**A National Cancer Policy Forum Workshop
convened in collaboration with the
Forum on Aging, Disability, and Independence
and the Standing Committee on the
Use of Emerging Science for
Environmental Health Decisions**

The Role of Companion Animals as Sentinels for Predicting
Environmental Exposure Effects on Aging and Cancer Susceptibility in Humans

December 1-3, 2021

Webcast: http://bit.ly/NASEMcompanionanimals

The National Academies of
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December 1, 2021

Dear Colleagues,

Welcome to the National Academies of Sciences, Engineering, and Medicine workshop, *The Role of Companion Animals as Sentinels for Predicting Environmental Exposure Effects on Aging and Cancer Susceptibility in Humans*. This workshop is hosted by the Academies' National Cancer Policy Forum in collaboration with the Forum on Aging, Disability, and Independence and the Standing Committee on the Use of Emerging Science for Environmental Health Decisions.

The One Health movement aims to focus attention and resources on the critical interconnectedness of animal, human, and environmental health and to promote improved multidisciplinary collaboration. This concept offers a promising and underutilized pathway for future research with the potential to improve both animal and human health. For example, pets share the environment of their human companions and are exposed to many of the same agents, so environmental exposure data collected on pets across their lifespan has the potential to provide new insights that are complementary to traditional toxicology research approaches, such as *in vitro* studies and laboratory animal testing. Because companion animals acquire a similar spectrum of disease as humans, they can serve as sentinels for human health risks.

This workshop will examine the potential role of companion animals as sentinels of relevant, shared environmental exposures that may affect human aging and cancer. We encourage workshop participants to explore the opportunities and challenges for using this novel translational approach to exposure science as a way to accelerate the knowledge turn in this evolving field.

The proceedings of the workshop will be published by the National Academies Press and may incorporate your comments and ideas. Archived presentations and videos from the workshop will be available at http://bit.ly/NASEMcompanionanimals.

Sincerely,

Linda S. Birnbaum, PhD
Planning Committee Chair
Scientist Emeritus and former Director
        National Institute of Environmental Health Sciences and National Toxicology Program
Scholar in Residence, Nicholas School of the Environment, Duke University

Notes for Virtual Attendees

- The livestream of the webcast is available at:
  http://bit.ly/NASEMcompanionanimals

- We welcome your involvement in the workshop. Please use the chatbox on our website (located below the livestream) to ask questions, and please include your name and affiliation.

- This workshop is being webcast and recorded. The webcast and presentation files will be archived on the project webpage.

- Please use hashtags **#NASEMCompanionAnimals, #NatlCancerForum, #AgingDisabilityForum,** and **#ESEHDWorkshop** to tweet about the workshop.

- Interested in receiving updates from the National Academies of Sciences, Engineering, and Medicine's Health and Medicine Division? Sign up at:

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Animal Cancer Foundation

College of Veterinary Medicine & Biomedical Science at
Texas A&M University

Environmental Protection Agency

Flint Animal Cancer Center, Colorado State University

National Institutes of Health/National Institute of Environmental
Health Sciences

Nicholas School of the Environment

North Carolina State University College of Veterinary Medicine

The Morris Animal Foundation

University of Colorado Cancer Center

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The Role of Companion Animals as Sentinels
for Predicting Environmental Exposure Effects
on Aging and Cancer Susceptibility in Humans
A Hybrid Workshop

500 Fifth St., N.W.
Keck 100, Washington, D.C. 20001

Webcast link: http://bit.ly/NASEMcompanionanimals

December 1, 2021	
7:30 am	**Registration and Breakfast** *Outside Keck 100 & E-Street Conference Room*
8:00 am	**Welcome and Workshop Overview** *Linda Birnbaum, Planning Committee Chair and Emeritus Director, National Institute of Environmental Health Sciences (NIEHS) and National Toxicology Program (NTP)* *Ned Sharpless, Director, National Cancer Institute (NCI)*

8:30 am	**Session 1: History and Current State of the Science of Environmental Exposure Effects on Aging and Cancer Susceptibility**
	 Co-Moderators: Bill Farland, Colorado State University Emeritus & Danielle Carlin, NIEHS*
	
	 State of the Science and Overview
	     o **Environmental Exposure and Cancer**
	        o *Gary Ellison, NIEHS/NCI*
	
	     o **Environmental Exposure and Cancer in Companion Animals**
	        o *Audrey Ruple, Virginia Tech*
	
	     o **Aging Targets for Environmental Exposure**
	        o *Marcia Haigis, Harvard University*
	        o *Cheryl Walker, Baylor College of Medicine**
	
	 Canine Genetic Systems and Relevance for Human Cancers
	     o *Elaine Ostrander, National Human Genome Research Institute*

10:15 am	**Break**
10:30 am	**Session 1: History and Current State of the Science of Environmental Exposure Effects on Aging and Cancer Susceptibility** *Co-Moderators: Bill Farland, Colorado State University Emeritus & Danielle Carlin, NIEHS** **Aging and Cancer Susceptibility** o *James DeGregori, University of Colorado Cancer Center*

*presenting remotely

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	What are the Gaps in Human Cancer Prevention and Control That May Be Addressed Through Companion Animal Research, and Vice Versa? o *Peter Rabinowitz, University of Washington** **Session 1 Panel Discussion**
12:15 pm	**Lunch Break with Virtual Poster Session** *E-Street Conference Room & Zoom link:* https://nasem.zoom.us/j/95073801945

1:30 pm	**Session 2a: Methods and Current Studies**
	Moderator: Myrtle Davis, Bristol Myers Squibb
	
	Exposome and Health
	    o *Gary Miller, Columbia University*
	
	Biomonitoring of Chemical Exposure in Companion Animals
	    o *Kurunthachalam Kannan, New York University*
	
	Assessing the Exposome Using Wearable Sensors: Challenges and Opportunities
	    o *Yuxia Cui, NIEHS**
	
	Ongoing Canine Population Studies
	    o *Matthew Breen, North Carolina State University*

3:00 pm	**Break**

3:20 pm	**Session 2a (cont'd): Methods and Current Studies**
	Moderator: Myrtle Davis, Bristol Myers Squibb
	
	Ongoing Canine Population Studies (cont'd)
	    o *Rod Page, Colorado State University*
	    o *Daniel Promislow, University of Washington*
	    o *Richard Lea, University of Nottingham*
	
	Session 2a Panel Discussion

5:30 pm	**Adjourn Day 1** **Evening Reception with In-Person Poster Session** *E-Street Conference Room & Balcony*
December 2, 2021	
7:30 am	**Breakfast** *E-Street Conference Room*
8:00 am	**Session 2b: Relevance of Companion Animal Exposures to Human Cancer and Aging** *Moderator: Nicole Deziel, Yale University*

