has led to increasing tendencies toward sloth in all domains of life. Dr. Sallis shared a diagram of an Ecological Model of Four Domains of Active Living. The four overlapping environmental domains include the policy, information, social cultural, and natural environments. The model depicts microenvironments within each domain and highlights problem areas and categories of potential interventions.

Researchers have identified some correlates and determinants of physical activity in adults and children, but more work is needed in this area.

### ***Interventions to Combat Physical Inactivity***

CDC's Guide to Community Preventive Services lists evidence-based interventions to promote physical activity. Effective interventions include point-of-decision prompts, school-based physical education, individually adapted programs, provision of places for physical activity and outreach activities, and possibly community-wide campaigns. The *National Physical Activity Guidelines Midcourse Report, 2013* contains guidelines for youth. The most effective strategies are multi-component school programs and physical education.

Research on populations from around the world underscores the availability of many effective physical activity interventions. However, they are not well implemented. Their implementation will require an interdisciplinary partnership that integrates diverse elements, including environment and behavior; geography; landscape architecture; criminology; economics; law; policy; and departments of parks and recreation, planning, and transportation. It will also require participation by advocates and policy makers. Once policies are implemented, it will be important to monitor results.

### ***Research Recommendations***

Dr. Sallis gave several research recommendations in the area of physical activity. Studies of co-benefits related to economic factors and climate change could improve implementation of physical activity policies. International studies to determine correlates and determinants of physical activity and to test interventions would provide useful lessons. More evaluations of environment, policy, and multi-level interventions also are needed. Finally, research should consider how to improve communication of research findings to decision makers.

## **Injury and Behavior Change Interventions**

David Sleet, Ph.D., CDC / Andrea Gielen, Sc.D., John Hopkins Center for Injury Research Policy

Injuries are an enormous public health problem, accounting for 180,000 deaths per year in the United States. Injury is a leading killer of children, adolescents, and young adults. Injuries are the second leading cause of hospitalization, the leading cause of emergency department visits, and one of the most expensive problems to treat. Injuries are responsible for more years of potential life lost in the United States than cancer, heart disease, prenatal death, or suicide. It is important to recognize that injuries are not accidents. Like many diseases, injuries are predictable and preventable.

### ***Injury Prevention***

There are multiple strategies for impacting public health. Interventions might target populations, focus on socioeconomic factors, or intervene at the individual level through counseling and education. Interventions at all levels have one thing in common—they all involve a dynamic interaction among the individual, behavior, and the social and physical environments.

Epidemiologists view injuries from the standpoint of the same epidemiological triangle that is used to study a disease such as malaria. The triangle represents the interaction among the host (humans), the agent (products such as motor vehicle), and the environment. Eliminating the risk from one side of the triangle will eliminate injury. However, it is hard to imagine any injury prevention intervention that does not require some behavioral component.

Studies show that policy interventions to reduce injury are effective. To highlight a few examples, window guards to reduce child falls were 90% effective. Child safety seat laws save the lives of 350 children under the age of 5 annually. Increasing the drinking age to 21 averted 800 deaths per year. CDC listed motor vehicle injury prevention among the 10 greatest public health achievements in the United States from 1900 to 2000.

### ***Injury and Behavioral and Social Science Research***

Despite the potential to save lives through interventions, behavioral and social sciences research in injury prevention is under-represented in the literature, under-developed in theory, under-used in practice, under-appreciated by injury professionals, and under-funded. For example, researchers tend not to conduct much research on the application of health behavior theory to injury prevention. The leading behavioral and social sciences textbooks rarely mention injury or discuss behavioral risks or interventions for injury.<sup>6</sup>

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<sup>6</sup> Two textbooks recently produced by CDC attempt to bridge this gap. The first textbook is Gielen AC, Sleet DA, and DiClemente RJ. 2006. *Injury and Violence Prevention: Behavioral Science Theories, Methods, and Applications*. The second is Doll L, Bonzo S, Sleet D, Mercy J, Haas EN. 2007. *Handbook of Injury and Violence Prevention*.

