

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
NATIONAL INSTITUTES OF HEALTH

NATIONAL ADVISORY COUNCIL FOR
BIOMEDICAL IMAGING AND BIOENGINEERING

Summary of Meeting¹
September 11, 2019

The National Advisory Council for Biomedical Imaging and Bioengineering (NACBIB) was convened for its 51st meeting on September 11, 2019, at the Bolger Center in Potomac, Maryland. Dr. Bruce Tromberg, Director of the National Institute of Biomedical Imaging and Bioengineering (NIBIB), presided as Council chairperson. In accordance with Public Law 92-463, the meeting was open to the public from 9:05 a.m. to 1:05 p.m. for review and discussion of program development, needs, and policy. The meeting was closed to the public from 2:10 p.m. to 3:05 p.m. for the consideration of grant applications.

Council members present:

Dr. Richard Buxton, University of California, San Diego, La Jolla, CA
Dr. Maryellen Giger, University of Chicago, Chicago, IL
Dr. David Grainger, University of Utah, Salt Lake City, UT
Dr. Paula Hammond, Massachusetts Institute of Technology, Cambridge, MA
Dr. John H. Linehan, Northwestern University, Evanston, IL
Dr. Carolyn Meltzer, Emory University Hospital, Atlanta, GA
Dr. Gordana Vunjak-Novakovic, Columbia University, New York, NY

Council member absent:

Dr. Sanjiv Gambhir, Stanford University, Stanford, CA
Dr. Robert Nerem, Georgia Tech University, Atlanta, GA
Dr. Bruce Rosen, Massachusetts General Hospital, Charlestown, MA

Ex officio member attending:

Dr. Zane Arp (*on behalf of Dr. Jeffrey Shuren*), U.S. Food and Drug Administration, Silver Spring, MD
Dr. Vincent Ho, Uniformed Services University of the Health Sciences, Bethesda, MD
Dr. Anne Plant, National Institute of Standards and Technology, Gaithersburg, MD
Dr. Sohi Rastegar, National Science Foundation, Arlington, VA

Ex officio members absent:

Mr. Alex M. Azar, National Institutes of Health, Bethesda, MD
Dr. Francis Collins, National Institutes of Health, Bethesda, MD

Chairperson:

Dr. Bruce J. Tromberg

Executive Secretary:

Dr. David T. George

¹ For the record, it is noted that members absent themselves from the meeting when the Council is discussing applications (a) from their respective institutions or (b) in which a conflict of interest may occur. This procedure only applies to applications that are discussed individually, not to "en bloc" actions.

Also present:

NIBIB staff present for portions of the meeting:

Ms. Roberta Albert	Dr. Guoying Liu
Dr. Tatjana Atanasijevic	Mr. Raymond MacDougal
Dr. Anita Bechtholt, Anita	Ms. Jacqueline Martinez
Ms. Lily Bisson	Dr. Rishi Mathura
Ms. Shirley Coney-Johnson	Ms. Jessica Meade
Ms. Christine Cooper	Mr. Todd Merchak
Mr. Anthony Dorion	Ms. Anna Miglioretti
Dr. Qi Duan	Dr. Grace Peng
Ms. Jacklyn Ebiasah	Dr. David Rampulla
Ms. Kate Egan	Ms. Julia Ringel
Dr. Zeynep Erim	Ms. Saltanat Satabayeva
Mr. Jason Ford	Dr. Seila Selimovic
Ms. Pam Glikman	Dr. Behrouz Shabestari
Ms. Kolbi Harrison	Mr. Shaun Sims
Dr. John Hayes	Mr. Russell Songco
Dr. Jill Heemskerk	Dr. Manana Sukhareva
Dr. Dennis Hlasta	Ms. Holly Taylor
Dr. John Holden	Dr. Shumin Wang
Ms. Alisha Hopkins	Ms. Jennifer Ward
Dr. Thomas Johnson	Dr. Andrew Weitz
Dr. Krishna Kandarpa	Dr. Patricia Wiley
Dr. Randy King	Dr. Michael Wolfson
Dr. Peter Kirschner	Dr. Ruixia Zhou
Dr. Tiffani Bailey Lash	Dr. George Zubal
Ms. Truc Le	Dr. Steven Zullo
Dr. Richard Leapman	

Non-NIBIB National Institutes of Health (NIH) employees:

Dr. Sharon Low, CSR, NIH, Bethesda, MD
Dr. Ross D. Shonat, CSR, NIH, Bethesda, MD
Dr. Songtao Liu, CSR, NIH, Bethesda, MD

Non-NIH Federal employees:

