Icahn School of Medicine at Mount Sinai

Institute for Exposomic Research

New York City Exposome Symposium

November 2-3, 2018

New York Academy of Medicine
New York, NY

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The Institute for Exposomic Research

is dedicated to understanding how early environmental exposures affect health and disease throughout life and translating findings into new strategies for prevention and treatment.

Our groundbreaking research catalogs the complex mix of chemical, nutritional, and social environmental influences and how these shape our health.

The Institute for Exposomic Research
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Program

Day 1: Friday, November 2

11:00AM-12:00PM	Registration Open *Lunch available in Reading Room, 3rd Floor*
12:00PM-12:30PM	Welcome and Overview *Reading Room, 3rd Floor* Robert O. Wright, MD, MPH, Icahn School of Medicine at Mount Sinai Dennis S. Charney, MD, Icahn School of Medicine at Mount Sinai David Balshaw, PhD, National Institute of Environmental Health Sciences Claudia Thompson, PhD, National Institute of Environmental Health Sciences
12:30PM-1:15PM	The Exposome Concept *Reading Room, 3rd Floor* Gary Miller, PhD, Columbia University
1:15PM- 2:00PM	Exposomics: Untargeted Chemical Screens *Reading Room, 3rd Floor* Stephen M. Rappaport, PhD, University of California, Berkeley
2:00PM-2:45PM	Silicone Wristbands to Assess Personal Chemical Exposure *Reading Room, 3rd Floor* Holly Dixon, Oregon State University
2:45PM-3:30PM	Blood Spots and Other Novel Matrices *Reading Room, 3rd Floor* Lauren Petrick, PhD, Icahn School of Medicine at Mount Sinai
3:30PM-3:50PM	Coffee Break
3:50PM-5:20PM	Parallel Workshops Workshop A Feature Extraction Data Processing Untargeted Work Flow *Room 21, 2nd Floor* Jon R. Sobus, PhD, United States Environmental Protection Agency Gary Patti, PhD, Washington University in St. Louis Workshop B Bioinformatics/Mixtures: Annotation, Statistical Analysis, Machine Learning *Room 20, 2nd Floor* Chris Gennings, PhD, Icahn School of Medicine at Mount Sinai Douglas Walker, PhD, Icahn School of Medicine at Mount Sinai Gaurav Pandey, PhD, Icahn School of Medicine at Mount Sinai
5:20PM-5:30PM	Break
5:30PM-6:30PM	Reception *Reference Area, 3rd Floor*

Day 2: Saturday, November 3

8:30AM-9:00AM	Doors Open *Breakfast available in Reading Room, 3rd Floor*
9:00AM-9:45AM	Modeling the Built Environment *Reading Room, 3rd Floor* Marta Jankowska, PhD, University of California, San Diego
9:45AM-10:30AM	Satellite Remote Sensing for Environmental Exposure Assessment *Reading Room, 3rd Floor* Allan C. Just, PhD, Icahn School of Medicine at Mount Sinai
10:30AM-11:15AM	Health Effects of Air Pollution and Temperature Exposures *Reading Room, 3rd Floor* Maayan Yitshak-Sade, PhD, Harvard University
11:15AM-12:00PM	Statistical Analysis of Mixtures and Large-Scale Exposure Data: Hopes, Hypes and Hypotheses *Reading Room, 3rd Floor* Bhramar Mukherjee, PhD, University of Michigan
12:00PM-1:20PM	Lunch *Reading Room, 3rd Floor*
1:20PM-2:50PM	Parallel Workshops Workshop C Geospatial Analysis of Environmental Data *Room 20, 2nd Floor* Michael Dorman, PhD, Ben-Gurion University of the Negev Workshop D Instrument Choices *Room 21, 2nd Floor* Jarod Grossman, PhD, Agilent Technologies
2:50PM-3:00PM	Break
3:00PM-3:45PM	Tooth Biomarkers and Exposomics *Reading Room, 3rd Floor* Manish Arora, BDS, MPH, PhD, FICD, Icahn School of Medicine at Mount Sinai
3:45PM-4:30PM	Inflammasome *Reading Room, 3rd Floor* Rosalind J. Wright, MD, MPH, Icahn School of Medicine at Mount Sinai
4:30PM-5:00PM	Closing Session *Reading Room, 3rd Floor* Robert O. Wright, MD, MPH, Icahn School of Medicine at Mount Sinai