Dr. Sleet discussed research opportunities in behavioral and social sciences and injury prevention. Efforts are needed to understand antecedents and correlates of injury behavior; study adoption, compliance, and maintenance of safe behaviors; broaden the application of behavioral theories; improve behavioral outcome measures and tools; conduct injury risk communications research; and evaluate the impact of injury policies. There also is a need to discover ways to encourage injury researchers and behavioral researchers to work together.

### ***Discussion of Presentation***

Of all the literature citations on injury prevention, most originate in other fields, such as engineering or architecture. Investigators in behavioral and social sciences tend not to access those results, which are not translated into interventions. Nevertheless, one big difference between the fields of behavioral research on injury and on physical activity is the great success in reducing the prevalence of injuries, compared with the difficulty in increasing physical activity.

Injury prevention may be one area that does not fit clearly into the mission of any of the NIH Institutes and Centers, except perhaps for the National Institute on Alcohol Abuse and Alcoholism. However, injury prevention research centers funded by CDC were successful in bringing scientists together for multidisciplinary research. One strategy to support more research on injury prevention is the cooperation of various NIH Institutes to bolster the work of CDC in this area.

### **General Discussion**

Dr. Kaplan asked meeting participants to consider the future research agenda for behavioral and social sciences research, how best to generate and present the data in a way to be more persuasive in the area of public policy, and approaches for breaking down the silos that exist in health research and within and among academic and government agencies. He noted that NIH has a cross-Institute working group to identify areas for research and to develop interdisciplinary research initiatives. Communication across agencies within the Department of Health and Human Services (HHS) and with agencies outside HHS is perhaps less effective.

Dr. Kaplan noted the need for research to improve the understanding of behavioral and social determinants of health. He also noted that OBSSR in collaboration with other agencies has sponsored a study by IOM to assess which behavioral and social factors should be included in electronic health records to create a database for the future. The study committee, chaired by Nancy Adler, released its report on April 8.<sup>7</sup> Dr. Kaplan also discussed a pilot effort between NIH/OBSSR and CDC to develop measures for the Behavioral Risk Factor Surveillance System (BRFSS), the world's largest ongoing telephone health survey system. This effort will help

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<sup>7</sup> IOM (Institute of Medicine). 2014. *Capturing Social and Behavioral Domains in Electronic Health Records: Phase I*. Washington, DC: The National Academies Press. Available at: [http://books.nap.edu/catalog.php?record\\_id=18709](http://books.nap.edu/catalog.php?record_id=18709)

generate quality-of-life data that can be combined with mortality data to facilitate estimation of QALYs for the U.S. population.

Meeting participants noted that economic and industry drivers contribute to the maintenance of research and policy silos. Suggestions for breaking down silos included NIH provision of opportunities for collaborative research; formation of a roundtable of public health; and engagement of the younger generation in behavioral and social sciences research. An emphasis on iterative research that moves from a genomic level to the community and back, or from big data to qualitative data and back, is needed to help break down research silos.

Dr. Barry Portnoy, Ph.D., of the NIH Office of Disease Prevention (ODP) discussed recent ODP activities. ODP has gone through a recent planning process in preparation for moving in new directions. ODP has initiated a portfolio analysis that is expected to take about 2 years to complete. According to data from the NIH Research, Condition, and Disease Categorization (RCDC) system, there are 11,000 grants for disease prevention. The portfolio assessment will show the types of studies and populations involved. ODP plans to improve the quality of prevention science and to increase collaboration among NIH Institutes and with CDC and AHRQ.

Meeting participants discussed common themes around which to organize the upcoming monograph. The monograph will be published either as a book or a special issue. It probably will not be possible to publish the monograph in its entirety in a biomedical journal such as *Science*, which must deal with page allocation constraints. One possibility is to publish some of the papers in *Science* and also to produce the whole volume as a book.