*presenting remotely

	Overview of Outdoor Air, Water, Ground
	    o *Caleb "Tuck" Finch, University of Southern California*
	
	A Comparative Assessment of SVOC Exposures in Domestic Dogs and Their Owners Using Silicone Passive Samplers
	    o *Heather Stapleton, Duke University*
	
	Indoor Products: Endocrine Disruptors, Flame Retardants, PFAS
	    o *Jan Dye, Environmental Protection Agency**
	
	Radon Exposures
	    o *Chad Johannes, Iowa State University*
	
	Heavy Metal Exposures
	    o *Norman Kleiman, Columbia University*

9:45 am	**Break**

10:00 am	**Session 2b (cont'd): Relevance of Companion Animal Exposures to Human Cancer and Aging**
	Moderator: Nicole Deziel, Yale University
	
	Dietary and Feeding Exposures
	    o *Joe Wakshlag, Cornell University*
	
	Pesticides/Herbicides and Mixtures
	    o *Elizabeth Ryan, Colorado State University*
	
	Session 2b Panel Discussion

12:00 pm	**Lunch Break with Virtual Poster Session** *E-Street Conference Room & Zoom link: https://nasem.zoom.us/j/95073801945*

1:15 pm	**Session 3: Accelerating Cross-species Comparisons: Opportunities and Challenges in Data Sources, Collection, Storage, Modeling, and Sharing**
	Moderator: Roy Jensen, University of Kansas*
	
	Human Exposure Assessment
	    o *Rena Jones, NCI*
	
	Data and Sample Collection/Storage and Sharing/Data Integration of Human and Companion Animal Data
	    o *Amy K. LeBlanc, NCI*
	    o *Marta Castelhano, Cornell University*
	    o *Anne Thessen, University of Colorado Anschutz Medical Campus*

2:40 pm	**Break**

*presenting remotely

3:00 pm	**Session 3 (cont'd): Accelerating Cross-species Comparisons: Opportunities and Challenges in Data Sources, Collection, Storage, Modeling, and Sharing**
	Moderator: Roy Jensen, University of Kansas*
	
	Data, Samples, and Modeling
	   o *Angela Hughes, Mars Petcare*
	   o *Adam Boyko, Embark Veterinary, Inc./Cornell University*
	   o *Mark Dunn, American Kennel Club*
	
	Session 3 Panel Discussion

5:00 pm	**Adjourn Day 2** **Evening Reception with In-Person Poster Session** *E-Street Conference Room & Balcony*
December 3, 2021	
8:30 am	**Breakfast** *E-Street Conference Room*

9:00 am	**Session 4: Equity, Ethics, and Policy**
	Moderator: Wendy Shelton, Virtual Beast/Colorado State University
	
	Ethical Considerations: Research Subject Protections, Citizen Science Issues, and Shared Health
	   o *Lisa Moses, Harvard Medical School**
	
	One Health Approaches in Arctic Indigenous Communities
	   o *Frank A. von Hippel, University of Arizona*
	
	Aligning Healthcare for a Bonded Family Society
	   o *Michael Blackwell, University of Tennessee, Knoxville**
	
	Session 4 Panel Discussion

10:45 am	**Break and Pick up Box Lunches** *E Street Conference Room*

11:00 am	**Facilitated Discussions with Planning Committee Members**
	E Street Conference Room
	
	Objectives:
	➢ Review key messages from the workshop discussions, including identifying potential next steps, promising areas for future action, and opportunities for collaboration.
	
	   o *TABLE 1: Bill Farland, Colorado State University, Emeritus*
	   o *TABLE 2: Nicole Deziel, Yale University*

*presenting remotely

	o *TABLE 3: Wendy Shelton, Virtual Beast/Colorado State University* o *TABLE 4: Daniel Promislow, University of Washington* o *TABLE 5: Matthew Breen, North Carolina State University* o *TABLE 6: Rod Page, Colorado State University* o *VIRTUAL TABLE: Danielle Carlin, NIEHS and Roy Jensen, University of Kansas** o *Zoom link: https://nasem.zoom.us/j/96994380813*
11:45 am	**Session 5: Identifying Research Gaps and Setting a Research Agenda: Recommendations and Next Steps for the Path Forward** *Moderator: Linda Birnbaum, NIEHS, NTP, Emeritus* **Report Backs from Facilitated Discussions and Workshop Reflections** (each with 5 minutes for report back summaries and workshop reflections, followed by open discussion among workshop participants) o *Bill Farland, Colorado State University, Emeritus* o *Nicole Deziel, Yale University* o *Wendy Shelton, Virtual Beast/Colorado State University* o *Daniel Promislow, University of Washington* o *Matthew Breen, North Carolina State University* o *Rod Page, Colorado State University* o *Danielle Carlin, NIEHS** o *Roy Jensen, University of Kansas** **Concluding Remarks and Next Steps for the Field** o *Linda Birnbaum, NIEHS, NTP, Emeritus*
1:00pm	**Adjourn**

THE ROLE OF COMPANION ANIMALS AS SENTINELS FOR PREDICTING ENVIRONMENTAL EXPOSURE EFFECTS ON AGING AND CANCER SUSCEPTIBILITY IN HUMAN

PLANNING COMMITTEE ROSTER

Linda S. Birnbaum, PhD *(Chair)*
Scientist Emeritus,
National Institute of Environmental Health Sciences
National Toxicology Program
Scholar in Residence,
Nicholas School of the Environment
Duke University

Matthew Breen, PhD
Professor of Genomics
Oscar J. Fletcher Distinguished Professor of Comparative Oncology Genetics
Dept. of Molecular Biomedical Sciences
College of Veterinary Medicine
North Carolina State University

Myrtle Davis, PhD
Executive Director
Discovery Toxicology
Bristol Myers Squibb

Nicole Deziel, PhD, MPH
Associate Professor
Yale School of Public Health
Yale Center for Perinatal, Pediatric, and Environmental Epidemiology
Yale University

William H. Farland, PhD, ATS
Professor Emeritus
Environmental and Radiological Health Sciences
College of Veterinary Medicine and Biomedical Sciences
Colorado State University

Roy A. Jensen, MD
Director
The University of Kansas Cancer Center
Kansas Masonic Cancer Research Institute
William R. Jewell, M.D. Distinguished Masonic Professor
The University of Kansas Cancer Center
The University of Kansas Medical Center

Daniel Promislow, DPhil
Principal Investigator and Co-Director
Dog Aging Project
Professor, Department of Lab Medicine & Pathology and Department of Biology
University of Washington School of Medicine

Wendy Shelton, DVM, MPH
Principal
Virtual Beast Consulting
Consultant
Colorado State University