Workshops

Day 1: Friday, November 2

Workshop A: Feature Extraction Data Processing Untargeted Work Flow

Jon R. Sobus, PhD, United States Environmental Protection Agency
Gary Patti, PhD, Washington University in St. Louis

The goal of metabolomics is to measure all of the small molecules within a biological sample. This includes not only metabolites produced by enzymes within cells, but also exposure chemicals originating from the environment. Given its breadth of coverage, metabolomics is most commonly performed by using liquid chromatography/mass spectrometry. The challenge of doing such experiments, however, is that thousands of signals are routinely detected that cannot be readily identified with existing software. In a typical metabolomic analysis of the exposome, for example, it is common for less than 10% of the total peaks to be annotated with chemical names. The remaining unassigned signals often lead to confusion during data analysis. The objective of the workshop is to provide an overview of available resources to overcome this critical interpretation barrier. We will discuss how the problem can start with poorly designed experiments that unnecessarily complicate results. Opportunities to optimize workflows will be highlighted and successful case studies presented.

Workshop B: Bioinformatics/Mixtures: Annotation, Statistical Analysis, Machine Learning

Chris Gennings, PhD, Icahn School of Medicine at Mount Sinai
Douglas Walker, PhD, Icahn School of Medicine at Mount Sinai
Gaurav Pandey, PhD, Icahn School of Medicine at Mount Sinai

This workshop aims to give an overview of approaches for evaluating and interpreting complex metabolomics data using an in-class example that will use untargeted metabolomics to link external exposure to internal dose and biological response. To identify metabolic features associated with exposure, we will demonstrate application of both bioinformatic and biostatistic approaches. Machine learning methods for building predictive models will be demonstrated to determine groups of peaks and their corresponding intensities that can help classify samples into two groups (e.g., non-exposed and exposed) or more. Next, we will demonstrate the use of a biostatistical method for correlated components to determine a covariate-adjusted "mixture effect" of components and an outcome of interest. Finally, we will apply computational metabolomic techniques for annotation of metabolomic features associated with exposure, which will include identification of internal dose biomarkers and biological response by pathway enrichment.

Day 2: Saturday November 3

Workshop C: Geospatial Analysis of Environmental Data

Michael Dorman, PhD, Ben-Gurion University of the Negev

This workshop aims to give an overview and examples of geospatial analysis of environmental data, using the R programming language and the Google Earth Engine cloud-based platform. First, the R programming language and environment will be introduced, presenting its capabilities and advantages for spatial analysis. Next, the way spatial data can be accessed and imported into R will be shown from the practical point of view. Finally, three specific case studies of working with spatial data will be presented. The case studies include data acquisition from public sources: Landsat data using Google Earth Engine and AOD data using Earthdata, and an example of data analysis: using satellite AOD data to predict PM.

Workshop D: Instrument Choices

Jarod Grossman, PhD, Agilent Technologies

This workshop will present analytical tools common to the exposome lab for both discovery and targeted investigations. With a focus on mass spectrometry, methodologies and workflows will be presented to capture broad swaths of the exposome space. We will further discuss specific challenges to acquiring reproducible data and define strategies to monitor and assure proper method performance.

Speakers

Robert O. Wright, MD, MPH, Icahn School of Medicine at Mount Sinai

Robert O. Wright, MD, MPH, is the Ethel H. Wise Professor and Chair of the Department of Environmental Medicine and Public Health, Director of the Institute for Exposomic Research, and Founder and Director of the Senator Frank R. Lautenberg Environmental Health Sciences Laboratory at Mount Sinai. Dr. Wright studies complex chemical mixtures and the role of social factors in modifying or mediating chemical toxicity. He has published over 200 research studies and has served on numerous national committee/advisory boards, including the National Advisory Environmental Health Sciences Council (NAEHSC) since September 2018. Prior to joining Mount Sinai in 2012, Dr. Wright was Associate Professor of Pediatrics at Harvard Medical School. He received his medical degree at the University of Michigan Medical School and completed his residency in Pediatrics at Northwestern University, as well as fellowships in Emergency Medicine, Medical Toxicology, Environmental Epidemiology, and Genetic Epidemiology.