Dr. Edward Margerrison, FDA, Silver Spring, MD
Dr. Kyle Myers, FDA, Silver Spring, MD

Members of the public present for portions of the meeting:

Dr. Nancy Allbritton, University of North Carolina, Chapel Hill, NC
Dr. Richard Baird, Olney, MD
Dr. Xiaoping Bao, Purdue University, West Lafayette, IN
Mr. Milton Berrios, Bolger Center, Potomac, MD
Dr. Erin Cadwalader, Lewis-Burke Associates, LLC, Washington, DC
Ms. Casey Cappelletti, The Academy for Radiology & Biomedical Imaging Research, Washington, DC
Ms. Renee L. Cruea, The Academy for Radiology & Biomedical Imaging Research, Washington, DC
Dr. Uzay Emir, Purdue University, West Lafayette, IN
Ms. Tina Getachew, American College of Radiology, Washington, DC
Mr. Norman Goodacre, 3T Biosciences, Inc, Menlo Park, CA
Dr. Ranu Jung, Florida International University, Miami, FL
Dr. Paul Kinahan, American Association of Physicists in Medicine, College Park, MD
Dr. Helen McNally, Purdue University, West Lafayette, IN
Ms. Martha Nolan, The Academy of Radiology & Biomedical Imaging Research, Washington, DC

Dr. Marjolein van der Meulen, Cornell University, Ithaca, NY

I. Call to Order: Dr. David T. George

Dr. David T. George called to order the 51st meeting of the National Advisory Council for Biomedical Imaging and Bioengineering. He reminded attendees that the morning session of the meeting was open to the public and welcomed attendees.

II. Director's Remarks: Dr. Bruce J. Tromberg

A. Welcome

Dr. Tromberg noted that that NIBIB has received final approval to have the FDA Commissioner as an Ex Officio Member of the NIBIB National Advisory Council. The FDA Commissioner has in turn designated Dr. Jeffrey Shuren as the FDA Ex Officio Council Member. Dr. Tromberg welcomed Dr. Zane Arp, attending as alternate FDA Ex Officio for Dr. Shuren at today's meeting. He also thanked Dr. Edward Magerrison of the FDA, who will periodically attend council meetings as an alternate FDA Ex Officio to Dr. Shuren. Dr. Tromberg then welcomed soon-to-be appointed Council Member, Dr. Ranu Jung, of Florida International University.

B. News

Strategic Planning: Development of a new strategic plan titled "Engineering the Future of Health" is underway. The goal of the plan is to set an aspirational vision for the institute and describe priorities and directions for future research. Updates from each working group will occur later in today's agenda.

NIBIB Staff Updates: Dr. Tromberg welcomed new extramural staff members who are serving in program director roles: Dr. Anita Bechtholt, on detail from the National Institute of Alcohol Abuse and Alcoholism (NIAAA), and Dr. Ilana Goldberg, an Association for the Advancement of Science (AAAS) and Technology Policy Fellow assigned to NIBIB. The NIBIB Intramural Research Program (IRP) has appointed two new tenure-track investigators, Drs. Alexander Cartagena-Rivera and Kaitlyn Sadtler. Dr. Cartagena-Rivera will head IRP's new Section on Mechanobiology and Dr. Sadtler will lead the new Section on Immunoengineering.

Biomedical Engineering Summer Intern Program (BESIP): BESIP celebrated its 20th year. It was initially supported by the Whitaker Foundation to promote biomedical engineering at NIH. The program supports students who have completed their junior year in undergraduate studies as they perform research for ten weeks in NIH labs.

Awards: Dr. Tromberg congratulated four NIBIB-nominated Presidential Early Career Awards for Scientists and Engineers (PECASE) awardees: Dr. Darren J. Lipomim, who is developing semiconductors for wearable and implantable sensors; Dr. Ron Alterovitz, for work on bronchoscopic steerable needles; Dr. Xudong Wang, who is developing nanogenerators for biomechanical energy harvesting; and Dr. Angela Pannier, for work on using cell priming methods and telecommunication modeling to enhance gene delivery for stem cell therapy.

Design by Biomedical Undergraduate Teams Challenge (DEBUT): DEBUT engaged 250 students who submitted 52 applications from 32 universities in 18 different states. The winning teams will receive their awards at the annual Biomedical Engineering Society conference in October. The first-place award, named the Dr. Steven H. Krosnick Prize in honor of the late Dr. Steven Krosnick former program director at NIBIB, was earned by a team from Columbia University for an intubation guided system. Second place was earned by a team from Georgia Institute of Technology for a device to rapidly screen for *C. difficile*. Third place went to a team from Carnegie Mellon University for a humidifying and speech-enabling tracheostomy device. An HIV/AIDS prize, new to the DEBUT competition this year and supported by the NIH Office of

AIDS Research, was awarded to a team from Georgia Institute of Technology for a safer way to arm and disarm scalpels.