Cheryl Lyn Walker, PhD
Alkek Presidential Chair in Environmental Health
Director
Center for Precision Environmental Health
Professor
Departments of Molecular & Cell Biology and Medicine
Baylor College of Medicine

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THE ROLE OF COMPANION ANIMALS AS SENTINELS FOR PREDICTING ENVIRONMENTAL EXPOSURE EFFECTS ON AGING AND CANCER SUSCEPTIBILITY IN HUMAN

SPEAKER AND MODERATOR ROSTER

Linda S. Birnbaum, PhD, DABT, ATS
Scientist Emeritus,
National Institute of Environmental Health
Sciences
National Toxicology Program
Scholar in Residence,
Nicholas School of the Environment
Duke University

Michael J Blackwell, DVM, MPH, FNAP
Assistant Surgeon General, U.S. Public Health
Service Commissioned Corps (Ret.)
Director
Program for Pet Health Equity
Center for Behavioral Health Research
University of Tennessee

Adam Boyko, PhD, MS
Associate Professor
Department of Biomedical Sciences,
Cornell University College of Veterinary
Medicine
Embark Veterinary, Inc.

Matthew Breen, PhD
Professor of Genomics
Oscar J. Fletcher Distinguished Professor of
Comparative Oncology Genetics
Dept. of Molecular Biomedical Sciences
College of Veterinary Medicine
North Carolina State University

Danielle J. Carlin, PhD, DABT
Health Scientist Administrator
Hazardous Substances Research Branch
National Institute of Environmental Health
Services

Marta G. Castelhano, DVM, MVSc
Director
Cornell Veterinary Biobank
Associate Research Professor, Department of
Clinical Sciences
Cornell University College of Veterinary
Medicine

Yuxia Cui, PhD
Health Scientist Administrator
Exposure, Response, and Technology Branch
Division of Extramural Research and Training
National Institute of Environmental Health
Sciences
National Institute of Health

Myrtle Davis, PhD
Executive Director
Discovery Toxicology
Bristol Myers Squibb

James DeGregori, PhD
Courtenay C. and Lucy Patten Davis Endowed
Chair in Lung Cancer Research
Professor, Department of Biochemistry and
Molecular Genetics
Deputy Director, University of Colorado
Cancer Center
University of Colorado Anschutz Medical
Campus

Nicole Deziel, PhD, MPH
Associate Professor
Yale School of Public Health
Yale Center for Perinatal, Pediatric, and
Environmental Epidemiology

Mark Dunn
Executive Vice President
American Kennel Club

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Janice A. Dye, DVM, MS, PhD
Diplomate,
The American College of Veterinary Internal
Medicine
U.S. Environmental Protection Agency,
Center for Public Health and Environmental
Assessment
Public Health and Integrated Toxicology
Division
Cardiopulmonary & Immunotoxicology Branch

Gary L. Ellison, PhD, MPH
Chief
Environmental Epidemiology Branch,
Epidemiology and Genomics Research Program,
Division of Cancer Control and Population
Sciences
National Cancer Institute
Acting Dirctor
Division of Extramural Research and Training
National Institute of Environmental Health
Sciences
National Institute of Health

William H. Farland, PhD, ATS
Professor Emeritus
Environmental and Radiological Health Sciences
College of Veterinary Medicine and Biomedical
Sciences
Colorado State University

Caleb Finch, PhD
Professor
ARCO/William F. Kieschnick Chair in
Neurobiology of Aging
Leonard Davis School of Gerontology
University of Southern California

Marcia C. Haigis, PhD
Professor
Department of Cell Biology
Harvard Medical School
Harvard University

Angela Hughes, DVM, PhD
Global Scientific Advocacy Relations Senior
Manager
Veterinary Geneticist
Mars Petcare

Roy A. Jensen, MD
Director
The University of Kansas Cancer Center
Kansas Masonic Cancer Research Institute
William R. Jewell, M.D. Distinguished
Masonic Professor
The University of Kansas Cancer Center
The University of Kansas Medical Center

Chad M. Johannes, DVM, DACVIM (SAIM,
Oncology)
Assistant Professor of Oncology
Iowa State University
College of Veterinary Medicine

Rena Jones, PhD, MS
Investigator
Occupational and Environmental Branch
Division of Cancer Epidemiology & Genetics
National Cancer Institute
National Institute of Health

Kurunthachalam Kannan, PhD
Professor
Department of Pediatrics and Department of
Environmental Medicine
New York University Grossman School of
Medicine

Norman Kleiman, PhD
Assistant Professor
Environmental Health Sciences
Columbia University Medical Center
Director,
Radiation Safety Officer Training Course
Columbia University

Richard Lea, PhD, SFHEA
Reader in Reproductive Biology
Deputy Head of Division, Global Health
Chair, Committee for Animal Research and
Ethics
Chair, Society for Reproduction & Fertility
School of Veterinary Medicine
University of Nottingham

Amy K. LeBlanc, DVM
Director, Comparitive Oncology Program
National Cancer Institute

Gary W. Miller, PhD
Vice Dean for Research Strategy and Innovation
Professor
Department of Environmental Health Sciences
Columbia University Mailman School of Public
Health

Lisa Moses, VMD, DACVIM
Research Fellow and Faculty in Bioethics,
Center for Bioethics
Harvard Medical School
Bioethics Scholar and Chair, Animal Ethics
Study Group
Yale Interdisciplinary Center for Bioethics
Visiting Scientist,
Vertebrate Genomics Group, The Broad
Institute of MIT and Harvard

Elaine A. Ostrander, PhD
Chief & NIH Distinguished Investigator
Cancer Genomics and Comparative Genomics
Branch
National Human Genome Research Institute
National Institutes of Health

Rodney Page, DVM, MS
Director, Flint Animal Cancer Center
Stephen J Withrow Presidential Chair in
Oncology
Professor of Oncology
Colorado State University

Daniel Promislow, DPhil
Principal Investigator and Co-Director
Dog Aging Project
Professor, Department of Lab Medicine
& Pathology and Department of Biology
University of Washington School of Medicine

Peter Rabinowitz, MD, MPH
Professor,
Department of Environmental/Occupational
Health Sciences, Department of Family
Medicine, Department of Global Health
Adjunct Professor, Department of Medicine and
the Division of Allergy and Infectious Disease,
Department of Epidemiology
Director, Center for One Health Research
(COHR)
Co-Director, UW Alliance for Pandemic
Preparedness
University of Washington

**Audrey Ruple, DVM, MS, PhD,
DipACVPM, MRCVS**
Associate Professor
Department of Population Health Sciences
Virginia-Maryland College of Veterinary
Medicine
Virginia Polytechnic Institute and State
University

Elizabeth P. Ryan, PhD
Associate Professor
Department of Environmental and Radiological
Health Sciences
College of Veterinary Medicine and Biomedical
Sciences
Colorado School of Public Health
Colorado State University