Dennis S. Charney, MD, Icahn School of Medicine at Mount Sinai

Dennis S. Charney, MD, is Anne and Joel Ehrenkranz Dean of the Icahn School of Medicine at Mount Sinai and President for Academic Affairs for the Mount Sinai Health System. Dr. Charney is a world expert in the neurobiology and treatment of mood and anxiety disorders, making fundamental contributions to the understanding of the causes of human anxiety, fear, and depression, and the discovery of new treatment for mood and anxiety disorders. His research on depression has led to discovery of new and novel therapies for treatment resistant depression including Ketamine and the first digital treatment for depression (EFMT). He has been honored with all of the major awards in his field for his scientific research, including World's Most Influential Scientific Minds 2014 and 2015, Ranked 48 out of 1,360 of Most Highly Cited Life Science Researchers in the World. His discovery for Ketamine for Treatment-Resistant Depression was named by Cleveland Clinic on its Top 10 list of 2017 Health Care Innovations. He holds 3 U.S. Patents, and 19 U.S. and Foreign Patent Applications, 10 of which are licensed to 2 companies. He has published 785 articles and book chapters, and 16 books, including Resilience: The Science of Mastering Life's Greatest Challenges, and Charney & Nestler's Neurobiology of Mental Illness 5th Edition. Dr. Charney was elected to the National Academy of Medicine in 2000, and the National Academy of Inventors in 2017.

David Balshaw, PhD, National Institute of Environmental Health Sciences

David Balshaw, PhD, is the Chief of the Exposure, Response, and Technology Branch at the National Institute of Environmental Health Sciences. Dr. Balshaw has been a leading figure in the development of the Exposure Science and the Exposome Program to develop a new generation of tools to characterize the personal environment integrating direct, personal assessment of multiple chemical factors; dietary intake, physical activity, and psychosocial stress; as well as assessment of the biological response to these factors on major biological pathways. He oversees a team focused on building research capacity in the environmental health sciences through planning and administration of NIEHS-funded research programs in bioengineering, integrated systems, and computational methods to understand complex systems; development of sensor technologies for environmental exposure assessment; discovery and validation of emerging biomarkers; and application of innovative "omics" research for reducing the risk of exposure and disease including development of databases.

Claudia Thompson, PhD, National Institute of Environmental Health Sciences

Claudia Thompson, PhD, is Chief of the Population Health Branch (PHB) in the Division of Extramural Research and Training (DERT) at the National Institute of Environmental Health Sciences (NIEHS). The PHB supports diverse programs in population-based, laboratory-based, and community-engaged research related to environmental exposures and their effects on human health, including an emphasis on how timing of exposure effects health outcomes across the life-span. She has led NIEHS research efforts in response to national disasters including coordinating World Trade Center research and outreach activities; assisting in the NIEHS response to hurricanes beginning with Katrina and Rita, through the most recent Hurricane Florence; and provided leadership to the trans- NIH Deepwater Horizon Disaster Academic Community Research Consortium that she developed to understand the potential health impacts of the Deepwater Horizon

Disaster on community members residing in the Gulf States. Currently, Dr. Thompson co-leads a trans-NIH working group on Household Air Pollution and Cookstoves and has a portfolio of grants related to cookstove research. She is the Program Director for the Environmental Health Sciences Core Centers program and Co-Director of the Children's Health Exposure Analysis Resource (CHEAR). Dr. Thompson received her PhD in Biochemistry and Nutrition from the University of North Carolina at Chapel Hill.

Gary W. Miller, PhD, Columbia University

Gary Miller, PhD, serves as Professor of Environmental Health Sciences and Vice Dean of Research Strategy and Innovation at Columbia University Mailman School of Public Health. Prior to Columbia, Dr. Miller was the Associate Dean for Research at the Emory Rollins School of Public Health, Founding Director of the HERCULES center, an NIEHS-funded center focused on the exposome, and Director of Emory's CHEAR U2C Center and Emory's NIEHS-funded T32 Training Grant in Environmental Health Sciences and Toxicology. He authored the first book on the topic, The Exposome: A Primer published by Elsevier. His research focuses on environmental drivers of neurodegeneration. His laboratory uses a variety of methods including transgenic mouse production, immunohistochemistry, neurotransmitter transport assays, high-resolution metabolomics, electrochemistry, and behavioral assays. He also serves as Editor-in-Chief of Toxicological Sciences, the official journal of the Society of Toxicology. Dr. Miller received his PhD in Pharmacology and Toxicology at University of Georgia and completed postdoctoral studies at Emory University and Duke University.