OBSSR is open to feedback and will be in touch with meeting participants about their contributions to the monographs, which will be submitted to internal peer review at NIH. Dr. Kaplan asked any authors who have not yet turned in their papers to submit them soon. OBSSR will ask for volunteers to write additional pieces to be included in the publication. The development of the monograph will be on a fast track.

Meeting participants identified the following key areas of emphasis for the monograph.

#### ***Communication with Biologists***

As pointed out by Dr. Adler in her presentation, the value of behavioral and social sciences is often underappreciated compared to biomedical science. Drs. Boyce and McEwen's presentations on developmental and neurologic responses to stress were closer to the nexus of biomedical research. Furthermore, technologies such as real-time data analysis can fuel the integration of biomedical and behavioral and social sciences research. Proactive communication among behavioral and social scientists and biologists is needed to spur collaborations in these and other areas.

Some biomedical investigators appreciate the behavioral and social aspects of disease risk. Behavioral and social sciences investigators should identify respected biomedical scientists with

this understanding and co-write commentaries about why behavioral and social sciences is so important for publication in major journals. In this way, prominent names in the biomedical field will be seen advocating for behavioral and social sciences research.

### *Communication to Inform Public Policy*

#### *Opportunity Costs and Return on Investment*

Dr. Russell in her presentation demonstrated that spending on behavioral and social interventions can have a greater impact on health than the same money spent on expensive drugs that extend lives by only a few months. Participants discussed the need to communicate this opportunity cost in health spending as well as the need to reward “value rather than volume” to policy makers.

Several presentations demonstrated return on investment. Dr. Berkman’s presentation of employer benefits of flexible work environments for employees and the effects of the EITC provides a good example. The impact of reduced smoking on CVD and cancer rates also speaks to the value of behavioral and social interventions.

Dr. Sallis’ presentation highlighted the idea of co-benefits of physical activity to the environment. Interventions to change food behaviors would have similar benefits. For example, decreased consumption of red meat and sweetened beverages and confectionary foods would have a positive effect on the environment. Behavioral and social science scientists must communicate such co-benefits to policy makers.

#### *Communication Strategies*

The return on investment in behavioral and social sciences research and interventions must be communicated to policy makers and the public alike. Part of the difficulty in communicating the importance of behavioral and social interventions is the desire among policy makers for quick, short-term solutions that have an immediate, visible impact. However, the benefit of many behavior modification interventions plays out across the life course. In addition, policy is often made before adequate data are available to inform the policy. Once the policy is in place, it is difficult to reverse it when data become available. Generally, investigators are not trained to make data accessible to nontechnical audiences, such as policy makers and the general public. Those who may be interested in this undertaking should consider building those skills.

Researchers need to learn how much, what type, and what quality of evidence is good enough to support public policy decisions. Efforts are required to better understand the type of methodologies, data, and communication strategies needed to inform public policy. HIA’s, CEAs, and CBAs will be useful. Interdisciplinary, comparative studies are also needed. Opportunity costs already are factored into the decision of whether to use drugs in the United Kingdom. The United States could learn from the U.K. model. However, the political culture in the United States tends to consider it almost unpatriotic to think that something can be learned from another country. It will also be important learn how to counteract the “more is better” cultural attitude.

The resistance of policy makers to supporting health economics research stems from a concern that people will be denied care should experts find it to not be cost effective. The influence of private-sector industry also plays a role in the resistance to supporting health economics research. The importance of reaching the public to overcome political resistance should not be discounted.

A possible role for NIH is the development of simple, understandable health metrics that would help convey the message of the need for behavioral and social sciences health interventions to policy makers and the public. RWJF has contracted with the RAND Corporation to build new indicators. NIH may be able to partner with RWJF in this endeavor.

### *Research and Regulatory Policy*

NCI is working with FDA to develop an inter-agency initiative to inform regulatory decisions about tobacco products and their marketing. The effort of generating evidence that a regulatory agency can use is a struggle because the scientific research system is principal investigator driven. Although clinical trials investigators are able to get advice on how to do the research that will be useful to FDA, that mechanism is not available in behavioral and social sciences research.