Norman E. "Ned" Sharpless, MD
Director
National Cancer Institute
National Institutes of Health

Wendy Shelton, DVM, MPH
Principal
Virtual Beast Consulting
Consultant
Colorado State University

Heather Stapleton, PhD
Ronie-Richele Garcia-Johnson Distinguished
Professor
Nicholas School of the Environment
Duke University

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Anne Thessen, PhD
Assistant Professor
Department of Environmental and Molecular
Toxicology
College of Agricultural Sciences
Oregon State University
Visiting Associate Professor
University of Colorado Anschutz Medical
Campus

Frank A. von Hippel, PhD
Professor
Environmental Health Sciences
Mel & Enid Zuckerman College of Public Health
University of Arizona

Joseph J. Wakshlag, DVM, PhD
Professor
Sections of Clinical Nutrition and Sports
Medicine and Rehabilitation
Section Chief of Nutrition
Cornell University College of Veterinary
Medicine
Diplomate, American College of Veterinary
Nutrition
Diplomate, American College of Veterinary
Sports Medicine and Rehabilitation

Cheryl Lyn Walker, PhD
Alkek Presidential Chair in Environmental
Health
Director
Center for Precision Environmental Health
Professor
Departments of Molecular & Cell Biology and
Medicine
Baylor College of Medicine

SPEAKER, MODERATOR, AND PLANNING COMMITTEE MEMBER BIOS

Linda S. Birnbaum, PhD, DABT, ATS
National Institute of Environmental Health Sciences

Linda S. Birnbaum, Ph.D., D.A.B.T., A.T.S. is the former Director of the National Institute of Environmental Health Sciences (NIEHS) of the National Institutes of Health, and the National Toxicology Program (NTP). After retirement, she was granted scientist emeritus status and still maintains a laboratory. As a board-certified toxicologist, Birnbaum served as a federal scientist for 40 years. Prior to her appointment as NIEHS and NTP Director in 2009, she spent 19 years at the U.S. Environmental Protection Agency (EPA), where she directed the largest division focusing on environmental health research.

Birnbaum has received many awards and recognitions. In 2016, she was awarded the North Carolina Award in Science. She was elected to the Institute of Medicine of the National Academies, one of the highest honors in the fields of medicine and health. She was also elected to the Collegium Ramazzini, an independent, international academy comprised of internationally renowned experts in the fields of occupational and environmental health and received an honorary Doctor of Science from the University of Rochester and a Distinguished Alumna Award from the University of Illinois. She has also received Honorary Doctorates from the University of Rhode Island, Ben-Gurion University, Israel, and Amity University, India; the Surgeon General's Medallion 2014; and 14 Scientific and Technological Achievement Awards, which reflect the recommendations of EPA's external Science Advisory Board, for specific publications. She has also received numerous awards from professional societies and citizen's groups.

Birnbaum is an active member of the scientific community. She was vice president of the International Union of Toxicology, the umbrella organization for toxicology societies in more than 50 countries, and former president of the Society of Toxicology, the largest professional organization of toxicologists in the world. She is the author of more than 1000 peer-reviewed publications, book chapters, abstracts, and reports. Birnbaum's own research focuses on the pharmacokinetic behavior of environmental chemicals, mechanisms of action of toxicants including endocrine disruption, and linking of real-world exposures to health effects. She is an adjunct professor at the University of Queensland in Australia, the School of Public Health of Yale University, the Gillings School of Global Public Health, the Curriculum in Toxicology, and the Department of Environmental Sciences and Engineering at the University of North Carolina at Chapel Hill, as well as in the Integrated Toxicology and Environmental Health Program at Duke University where she is also a Scholar in Residence.

A native of New Jersey, Birnbaum received her M.S. and Ph.D. in microbiology from the University of Illinois at Urbana-Champaign.

Michael J. Blackwell, DVM, MPH, FNAP
University of Tennessee

Dr. Blackwell currently serves as the Director of the Program for Pet Health Equity at the University of Tennessee. His mission is to improve access to veterinary care, especially for families with limited means. Previous to this position, Dr. Blackwell served as:

> Dean, College of Veterinary Medicine, University of Tennessee
> Chief of Staff, Office of the Surgeon General of the United States
> Deputy Director, Center for Veterinary Medicine, Food and Drug Administration
> Chief Veterinary Officer, U.S. Public Health Service

During 23 years on active duty with the U.S. Public Health Service, he achieved the rank of Assistant Surgeon General/Rear Admiral.

Dr. Blackwell has received numerous awards and recognitions, including the Distinguished Service Medal, Meritorious Service Medal, and two Surgeon General's Exemplary Service Medals. He is the 2020 recipient of the Avanzino Leadership Award and the 2021 Senator John Melcher, DVM Leadership in Public Policy awardee.

Adam Boyko, PhD, MS
Cornell University

Adam Boyko is an Associate Professor in Biomedical Sciences at the Cornell University College of Veterinary Medicine conducting research on canine genetics. He is also co-founder and Chief Science Officer of Embark Veterinary, a dog DNA testing company founded in 2015 and incubated at the Cornell McGovern Center, and a trustee for the Morris Animal Foundation. His research focuses on complex trait mapping, bioinformatics, statistical genetics, inference of evolutionary forces and demographic history from genomic data, and understanding the evolutionary process of domestication and rapid adaptation.

Prior to joining the faculty at Cornell, Boyko received undergraduate degrees in computer science and evolutionary ecology from the University of Illinois as well as a masters in Computer Science and doctorate in Biology at Purdue. He also worked as a postdoc and research associate at Cornell and Stanford studying computational biology and population genomics.

Matthew Breen, PhD, C. Biol, FRSB
North Carolina State University

Dr. Matthew Breen is a Professor of Genomics and the Oscar J. Fletcher Distinguished Professor of Comparative Oncology Genetics in the Dept. of Molecular Biomedical Sciences at the NCSU College of Veterinary Medicine. He is also a member of the NCSU Comparative Medicine Institute (CMI), Center for Human Health and the Environment, and
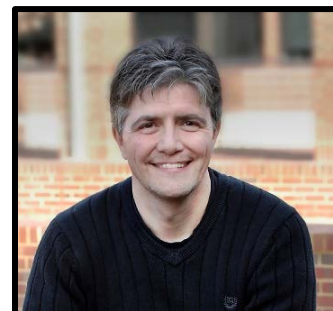
the Genetics and Genomics Initiative, as well as the Duke Cancer Institute, and the Cancer Genetics Program at the University of North Carolina's Lineberger Comprehensive Cancer Center. Dr. Breen is a member of the NCSU Research Leadership Academy.