Stephen M. Rappaport, PhD, University of California, Berkeley

Stephen Rappaport, PhD, MSPH, is the Director and Principal Investigator of the Berkeley Center for Exposure Biology, a multidisciplinary program that brings together Berkeley researchers from public health, chemistry, and electrical engineering to develop a new generation of biomarkers and biosensors for environmental epidemiology. He is a pioneer in the emerging field of exposure biology and a prominent advocate of the concept of the exposome as a new paradigm for environmental health. Much of his current research involves the development and application of blood protein adducts as biomarkers of exposure to toxic chemicals arising from inhalation, ingestion, and endogenous processes. Dr. Rappaport received his PhD at the University of North Carolina, Chapel Hill.

Holly Dixon, Oregon State University

Holly Dixon is a graduate fellow in the Department of Environmental and Molecular Toxicology at the Oregon State University. Ms. Dixon's work focuses on the development and applications of novel passive sampling silicone wristbands, which are used to measure personal exposure to organic chemicals. These wristbands are easy-to-use, inexpensive samplers that have now been deployed in over ten countries and worn by over two-thousand people. She works in the lab of Kim Anderson, PhD, Professor of Environmental and Molecular Toxicology at Oregon State University, and is involved in helping remove the mystery around personal chemical exposure and investigating the health implications associated with chemical exposure. Ms. Dixon received her BS from University of Puget Sound.

Lauren Petrick, PhD, Icahn School of Medicine at Mount Sinai

Lauren Petrick, PhD, serves as Assistant Professor in the Department of Environmental Medicine and Public Health, and Head of Untargeted Metabolomics at the Senator Frank R. Lautenberg Environmental Health Sciences Laboratory at the Icahn School of Medicine at Mount Sinai. Dr. Petrick is an analytical chemist with training in metabolomics/exposomics. Her research interests are in developing EWAS (exposome-wise association study) methodologies for environmental health research using high-resolution mass spectrometry (HRMS) and advanced biostatistics/bioinformatics techniques. Dr. Petrick's current work focuses on the development of metabolomics methods for investigations of early life exposures and small sample volumes, where she is pioneering a method for interrogation of the neonatal exposome using archived neonatal dried blood spots (DBS). This method was applied to archived DBS from 332 pediatric acute lymphoblastic leukemia (ALL) cases and 324 controls as part of the California Childhood Leukemia Study (CCLS), and preliminary results indicate that this methodology can be used for investigating early-life factors associated with disease.

Jon R. Sobus, PhD, United States Environmental Protection Agency

Jon Sobus, PhD, is a physical scientist in the U.S. Environmental Protection Agency's (EPA's) Office of Research and Development (ORD), National Exposure Research Laboratory (NERL), in Research Triangle Park, North Carolina. At EPA, Dr. Sobus serves as a task leader for rapid exposure and dosimetry research under the Chemical Safety for Sustainability national research program. He further serves as a team leader and principal investigator for EPA's non-targeted analysis (NTA) research program. His current research interests involve designing experiments and developing protocols to carefully examine and ultimately enhance the abilities of NTA methods to identify contaminants-of-emerging-concern in a variety of media. Dr. Sobus received his PhD in Environmental Sciences and Engineering from the University of North Carolina at Chapel Hill.

Gary Patti, PhD, Washington University in St. Louis

Gary Patti, PhD, is the Michael and Tana Powell Associate Professor of Chemistry at Washington University in St. Louis. Dr. Patti's research focuses on metabolism and metabolomics. He is developing new mass spectrometry and nuclear magnetic resonance (NMR) technologies that enhance metabolome coverage, improve the quality of analytical measurements, and extend biochemical insight. He is interested in identifying artifacts, contaminants, adducts, fragments, and oligomers in metabolomic data sets, which often represent a major fraction of the data. His laboratory's work involves the application of stable isotope labels to perform credentialing and assess metabolic fluxes. Dr. Patti received his PhD at Washington University in St. Louis.