Upcoming NIBIB Meetings: A meeting on integrating machine learning with multiscale modeling as part of the Interagency Modeling and Analysis Group, led by Dr. Grace Peng, director for the Mathematical Modeling, Simulation, and Analysis program, will be held in October 24-25, 2019 in Bethesda, MD. The meeting aims to bridge math and physics with computer science for biomedical, biological, and behavioral systems.

The first Synthetic Biology Consortium Meeting, to be held October 28-29, 2019 in Bethesda, MD and coordinated by Dr. David Rampulla, director for the Synthetic Biology for Technology Development program, will focus on rewiring biology to engineer health. The meeting will build community among young and new investigators and have sessions focused on technical road mapping.

An NIH-IEEE meeting on Point-of-Care Technologies, led by Dr. Tiffani Lash, director for the Point of Care Technologies-Diagnostics program, will focus on unmet clinical needs driving technological innovations. The meeting, to be held on November 20-22, 2019 in Bethesda, MD, will feature four new centers in the Point-of-Care Technologies Research Network (POCTRN).

Stimulating Peripheral Activity to Relieve Conditions (SPARC)

SPARC is an NIH Common Fund program seeking to accelerate development of therapeutic devices that modulate electrical activity in nerves to improve organ function. SPARC is generating maps and tools to identify and influence therapeutic targets that exist within the neural circuitry of a wide range of organs and tissues. Recently a new portal was launched that hosts curated datasets and experimental protocols from SPARC investigators. It also features an online computing platform to facilitate simulations of neural control of organ function.

C. New Initiatives

Notices of Special Interest (NOSI): Dr. Tromberg announced publication of five Notices of Special Interest (NOSIs)—four led by NIBIB and one by NIH OD. The four NIBIB NOSIs, motivated by the recent conference on Innovations in Technologies to Extend the Golden Hour, are: X-ray-based Devices for Trauma Care (NOT-EB-19-015), Optics-based Devices for Trauma Care (NOT-EB-19-016), Ultrasound and Radiation Monitoring for Trauma Care (NOT-EB-19-017), and Physiological Monitoring and Point of Care Technologies for Trauma Care (NOT-EB-19-018). Additionally, NIBIB participates on an NIH-wide NOSI for the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Applications Directed at the Adoption of the Fast Healthcare Interoperability Resources (FHIR®) Standard (NOT-OD-19-127).

NIBIB Biomedical Technology Resource Centers (P41s): NIBIB began funding P41s soon after its establishment in 2002 and then in 2012, a number of P41 Centers of NCCR were transferred to NIBIB thereby doubling the number of NIBIB P41s. Currently, NIBIB funds 29 P41 Centers totaling \$30 million of support. NIBIB P41 centers are highly leveraged and currently have more than 500 collaborative projects across the United States.

Harnessing Data Science for Health Discovery and Innovation in Africa Common Fund Proposal: Dr. Tromberg announced that the initiative led by FIC, NIBIB, NIMH, and NLM is receiving common-fund support from NIH OD. To date, 19 ICs have signed on to the initiative. As background, Dr. Tromberg explained that Africa carries a disproportionate share of the global burden of disease and comprises unique populations, genes, and exposures. There is a critical medical workforce shortage and a need for clinical decision making in Africa. Fortunately, there is extensive mobile phone coverage and opportunities for technology innovation. This common fund program is organized into five components: 1) six research hubs focused on key health problems, 2) data science and innovation training programs, 3) ethical, legal, and

social implications of data science and innovation research, 4) open data science platform and coordination, 5) symposia for each hub in years one and six. The primary building blocks of the structure are the research hubs. Each hub will focus on critical health research problems, bring together multi-disciplinary expertise, and engage with partners from government and the private sector. Deliverables at the end of five and ten-year timepoints will demonstrate the impact of the centers, along with advances in policy, products, and collaboration.

D. Budget

In June, the House passed a version of the Labor, HHS appropriations bill for FY20, including a \$2 billion increase for NIH (to \$41.08 billion) and \$404,498,000 billion for NIBIB—a 4.8% increase. The Senate Subcommittee on Labor, HHS, Education, and Related Agencies proposed their FY20 appropriations bill with an increase to \$42.1 billion for NIH. A two-year budget agreement (FY20 and FY21) became law and increased spending caps previously imposed by sequestration. In effect, this ends sequestration and the automatic budget cuts that would have occurred. A short-term continuing resolution will likely be passed to fund the government at the current levels pending the final budget appropriation.