Dr. Breen's research focuses on genetics, genomics, and the comparative aspects of animal and human health. The lab uses a range of genetic and genomic technologies for evaluating changes to genome structure that occur in canine cancers. With these data the lab aims to improve outcomes for canine cancer patients and also advance our understanding of the comparable cancers in people. In addition, the lab are assessing the impact of environmental exposures on animal health, as a sentinel for human health. He was a charter member, and serves on the Board of Directors, of the Canine Comparative Oncology and Genomics Consortium (CCOGC), a 501c3 not-for-profit organization established to promote the role of the dog in comparative biomedical research, and also serves on the board of directors of the Canines-N-Kids Foundation, a 501c3 committed to finding a cure to the devastating cancers that canines and children face in common. He is member of the steering committee of the NCI's Integrated Canine Data Commons and serves on the Data Governance Advisory Board of that initiative. Dr. Breen was appointed to the National Academies expert committee tasked with planning a public workshop to examine the role of companion animals as sentinels of shared environmental exposures that may impact human aging and cancer.

Dr. Breen has served on scientific review committees for organizations including the National Institutes of Health, AKC Canine Health Foundation, and the Morris Animal Foundation. He is a regular reviewer for numerous scientific funding agencies and journals and serves on the editorial board of several journals.

Danielle Carlin, PhD, DABT
National Institute of Environmental Health Sciences

Danielle Carlin, Ph.D., D.A.B.T., is a program administrator with the Superfund Research Program (SRP). Her position consists of providing guidance and advice to grantees applying for SRP P42 Center grants, and serving as the lead liaison between SRP trainees and the various training opportunities offered by SRP. She also oversees the xenobiotic metabolism and asbestos grant portfolios (e.g., R01s). Her current research interests include chemical mixtures, combined exposures, metals, asbestos, and xenobiotic metabolism.

Prior to her current position, she was a post-doctoral researcher for four years at the University of North Carolina: two years within the Eshelman School of Pharmacy, Division of Molecular Pharmaceutics, studying aerosolized drugs/vaccines for treatment and prevention of tuberculosis; and two years within the Curriculum in Toxicology conducting her research at the U.S. Environmental Protection Agency, in Research Triangle Park, N.C., where she studied the toxicological effects of exposure to Libby amphibole asbestos in the rat model. Her areas of expertise include cardiopulmonary/reproductive physiology and inhalation toxicology/pharmacology. She received her Ph.D. in 2005 from Kansas State University, College of Veterinary Medicine, Department of Anatomy and Physiology. She also has a B.S. and M.S. in animal science from New Mexico State University.

Marta Castelhano, DVM, MVSc
Cornell University

Dr. Castelhano received her Doctor of Veterinary Medicine and Master of Veterinary Science degrees from the University of Lisbon, Portugal. Serving as an Associate Research Professor at Cornell University, the Director of the Cornell Veterinary Biobank (CVB), and the Dog Aging Project Biobank, she has over 15 years of experience in the standardized collection, processing, storage, and distribution of high-quality biospecimens and associated data.

Dr. Castelhano is a member of the Education and Training Committee at the International Society for Biological and Environmental Repositories (ISBER), where she creates educational opportunities for biobankers worldwide, and has contributed to the writing of the 4th edition of the *ISBER Best Practices: Recommendations for Repositories*. A frequent speaker at biobank conferences and symposiums, Dr. Castelhano was invited by the National Institutes of Standards and Technology (NIST) to represent the U.S. position in biobanking as an ISO expert and delegate. With her contribution, *ISO 20387: General Requirements for Biobanking* was published, the first ISO standard created specifically for biobanks.

In April 2019, Dr. Castelhano led the CVB through third-party conformity assessment by the American Association of Laboratory Accreditation (A2LA) to become the first biobank in the world to receive accreditation to the ISO 20387 standard. She also serves in the ISBER COVID-19 task force, assessing the needs of biobankers worldwide during the pandemic, to inform the next generation of standard documents and to create targeted improvement opportunities, particularly for biobanks with limited resources.

Yuxia Cui, PhD
National Institute of Environmental Health Sciences

Yuxia Cui, Ph.D., is a health scientist administrator at the National Institute of Environmental Health Sciences (NIEHS). Dr. Cui oversees the exposure science and the exposome grant portfolio that is focused on emerging technologies towards improved exposure and risk assessment in environmental health research. These include sensor technologies, omics-based approaches, computational and informatics-based methodologies, as well as other innovative approaches to enable an integrated view and better understanding of the exposome. Cui currently serves as the program officer for the laboratory network of the Human Health Exposure Analysis Resource (HHEAR). She is also a member of the NIH Common Fund Metabolomics Program leadership team and oversees the day-to-day operations of the Program. Cui received training in molecular toxicology and transcriptomics and received her doctorate in Environmental Toxicology from Duke University.

Myrtle A. Davis, DVM, PhD
Bristol Myers Squibb

Dr. Myrtle Davis is the Vice President of Discovery Toxicology at Bristol Myers Squibb. Myrtle joined BMS from the National Cancer Institute where she was the Chief of the Toxicology and Pharmacology Branch of the Developmental Therapeutics Program. Myrtle has previous experience as a Research Advisor in the Drug Safety group of Lilly Research Laboratories. In both roles, she contributed critical expertise to the advancement of several drugs candidates and to the understanding of toxicological mechanisms. She also has several years of academic experience as an Associate Professor in the Department of Pathology in the School of Medicine at the University of Maryland.

Myrtle is currently responsible for leading the scientific efforts in Discovery Toxicology to provide target and molecular hazard identification and risk assessments for issues identified in discovery research. She also leads and oversees the investigative toxicology efforts needed to support mechanistic understanding of compound- or target-mediated toxicities in discovery and development.
Myrtle is a Fellow of the Academy of Toxicological Sciences, an active member of the Society of Toxicology (recently elected as Vice President elect for the Society), and a member of the Society of Toxicologic Pathology. She is currently serving on the Board of Scientific Councilors of the National Toxicology Program, and she is a reviewer for the Assay Development and Screening Technologies Laboratory of the National Center for Advancing Translational Sciences (NCATS). She is an Associate Editor for *Toxicological Sciences* and *Toxicologic Pathology*, and she is Editor-in-Chief of the ILAR Journal (Institute for Laboratory Animal Research of the National Academy of Sciences).

Myrtle attended Tuskegee University where she pursued a BS degree in Chemistry and Mathematics followed by a Doctorate of Veterinary Medicine. She then received her Ph.D. in Toxicology from the University of Illinois and obtained post-doctoral training in Toxicologic Pathology at the University of Maryland before starting her academic career.