Chris Gennings, PhD, Icahn School of Medicine at Mount Sinai

Chris Gennings, PhD, serves as Director of the Division of Biostatistics and Research Professor in the Department of Environmental Medicine and Public Health and Research Professor in the Department of Population Health Science and Policy at the Icahn School of Medicine at Mount Sinai. She also serves as Director of the Statistical Services and Methods Development Resource of the Children's Health Exposure Analysis Resource (CHEAR) Data Center, which provides multi-disciplinary expertise in statistics, epidemiology, and bioinformatics for collaboration within the broader children's environmental health research community, and Director of the Biostatistics and Bioinformatics Core of the Mount Sinai Transdisciplinary Center on Early Environmental Exposures, where researchers are studying the health impacts of chemical, genetic, nutritional, and social exposures and the interactions among them. Her research interests have focused on design and analysis methodologies for studies of chemical mixtures. Dr. Gennings received her PhD at Virginia Commonwealth University.

Douglas Walker, PhD, Icahn School of Medicine at Mount Sinai

Douglas Walker, PhD, serves as Assistant Professor in the Department of Environmental Medicine and Public health at the Icahn School of Medicine at Mount Sinai. His research focuses on continued development and application of advanced analytical strategies for measuring the occurrence, distribution and magnitude of previously unidentified environmental exposures and assist in delineating the mechanisms underlying environment-related diseases in humans. Prior to Mount Sinai, Dr. Walker acted as Director of Exposome Research for the Clinical Biomarkers Laboratory and was a member of the HERCULES Exposome Research Center at Emory University. Through application of high-resolution mass spectrometry platforms, Dr. Walker has shown it is possible to provide measures of 10,000-100,000 chemical signals in a cost-effective manner using a single human blood sample, providing a key advance for nutritional assessment, precision medicine and exposome research. Dr. Walker received his PhD from Tufts University in Environmental and Water Resources Engineering.

Gaurav Pandey, PhD, Icahn School of Medicine at Mount Sinai

Gaurav Pandey, PhD, is an Assistant Professor in the Department of Genetics and Genomic Sciences and is part of the Institute for Genomics and Multiscale Biology at the Icahn School of Medicine at Mount Sinai. His primary fields of interest are computational biology, genomics, and environmental health and large-scale data analysis and mining. Dr. Pandey received the IBM Faculty Award in 2015. He completed his PhD in computer science and engineering from the University of Minnesota, Twin Cities, and subsequently completed a post-doctoral fellowship at the University of California, Berkeley.

Marta Jankowska, PhD, University of California, San Diego

Marta Jankowska, PhD, is an Assistant Research Scientist in the Calit2/Qualcomm Institute at the University of California, San Diego. Her expertise is in spatial analytics including geographic information systems (GIS), GPS, and spatial statistics as applied to health related problems. Dr. Jankowska's interests and working projects are topically diverse, but always come back to the spatial components of human health. Examples include using tools like GPS to better understand children's health perceptions, using body worn sensors to assess exposures to the environment, integrating omics with environmental data, using big data approaches to see how the urban environment influences health, and developing machine learned algorithms to predict when and where specific health behaviors will happen. She is currently the principal investigator of an National Science Foundation-funded grant examining the relationship between the built food environment, obesity, and dietary behaviors in a cohort of Hispanics. Dr. Jankowska received her PhD from San Diego State University and University of California, Santa Barbara in geography, specializing in GIS, spatial statistics, and health geography.

Allan C. Just, PhD, Icahn School of Medicine at Mount Sinai

Allan Just, PhD, is an environmental epidemiologist and Assistant Professor in the Department of Environmental Medicine and Public Health at the Icahn School of Medicine at Mount Sinai. His research interests are in children's environmental health, air pollution and temperature modeling using satellite data for epidemiologic applications, and computational methods for epigenomics. He uses remote sensing, data science, and the methods of molecular epidemiology to investigate links between environmental exposures and children's health. Dr. Just received his PhD in Environmental Health Sciences from Columbia University.

Maayan Yitshak-Sade, PhD, Harvard University

Maayan Yitshak-Sade, PhD, is a Postdoctoral Research Fellow in the Department of Environmental Health at Harvard T.H. Chan School of Public Health. She is an epidemiologist with a main research interest in environmental health, and the focus of her research has been air pollution exposure and cardiovascular health. Currently, she is studying the interrelationship between multiple environmental exposures and human health and investigating the modification of the air pollution effect on mortality and obstetric outcomes, by individual and neighborhood measures of racial and economic segregation as well as by land-use characteristics of the environment. Dr. Yitshak-Sade completed her PhD and MPH at Ben Gurion University of the Negev, Israel.