### *Areas of Emerging Methodologies*

#### *Systems Modeling*

The need for a systems model of research was a common theme among presenters. Such a model considers cellular systems as occurring within the organismal system, and that within the context of individual behaviors. Behaviors in turn occur within the context of a variety of environments. This can be thought of as a “systems within systems” approach, moving from micro- to macro-levels of systems.

#### *Basic Research*

Although a systems model approach to public health research is the terrain of the future, in the short term the behavioral and social sciences field needs to assess where more progress is needed. For example, the lack of behavioral change with respect to physical activity, as presented by Dr. Sallis, is sobering.

The field of nonconscious behavioral research, as presented by Dr. Marteau, for example, is not yet ready for translational research. Basic transdisciplinary research is needed to determine effect sizes of possible interventions and to determine which aspects of the environment should be targeted for change.

Another common theme was the idea of understanding the biological embedding of behaviors and the role of mediators between behavior and biology. The monograph should address the role of qualitative research methods for researching the complex linkages between SES levels, social factors, structural factors, behavior, and policy.

### *Community-Focused Research*

The emphasis of health research and interventions must shift from a focus on the individual to a focus on the community. In California, a Health in All Policies task force has been created to define what is meant by healthy communities. Part of the research agenda is to understand the components of communities with healthy social and environmental characteristics and to determine how to create them. This focus will also help to reduce disparities between populations.

### *Interdisciplinary Research*

An interdisciplinary approach to behavioral and social sciences that goes beyond epidemiology is needed. Such an approach should incorporate sociology, psychology, environmental biology, neurology, developmental biology, genetics, epigenetics, anthropology, political science, engineering, computer science, etc.

For example, interdisciplinary research is best suited to answer questions raised by Dr. Pickett's presentation. That is, is it the effect of inequality itself that contributes to lower lifespan or are the conditions in a society that tolerate that inequality the cause? Behavioral and social scientists must move outside of their comfort zones to do this type of research.

Another question for interdisciplinary research is, "How much of the change in life expectancy over the years is medically related and how much is behavioral?" For example, drugs for reducing cholesterol levels are available, but people have to decide whether to take them. Research suggests about half of the reduction in cardiovascular death is due to medical intervention and the other half is due to behavioral change

The need for increased physical activity and the health effects of poor air quality create an intersection for interdisciplinary research. Although exercise is beneficial to health, the poor air quality in many developing countries creates a less than ideal environment for exercise. This predicament should be researched in partnership with the environmental health community.

Partnerships for cost sharing of interdisciplinary research should be formed among NIH Institutes, the environmental health science community, and other agencies with a vested interest in addressing macro-risk exposures in various environments. The challenge is to find a way to come together around the issues—to recognize the commonality of all the research discussed at this meeting and to determine how to move forward.

### *Big Data and Machine Learning*

There is an emerging paradigm shift away from traditional RCT-style research to machine learning and big data research. These innovative methods are challenging the traditional requirements of scientific method for an a priori hypothesis with clearly defined dependent and independent variables. Big data are allowing the rapid elucidation of relationships that previously took years to explore.

There will be a continued, but smaller role for RCTs. Now that data are becoming cheaper and more plentiful, researchers must move to incorporate nontraditional methods. Whether an investigator chooses to use an RCT or big data will depend on the context of the research.

Behavioral and social sciences needs improved and more complex models to detect interactions of sociobehavioral factors and health in a dynamic system with real-time measurements. NIH, the Defense Advanced Research Projects Agency, and the National Science Foundation have begun to invest in neuroanatomy, which will contribute important data to the mix. This and other neuroanatomy research in combination with genomics and epigenetic research, the emerging use of electronics health records, and real-time big data will combine to create a remarkably new and exciting science. Behavioral and social scientists need to think about how to put the pieces together.