III. Strategic Planning

The NACBIB strategic planning working groups met on September 10th, 2019 to outline ideas for the NIBIB Strategic Plan. Each of the seven working groups reported on their progress by briefly summarizing their goals, projected impact, and proposed strategy to achieve each goal. The goals of each group are reported below.

Group 1: Quantitative Data Science, Modeling, and Computation

The group outlined goals including:

1) computational models/biomedical computing, 2) biomedical image/signal manipulations, 3) artificial intelligence, 4) simulation, and 5) visualization. NIBIB could lead the effort to define technology assessments and standards. The group envisions digital healthcare innovation (e.g. digital biomarkers, clinical decision-making) to be at the center of NIBIB's future. Lastly, NIBIB should be critically involved in building data and computational infrastructure at NIH.

Group 2: Engineering Biology

The group proposed a convergence of imaging and bioengineering to solve clinical problems. This convergence would drive the development of each area independently. Technology should be developed for a medical need. The approaches should be transformative, enable medicine and biology, and need to be democratized.

Group 3: Sensing Health & Disease

The group proposed efforts to 1) improve early detection capabilities, 2) promote personalized medicine, 3) exploit better sensor data to enhance healthcare value, 4) enhance commercialization/translational awareness for technology impact, 5) stimulate sensing innovation and improvements in capabilities impact, and 6) address healthcare cost containment and value-based healthcare.

Group 4: Imaging Health & Disease

This group outlined an overarching vision that NIBIB could be the biomedical imaging hub at NIH. NIBIB could be involved from the development stages of a project and continue to guide investigators until the work has reached translation/commercialization phases in collaboration with other ICs as needed. NIBIB needs to

embrace risk, and while embracing risk, create infrastructure to collect protocols and data from failed projects so that researchers might learn from failures and propose new ideas. Lastly, NIBIB can be a leader in rigorous application of artificial intelligence to imaging.

Group 5: Advanced Therapies & Cures

NIBIB could develop a discovery-to-delivery pathway at NIH that is initiated by a clinical need. Moonshot or grand challenge projects at NIH could be led by NIBIB with other NIH partners. NIBIB should consider partnering with translational/commercialization partners.

Group 6: Technology Development Pipeline

An important focus for NIBIB is finding a better way to design, build and deliver technology to foster the improvement of healthcare. Two major approaches are funding and convening. Past programs must be evaluated to steward the best use of funds for future programs. Public-private partnerships may provide more resources for NIBIB. Developing and delivering technology by bridging new communities should be an NIBIB priority. Lastly, educating and mentoring grantees on the commercialization process is key to NIBIB leading the technology development pipeline.

Group 7: Biomedical Imaging & Bioengineering Workforce

The proposed goals from this group are to: 1) improve access to educational/career development pathways, 2) engage academic institutions in health/prosperity of communities, 3) incorporate engineering systems science into medical education, 4) embed team mentoring plans in all technology development grants, and 5) intentionally focus on diversity of internal and external decision-making bodies.

IV. Initiative Concept Clearances

Trailblazer Initiative

Dr. Randy King, director of NIBIB's Ultrasound and Optical Imaging programs, presented concept clearance for the reissuance of the Trailblazer R21 initiative. He described the background leading to the establishment of the Trailblazer initiative in 2016: to increase the R01 payline and support early-stage and new investigators. NIBIB wanted to manage its R21 spending and focus R21 funding on the original intent of high-risk/high-reward projects with minimal or no preliminary data. Since the initial release of the new NIBIB R21 and Trailblazer mechanisms, the number of incoming R21 applications has returned to 2013/14 levels and the management of the R21 program has contributed to increased funding of investigator initiated R01 applications.

The R21 Trailblazer will be reissued for FY20 for new and early stage investigators. The applications should differ from current thinking or practice. Again, only minimal preliminary data would be allowed, and applicants may request up to \$400,000 in direct costs over three years. Council was supportive of reissuing the Trailblazer Award FOA.

Helping to End Addiction Long-term Initiative:

Dr. Michael Wolfson, NIBIB Program Director, on behalf of the Helping End Additional Long-Term (HEAL) Initiative, presented an FOA concept for clearance: Translational Development and Demonstration of Devices to Prevent and Treat Opioid Misuse and Addiction. The goal of this initiative, proposing to use a cooperative-agreement funding mechanism, is to support engineering activities to develop mature medical devices that are built upon a mechanistic understanding of the underlying biology. The devices should be developed to the point of clinical testing and should propose design-directed development of a new

technology or approach. This new initiative proposes to build upon a successful model of developing translational devices to diagnose and treat pain. The endpoint for this initiative is a demonstration via first-in-human clinical trial. Council was supportive of reissuing this initiative.