Bhramar Mukherjee, PhD, University of Michigan

Bhramar Mukherjee, PhD, serves as the Department Chair of Biostatistics and Professor of Epidemiology at the University of Michigan School of Public Health. Her principal research interests lie in Bayesian methods in epidemiology and studies of gene-environment interaction. She is also interested in modeling missingness in exposure, categorical data models, Bayesian nonparametrics, and the general area of statistical inference under outcome/exposure dependent sampling schemes. Dr. Mukherjee is involved as a co-investigator in several National Institute of Health R01 grants led by faculty in Internal Medicine, Epidemiology and Environment Health sciences at University of Michigan. Her collaborative interests focus on genetic and environmental epidemiology, ranging from investigating the genetic architecture of colorectal cancer in relation to environmental exposures to studies of air pollution on pediatric asthma events in Detroit. She is actively engaged in global health research. Dr. Mukherjee received her PhD from Purdue University.

Michael Dorman, PhD, Ben-Gurion University of Negev

Michael Dorman, PhD, is a programmer in the Department of Geography at Ben-Gurion University of Negev, Israel. He is assisting researchers and students in computational tasks such as data processing, spatial analysis, geo-statistics, development of web applications, mostly using the R, JavaScript, and Python programming languages. He has authored a book on spatial analysis using R, and authored or co-authored 20 papers in the scientific literature. He has authored three R code packages which are published in the Comprehensive R Archive Network (CRAN). Dr. Dorman received his PhD and his Masters in Life Sciences from the Ben-Gurion University of Negev, Israel.

Jarod Grossman, PhD, Agilent Technologies

Jarod Grossman, PhD, is an Application Scientist at Agilent Technologies where he utilizes his extensive experience and knowledge in small molecules analysis, environmental applications, and workflow development to provide wholesome detection solutions to scientists around the world. Dr. Grossman is a subject matter expert in exposomics and he considers himself a problem solver at heart, which can be seen in his implementation of novel workflows for "big data" exposomics and non-targeted analysis. He has previously worked at the U.S. Environmental Protection Agency, where he developed workflows for non-targeted analysis and suspect screening to map the chemical space of common media and environments, leading to novel exposure forensics and exposure classification. Dr. Grossman eceived his PhD in Chemistry at Syracuse University.

Manish Arora, BDS, MPH, PhD, FICD, Icahn School of Medicine at Mount Sinai

Manish Arora, BDS, MPH, PhD, FICD, is the Edith J. Baerwald Professor and Vice Chairman of the Department of Environmental Medicine and Public Health and Director of the Exposure Biology Lab at the Senator Frank R. Lautenberg Environmental Health Sciences Laboratory at the Icahn School of Medicine at Mount Sinai. Dr. Arora is an exposure biologist and environmental epidemiologist with training in advanced analytical chemistry methods. He developed sophisticated laboratory methods for the application of chemical measurements in teeth as markers of environmental chemical exposures with a focus on reconstructing prenatal and early childhood exposure history. In recognition of his research, he was awarded the PECASE medal by the office of President Barack Obama. Dr. Arora received his MPH from Wollongong University, Australia, and his PhD at the University of Sydney after graduating as a dental surgeon.

Rosalind J. Wright, MD, MPH, Icahn School of Medicine at Mount Sinai

Rosalind Wright, MD, MPH, serves as the Horace W. Goldsmith Professor of Children's Health Research, Dean for Translational Biomedical Sciences, Professor of Environmental Medicine and Public Health and Pediatrics, and Co-Director of the Institute for Exposomic Research. She is a developmental epidemiologist with transdisciplinary training in environmental health and stress mechanisms. Prior to Mount Sinai she joined the clinical faculty at the Beth Israel Deaconess Medical Center and the research faculty at the Channing Laboratory, Brigham & Women's Hospital, Harvard Medical School and the Harvard School of Public Health. Dr. Wright received her MD from University of Michigan Medical School and completed her residency in Internal Medicine at Northwestern University and her fellowship in Pulmonary and Critical Care Medicine at Harvard Medical School. She also received her MPH from Harvard School of Public Health.

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