The shifting research environment makes it necessary to educate researchers on the underlying analytics of big data and machine learning to eliminate anxiety about their use. There is a sense of “always living in beta mode,” in that the technologies are constantly evolving. This will be a good area for younger investigators.

### **Evidence Synthesis**

Evidence synthesis in behavioral and social sciences is largely a volunteer effort (e.g., through Cochran reviews, etc.), which is subject to bias. For example, the best known group in the United States is the National Comprehensive Cancer Network (NCCN), which is an elite group of the largest, most well-funded of the NCI-supported cancer centers.

### **Opportunities for Translational Research**

Dr. Kaplan stated that OBSSR has an opportunity to influence behavioral and social sciences research through T4 translational research. He invited ideas for translational research projects. Dr. Andrea Sawczuk of the National Center for Advancing Translational Sciences (NCATS) recommended that Dr. Kaplan and meeting participants speak with NCATS leadership to identify potential opportunities for clinical translational science awards (CTSA) in behavioral and social sciences. She noted that a recent IOM report recommended that NCATS better integrate various elements into early-phase translational research. The report particularly recommended integrating research on community engagement, child health, and workforce. Furthermore, CTSA's have been set up to perform big data analysis.

### **Concluding Remarks**

Robert Kaplan, Ph.D., OBSSR, NIH

In his concluding remarks Dr. Kaplan thanked participants for attending and reemphasized that the discussion areas are central to the NIH mission. He noted that few presentations at the meeting pertained to specific diseases that would fit well into one of the 27 NIH Institutes and Centers. Thus, the planned monograph will deal less with diseases and more with the broader

topical groupings presented at the meeting, such as tobacco use, physical activity, and injury prevention. It also will address the issue of how to maximize the impact of behavioral and social sciences research on public health. The monograph is expected to bring greater visibility for the field and to have a lasting impact.

## APPENDIX A: MEETING AGENDA

### Wednesday, March 26, 2014

9:00am-9:20am	<b>Robert Kaplan</b> Opening Remarks
9:20am-9:40am	<b>Richard Wilkinson / Kate Pickett</b> <i>(Video Conference)</i> Causal factors linking environmental/economic/social inequality to life risks and life expectancy
9:40am-10:00am	<b>Lisa Berkman</b> <i>(Video Conference)</i> Employment and family (including labor policies)
10:00am-10:20am	Discussion
10:20am-10:30am	Break
10:30am-10:50am	<b>Louise Russell</b> The science of making better decisions about health: Cost-effectiveness and cost-benefit analysis
10:50am-11:10am	<b>Steve Teutsch / Jonathan Fielding / Brian Cole</b> Health impact assessments for program implementation
11:10am-11:30am	Discussion
11:30am-11:40am	Break
11:40am-12:00pm	<b>Sherry Glied / Richard Frank</b> Mental health and mental health services
12:00pm-12:20pm	<b>Robert Croyle / Peter Kaufmann</b> Population health perspectives at NCI and NHLBI
12:20pm-12:40pm	Discussion
12:40pm-1:40pm	Lunch

1:40pm-2:00pm	<b>Theresa Marteau</b> Changing population behavior and reducing health disparities: Exploring the potential of “Choice Architecture” interventions
2:00pm-2:20pm	<b>David Cutler / Susan Stewart</b> Behavioral epidemiology and health problems over time
2:20pm – 2:40pm	<b>Steve Woolf / Emily Zimmerman</b> Understanding the relationship between education and health: A review of the evidence and an examination of community perspectives
2:40pm-3:00pm	Discussion
3:00pm-3:20pm	Summary of Day / Wrap-up