James DeGregori, PhD
University of Colorado Cancer Center

James DeGregori is a Professor in the Department of Biochemistry and Molecular Genetics (faculty since 1997) and Deputy Director of the University of Colorado Cancer Center. He has degrees from the University of Texas at Austin (B.A. Microbiology) and the Massachusetts Institute of Technology (PhD Biology), and received postdoctoral training at Duke University. He holds the Courtenay and Lucy Patten Davis Endowed Chair in Lung Cancer Research. His lab studies the evolution of cancer, in the context of their Adaptive Oncogenesis model, with a focus on how aging, smoking, Down Syndrome, and other insults influence cancer initiation and responses to therapy. In this model, mutations face fitness landscapes that vary with age, genetics, or following carcinogen exposure. These fitness landscapes are highly dependent on the state of the tissue microenvironment in which stem cells reside. The lab has developed this cancer model based on classic evolutionary principles, and substantiated this model by theoretical, experimental and computational studies. Additional studies in the lab seek to identify metabolic and signaling vulnerabilities in cancer, with a focus on acute myeloid leukemias, that can be exploited for the

development of more effective therapies. For all of these studies, we leverage a variety of tools, including computational biology, genomics, metabolomics, cell biology, and biochemistry, leveraging both mouse models and human samples.

Nicole Deziel, PhD, MHS
Yale University

Dr. Nicole Deziel, PhD, MHS is an Associate Professor in Environmental Health Sciences at the Yale School of Public Health and a member of the Yale Cancer Center and Yale Center for Perinatal, Pediatric and Environmental Epidemiology. Over the past 15 years, her research has involved applying existing and advanced statistical models, biomonitoring techniques, and environmental measurements to provide comprehensive and quantitative assessments of exposure to combinations of traditional and emerging environmental contaminants. Dr. Deziel's work involves the use of large administrative datasets in conjunction with detailed field-based studies. Her exposure assessment strategies aim to reduce exposure misclassification for epidemiologic studies, advancing understanding of relationships between of exposure to environmental chemicals and risk of adverse health outcomes, particularly among women and children. She served as Principal Investigator of a study funded by the American Cancer Society evaluating co-exposures to multiple flame retardants, pesticides, and other persistent pollutants and thyroid cancer risk in adult women, and is now leading a project studying environmental exposures and pediatric thyroid cancers. She is also leading an inter-disciplinary team of investigators on a project entitled "Drinking water vulnerability and neonatal health outcomes in relation to oil and gas production in the Appalachian Basin," which is evaluating whether exposure to water contaminants from the process of hydraulic fracturing is associated with adverse human developmental and teratogenic effects. Dr. Deziel serves as Associate Editor for the *Journal of Exposure Science and Environmental Epidemiology* and is on the Editorial Board of *Environment International*. She is also a member of the National Academies of Sciences Standing Committee the Use of Emerging Science for Environmental Health Decisions.

Mark Dunn, MBA
American Kennel Club

Mark Dunn is the Executive Vice President of the American Kennel Club (AKC) and is the Managing Director of AKC Reunite. Founded in 1884, the AKC is the oldest all-breed dog registry in the US and the largest in the world. Mark leads the AKC's efforts to meet the needs of breeders and dog owners. He also works with pet industry leaders and international registry organizations to do good things for dogs and the people who love them around the world. As part of those responsibilities, Mark oversees AKC's DNA Program. AKC has for more than twenty years harnessed the power of genotyping technology to ensure the integrity of its registry and to assist breeders with the accuracy of their breeding records. Mark joined AKC in 2009 as Director of Internal Consulting. Previously he was Director of Engineering and Quality at Qualex, a subsidiary of Eastman Kodak, and has over twenty years of experience leading operations, engineering, and business development teams.

Janice A. Dye, DVM, PhD, MS
U.S. Environmental Protection Agency

Jan Dye is a scientist within the U.S. EPA's Center for Public Health & Environmental Assessment. She is a board-certified veterinary internist whose clinical interests include comparative respiratory diseases, lung function testing, and airway cell biology as well as general internal medicine and infectious disease. Using animal model, animal sentinel, and *in vitro* cellular approaches, the purpose of her toxicological research is to increase understanding of mechanisms by which exposure to air pollutants, environmental agents, and non-environmental factors may contribute to increased susceptibility to developing adverse respiratory, cardiometabolic, or endocrine health outcomes.

Gary Ellison, PhD, MPH
National Cancer Institute/ National Institute of Environmental Health Sciences

Dr. Gary L. Ellison is on detail to the National Institute of Environmental Health Sciences (NIEHS) where he has served as Acting Director of the Division of Extramural Research and Training since January 2021. His position of record is Chief of the Environmental Epidemiology Branch (EEB) in the Epidemiology and Genomics Research Program (EGRP), Division of Cancer Control and Population Sciences (DCCPS), at the National Cancer Institute (NCI). There, he oversees a program of extramural research focused on modifiable factors and risk of cancer. Dr. Ellison leads a group of Program Officers within EEB with expertise that spans all domains of the exposome, including the general external (e.g., broader social and policy context), specific external (e.g., lifestyle factors, environmental pollutants, chemical, physical, and infectious agents), and internal environments (e.g., microbiome, biomarkers of effect, early damage). Dr. Ellison has served as an *ex-officio* member of the National Advisory Environmental Health Sciences Council (NAEHS), a Congressionally mandated body that advises the secretary of Health and Human Services (HHS), director of the National Institutes of Health (NIH), and the director of the NIEHS on matters relating to research, research training, and career development supported by NIEHS. He has received NIH Director's Awards for the 2010 Gulf Oil Spill Response (2011); NIH Working Group for the US-China Biomedical Research Cooperation Program (2013); and GEOHealth Team for conceptualizing and implementing the Global Environmental and Occupational Health (GEOHealth) Program (2018). In 2014, he received an NIH Award of Merit for providing sustained leadership, scientific direction, and programmatic management for the Breast Cancer and the Environment Research Program.

William H. Farland, PhD, ATS
Colorado State University

Dr. Farland is an independent consultant in toxicology and environmental and public health, and a Professor Emeritus in Environmental and Radiological Health Sciences, School of Veterinary Medicine and Biomedical Sciences, Colorado State University (CSU). Formerly, Bill served as Vice President for Research at CSU from 2006-

2013. Prior to that, Bill had a 27-year federal career at the USEPA, serving ultimately as the Deputy Assistant Administrator for Science in the Office of Research and Development, and acting Agency Science Advisor in 2005. His tenure at EPA was characterized by a commitment to the development of national and international approaches to research, testing and assessment of the fate and effects of environmental agents. Bill holds a Ph.D. from UCLA in cell biology and biochemistry. Throughout his career, Bill has served extensively on executive-level committees and advisory boards within the federal government, academia and internationally. He is currently the Chair of the Board on Environmental Studies and Toxicology for the National Academies of Science, Engineering and Medicine in Washington, DC.
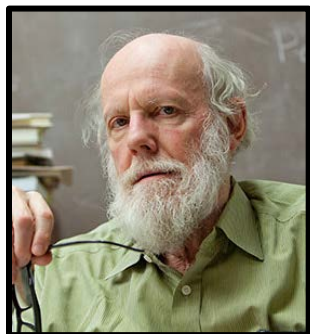
Caleb Finch, PhD
University of Southern California