V. 6th Annual Lopez Lecture - Intestine on a Chip: Tools to Investigate Metabolites, Drugs, Mucus, & Microbiome. Nancy Albritton, MD/PhD

The annual Hector Lopez Lecture was presented by Nancy Albritton, MD, PhD, Professor and Chair of the joint department of biomedical engineering at the University of North Carolina at Chapel Hill and North Carolina State University. The talk was entitled “Intestine on a Chip: Tools to Investigate Metabolites, Drugs, Mucus, and Microbiome,” in which she described the development of a “Simulator of the Large Intestine.”

Allbritton chose to build a simulator of the large intestine because of its importance in human health and disease, and its role in drug metabolism. The cost of drug development is approximately \$1.5 billion over a ten-year period per marketed drug. Therefore, accurate models of human organ systems for drug testing could save millions of dollars—requiring fewer animals and fewer individuals in final clinical trials.

The large intestine is populated with some 400 species of microbes, which is ten times more than the bacteria in the rest of the body. These microbes have regulatory roles in the maturation of the immune system; metabolism; energy salvage; mental function; cardiovascular health; and drug effectiveness, toxicity, and metabolism. She stated that, given this plethora of microbe interactions with human physiology, an important advance would be microbe-manipulating drugs.

Building the large intestine platform required creating the colon’s array of crypts, which contain proliferative stem cells at the base that differentiate into epithelial cells as they make their way up the crypt to the surface that lines the lumen of the intestine. Rather than using cell lines, her laboratory is building an organ simulator using samples of intestinal crypts obtained, with consent, from patients undergoing procedures such as a colonoscopy. Albritton stressed the importance of building the simulators on equipment that scientists are familiar with so that it can be integrated directly into their daily workflow. Albritton explained that her simulator is built by remodeling the bottom of 96-well plates so that they have the accordion-like shape of the intestinal crypts with stem cells at the bottom of a fold and the differentiated endothelial cells at the top of each fold. The rebuilding of the plate also included openings in the bottom so that oxygenated culture media enters the bottom of the plate where the stem cells, which require the oxygenated media, reside. The top of the crypt, which lines the lumen of the intestine, has low oxygen—it is anaerobic. Thus, the simulator plate also has an oxygen gradient ranging from normal oxygenation at the bottom to low oxygen at the top.

The large intestine simulator is now being used for drug and nutritional supplement screening; transport and metabolism assays; tissue regeneration; inflammatory responses; appetite control and satiety; fibrosis; and models of cancer metastasis. Current highlights using the model system include studies of *C. difficile* toxin, showing the importance of the mucus coating of the intestine for blocking toxic effects; identifying the importance of the creation of both oxygen and growth factor gradients in the colon and how disruption of these gradients can cause disease; and studies of dietary products such as fiber and its impact on the risk of colon cancer.

VI. Adjournment

The open session of the NACBIB meeting was adjourned at 1:05 p.m.

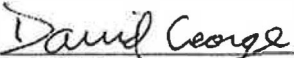
VII. Closed Session

Review of Council Procedures and Regulations: Dr. David T. George

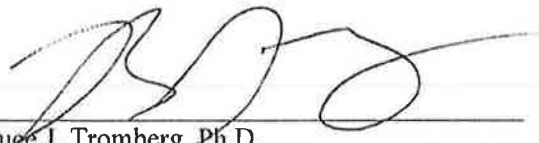
The grant application review portion of the meeting was closed to the public in accordance with provisions set forth in Section 552b(c)(4) and 552b(c)(6), Title 5, U.S. Code, and 10(d) of the Federal Advisory Committee Act, as amended (5 U.S.C. appendix 2). The closed session was adjourned at 3:05 p.m.

Certification:

We certify that, to the best of our knowledge, the foregoing minutes are accurate and complete.²



David T. George, Ph.D.
Executive Secretary
National Advisory Council for Biomedical Imaging and Bioengineering
Associate Director for Research Administration
National Institute of Biomedical Imaging and Bioengineering



Bruce J. Tromberg, Ph.D.
Chairperson,
National Advisory Council for Biomedical Imaging and Bioengineering
Director,
National Institute of Biomedical Imaging and Bioengineering

² These minutes will be approved formally by the Council at the next meeting on January 23, 2020, and corrections or notations will be stated in the minutes of that meeting.