**Thursday, March 27, 2014**

8:15am-8:30am	Recap and Agenda
8:30am-8:50am	<b>David Abrams</b> Tobacco use behavior: The rise and decline of the greatest behavioral disease epidemic of the 20th century
8:50am-9:10am	<b>Kevin Patrick</b> Big data: New opportunities for measurement, analysis, and intervention in the behavioral and social sciences
9:10am-9:30am	Discussion
9:30am-9:40am	Break
9:40am-10:00am	<b>W. Thomas Boyce</b> Exposure to early adversity and life course health/development
10:00am-10:20am	<b>Bruce McEwen</b> <i>(Video Conference)</i> Brain on stress: How behavior and the social environment “Get Under the Skin”
10:20am-10:50am	Discussion
10:50am-11:00am	Break

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11:00am-11:20am	<b>Wendy Baldwin</b> Burden of noncommunicable diseases (and injury) in the developing world
11:20am-11:40am	<b>David Sleet / Andrea Gielen</b> Injury and behavior change interventions
11:40am-12:00pm	Discussion
12:00pm-12:10pm	Break
12:10pm-12:30pm	<b>James Sallis / Jordan Carlson</b> Physical activity: Numerous benefits, and effective interventions
12:30pm-12:50pm	<b>Nancy Adler</b> Social determinants for health
12:50pm-1:10pm	Discussion
1:10pm-1:40pm	Open Floor
1:40pm-2:00pm	Closing Remarks

## APPENDIX B: LIST OF PARTICIPANTS

### Invited Attendees/Speakers

David Abrams, American Legacy Foundation  
Nancy Adler, University of California, San Francisco  
Wendy Baldwin, Independent Consultant  
Lisa Berkman, Harvard University  
W. Thomas Boyce, University of California, San Francisco  
Jordan Carlson, University of California, San Diego  
Brian Cole, University of California, Los Angeles  
Robert Croyle, National Cancer Institute, NIH  
David Cutler, Harvard University  
Jonathan Fielding, Los Angeles County Department of Public Health  
Richard Frank, Harvard Medical School  
Andrea Gielen, Johns Hopkins Center for Injury Research and Policy  
Sherry Glied, New York University  
Peter Kaufmann, National Heart, Lung, and Blood Institute, NIH  
Theresa Marteau, University of Cambridge  
Bruce McEwen, The Rockefeller University  
Kevin Patrick, University of California, San Diego  
Kate Pickett, University of New York  
Louise Russell, Rutgers University  
James Sallis, University of California, San Diego  
David Sleet, Centers for Disease Control and Prevention  
Susan Stewart, University of California, Davis  
Steve Teutsch, Los Angeles County Department of Public Health  
Richard Wilkinson, University of Nottingham  
Steve Woolf, Virginia Commonwealth University  
Emily Zimmerman, Virginia Commonwealth University

### Other NIH Attendees

Rebecca Clark, *Eunice Kennedy Shriver* National Institute of Child Health and Human  
Development  
Elisabeth Nielsen, National Institute on Aging  
Andrea Sawczuk, National Center for Advancing Translational Sciences, NIH

## **OBSSR Attendees**

Robert Kaplan, Director  
Nana Afari, Web Manager  
Jaclyn Crouch, Program Analyst  
Daryn David, AAAS Science and Technology Policy Fellow  
William Elwood, Health Scientist Administrator  
Gregg Furie, AAAS Science and Technology Policy Fellow  
Veronica Irvin, Post-Doctoral Fellow  
Yu Chi (Sabrina) Liao, Digital Media Specialist  
Amy Lossie, AAAS Science and Technology Policy Fellow  
Wendy Nilsen, Health Scientist Administrator  
Attallah Page, Operations Coordinator  
Stephane Philogene, Associate Director for Policy & Planning  
Sonja Preston, Management Analyst  
Paula Roberts, OppNet Data Analyst  
Allison Ruggeri, Lead Program Specialist  
Dana Sampson, Senior Program Analyst  
Michael Spittel, Health Scientist Administrator  
Erica Spotts, Health Scientist Administrator  
Wendy Smith, Director for Research Development and Outreach  
Lynette Sun, Statistician  
Deborah Young-Hyman, Health Scientist Administrator  
Tia Zeno, AAAS/PAA Science and Technology Policy Fellow

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