Caleb Finch, Ph.D. is ARCO Professor of Gerontology and Biological Sciences at the University of Southern California, with adjunct appointments in the Dept of Anthropology, Molecular Biology, Neurobiology, Psychology, Physiology, and Neurology. Major research interest is the neurobiology of aging and human evolution. Finch received his undergraduate degree from Yale in 1961 (Biophysics) and Ph.D. from Rockefeller University in 1969 (Biology). His life work is the fundamental biology of human aging, started in graduate school and continued since 1972 at USC. Discoveries include oligomeric Abeta, a novel form of neurotoxicity of amyloid peptides in Alzheimer disease; the role of shared inflammatory pathways in normal and pathological aging process; the acceleration of aging processes by air pollution. Finch was founding Director of the NIA-funded USC Alzheimer Disease Research Center (1984), and continues as coPI. He also co-founded Acumen Pharmaceuticals, which develops therapeutics for Alzheimer disease. Fifteen of his mentored students hold senior positions in universities or pharmaceutical corporations. Finch has received most of the major awards in biomedical gerontology, including the Robert W. Kleemeier Award (1985), the Sandoz Premier Prize (1995), and the Irving Wright Award (1999). In 2018, the French Academy (EPHE) awarded the doctorate *Honaris causis*. He has written six books, most recently *The Role of Global Air pollution in Aging and disease:* (Academic Press, 2018). Current lab focus is on gene-environment interactions for brain aging, particularly air pollution components.

Marcia C. Haigis, PhD
Harvard Medical School

Marcia C. Haigis is a Professor in the Department of Cell Biology and the Director of Gender Equity for Faculty in Science at Harvard Medical School. She obtained her Ph.D. in Biochemistry from the University of Wisconsin and performed postdoctoral studies at MIT studying mitochondrial metabolism. Dr. Haigis is an active member of the Dana Farber/Harvard Cancer Center, the Paul F. Glenn Center for the Biology of Aging Research, and the Ludwig Center at Harvard Medical School. Her research has made fundamental contributions to our understanding of how mitochondria mediate metabolic reprogramming in cancer, including identifying nodes of metabolic vulnerability in the control of fat oxidation in leukemia and metabolic recycling of ammonia to generate amino acids important for tumor growth. Most recently, her work has shed light on our understanding of how diet and environmental

factors regulate anti-tumor immunity. She is the recipient of numerous honors and awards, including the Brookdale Leadership in Aging Award, the Ellison Medical Foundation New Scholar Award, the American Cancer Society Research Scholar Award, and the National Academy of Medicine Emerging Leaders in Health and Medicine Program.

Angela Hughes, DVM, PhD
Mars Petcare

Dr. Angela Hughes, DVM, PhD serves as Global Science Advocacy Senior Manager at Mars Petcare where she focuses on educating people about the science behind the human-animal bond, as well as the development of new markers of health and disease in pets. She is a trained veterinary geneticist who pioneered the concept of genetically aligning potential breeding dogs to evaluate genetic diversity and launched this in a first-of-its-kind test called Optimal Selection™. Dr. Hughes completed her veterinary degree, veterinary genetics residency, PhD in genetics, and held an associate clinical professor position at the University of California, Davis prior to joining Mars Petcare. She has been published in multiple academic publications including the *Journal of the American Veterinary Medical Association*, *PLOS Genetics*, and PLOS One and has contributed chapters for publication in *Veterinary Clinics of North America Small Animal Practice: Pediatrics* and several editions of *Large Animal Internal Medicine*. Dr. Hughes's special interests include small animal and equine genetics and small animal reproduction and pediatrics.

Roy Jensen, MD
University of Kansas Cancer Center

Dr. Jensen was appointed director of The University of Kansas Cancer Center in 2004. As a result of a broad-based university, community and regional effort, The University of Kansas Cancer Center was designated as a cancer center by the National Cancer Institute in July 2012. Dr. Jensen is currently Professor of Pathology and Laboratory Medicine, Professor of Anatomy and Cell Biology, Professor of Cancer Biology, and the William R. Jewell, M.D. Distinguished Kansas Masonic Professor, at the University of Kansas Medical Center. Prior to his appointment at Kansas, Jensen was a member of the Vanderbilt-Ingram Cancer Center and a faculty member in Pathology, Cell Biology, and Cancer Biology for 13 years.

Dr. Jensen graduated from Vanderbilt University School of Medicine in 1984 and remained there to complete a residency in Anatomic Pathology and a Surgical Pathology fellowship with Dr. David Page. Following his clinical training he accepted a postdoctoral fellowship at the National Cancer Institute in the laboratory of Dr. Stuart Aaronson. After joining the faculty at Vanderbilt University, Dr. Jensen's research interests focused on understanding the function of BRCA1 and BRCA2 and their role in breast neoplasia; and in the characterization of premalignant breast disease at both the morphologic and molecular levels. He currently has over 150 scientific publications and has lectured widely on the clinical and molecular aspects of breast cancer pathology.

Dr. Jensen has served on numerous grant review panels, study sections, and site visit teams for the NIH, the Department of Defense-Breast Cancer Research Program, the Medical Research Council of Canada,

the California Breast Cancer Research Program, the Susan G. Komen Breast Cancer Foundation and the Federation of American Societies for Experimental Biology. Jensen serves on the Science Policy and Governmental Affairs Committees for the American Association for Cancer Research (AACR) and is a member of the AACR Pathology Task Force and AACR Publications Committee. He served as a member of the Science Policy Working Group of the American Society for Investigative Pathology, and co-chaired the research committee for C-Change. In 2013, he was elected to the Board of Directors for the Association of American Cancer Institutes (AACI) and served as the president of AACI from 2018-2020. Jensen was chair of NCI's Subcommittee A from 2018-2020 and also served on the Director's Working Group for the Board of Scientific Advisors to the National Cancer Institute. Finally, he is the Chair of the University of Oklahoma Stephenson Cancer Center External Advisory Board.

Chad M. Johannes, DVM, DACVIM
Iowa State University

Chad M. Johannes, DVM, DACVIM (SAIM, Oncology) is an Associate Professor of Oncology at Iowa State University. His industry experience includes former Medical Director at Ariana Therapeutics, Inc. and coordination of the launch of Palladia®, the first FDA-approved veterinary cancer therapeutic, during his time with Pfizer Animal Health (now Zoetis). Dr. Johannes's practice experience includes primary care, specialty care and academic settings. His areas of research interest include oncology therapeutic development, immunotherapeutics and effective management of treatment-related side effects.

Rena Jones, PhD, MS
National Cancer Institute

Dr. Rena Jones, Ph.D., M.S., is an Investigator in the Occupational and Environmental Epidemiology Branch, Division of Cancer Epidemiology & Genetics at the National Cancer Institute, where her intramural research program seeks to identify and clarify the role of environmental exposures in the development of cancer. Dr. Jones' work relies on the application of Geographic Information Systems and novel approaches to assess environmental exposures, a critical component of cancer epidemiology studies. She takes several approaches to improving long-term environmental exposure estimates, including optimizing the spatial accuracy of residential addresses and exposure sources, characterizing participant mobility and time spent in microenvironments, and incorporating information from surveys, regulatory environmental monitoring data, biomonitoring, and other secondary datasets. Her research program leads several large-scale, multidisciplinary efforts to characterize general population exposure to drinking water contaminants and point source air pollution. In addition, she co-leads NCI working groups focused on geospatial analyses and incorporation of new technologies for human exposure assessment in population studies. The novelty and quality of Dr. Jones' work has been recognized through multiple research awards, including the 2020 NCI Director's Intramural Innovation Award. She received her masters and doctoral degrees in epidemiology from the University at Albany, State University of New York.

Kurunthachalam Kannan, PhD
New York University

Dr. Kurunthachalam Kannan is a Professor in the Department of Pediatrics, Division of Environmental Pediatrics at New York University School of Medicine. He has published over 780 research articles in peer-reviewed journals, 25 book chapters and co-edited a book. Dr. Kannan is the top 5 most highly cited researchers (ISI) in Ecology/Environment globally with an H-index of 135 (google scholar) or 118 (scopus). He is known for his work on the discovery of perfluorochemicals in the global environment, among several others. Currently his research is focused on biomonitoring of human exposure to organic pollutants. Dr. Kannan has won several medals for his stellar academic career gold medals for his top rank in undergraduate academic career throughout, and to name a few, Governor's gold medal in 1986 and SETAC's Weston F Roy Environmental Chemistry award in 1999, New York State Department of Health's Sturman Award for Excellence in Research in 2019. He has mentored more than 15 Master's and doctoral level students and advised more than 60 postdoctoral research associates in his laboratory.

Norman Kleiman, PhD, MS
Columbia University

Dr. Kleiman works at the intersection of public health, radiation research and ophthalmology, often using the eye as a model system to study the effects of environmental exposures, and radiation in particular, on human and animal health. For example, NASA and DOE funded research projects were designed to better understand ocular risks, and radiation cataract in particular, underlying eye exposure to low doses of different kinds of radiation, e.g. X-rays and high energy space radiation, (think cosmic rays). Related human research in Dr. Kleiman's laboratory estimates relative risk of radiation cataract in medical professionals such as interventional cardiologists and associated nursing personnel following occupational exposure to X-ray during fluoroscopic imaging procedures. A collaborative study with Ukrainian colleagues examines ocular radiation risk in Chornobyl accident cleanup workers. Recently, new projects have examined health risks posed by exposure to radiation, heavy metals and other environmental hazards in mice, voles and semi-domesticated dogs living within the Chornobyl exclusion zone.

In other areas related to eye pathology, a NIEHS funded project investigates the potential relationship between arsenic exposure and cataract and recently reported significantly elevated arsenic concentrations in eye tissue. A recently funded NIEHS study examines the potentially carcinogenic heavy metal risks associated with e-cigarette use. At a mechanistic level, Dr. Kleiman applies molecular and biochemical approaches to examine how environmental toxins such as radiation, heavy metals or e-cigarette use causes DNA damage, misrepair and mutagenesis and how individual genetic determinants influence risk. Overall, these investigations help in formulating appropriate risk policies and aid in development of human exposure guidelines as well as having important therapeutic implications for radio- and/or chemo-sensitive subsets of the human population. Among other responsibilities, Dr. Kleiman is a technical cooperation expert for the International Atomic Energy Agency and serves on

scientific committees of the National Council on Radiation Protection (NCRP) and the International Commission on Radiological Protection (ICRP).

Richard Lea, PhD, SFHEA
University of Nottingham, UK

Dr. Richard Lea is currently a Reader and Associate Professor in the School of Veterinary Medicine and Science at the University of Nottingham, UK and will take up the position of Professor of Reproductive Biology in January 2022. Dr Lea is Chair of the School Committee for Animals and Research ethics (CARE), deputy head of the division of Global Health and has been central to the development of the teaching curriculum in veterinary reproduction for over 15 years. Dr Lea is also the Chair of the Society for Reproduction and Fertility (SRF) and actively promotes public awareness on environmental threats to reproductive health.

Dr. Lea has over 30 years' experience of research into environmental influences on fertility and reproduction. His primary research program concerns the topical issue of environmental chemicals and their effects on mammalian reproductive well-being and his experimental approaches encompass both animal and human studies. Dr Lea's primary research programmes concern firstly the dog as a sentinel species for human exposure to household and industrial pollutants and secondly, the sheep as 'real-life' model for exposure to chemical mixtures in a commonly used agricultural fertiliser. Of note is the demonstration of a 26-year decline in dog semen quality that parallels that widely reported in the human and, maternal exposure linked perturbations in ovine female fetal reproductive development. These programs have been supported by grants awarded by the European Union, national UK charities and currently, Dr Lea is the Nottingham (UK) PI on an R01 NIH funded study focussed on multi-generational effects in sheep following maternal exposure to environmentally relevant chemical mixtures. Dr Lea's complimentary research paradigms suggest that the utilisation of the sheep and dog in future research provides a means of investigating environmental influences on fertility in a manner complimentary to essential human studies.

Amy K. LeBlanc, DVM
National Institutes of Health

Dr. Amy LeBlanc is a board-certified veterinary oncologist, Senior Scientist and the Director of the intramural NCI's Comparative Oncology Program. In this position she conducts preclinical mouse and translational pet dog studies that are designed to inform the drug and imaging agent development path for human cancer patients, specifically those with osteosarcoma. She directly oversees the NCI Comparative Oncology Trials Consortium (COTC), which provides infrastructure necessary to connect participating veterinary academic institutions with stakeholders in drug development to execute fit-for-purpose comparative clinical trials in novel therapeutics and imaging agents. Her program provides support to several extramural NCI-funded initiatives including the Integrated Canine Data Commons and Cancer Moonshot-funded canine immunotherapeutic clinical trials conducted under the PRECINCT network.

Gary W. Miller, PhD
Columbia University

Dr. Miller serves as Vice Dean for Research Strategy and Innovation and Professor of Environmental Health Sciences at the Columbia University Mailman School of Public Health. He is an international leader on the exposome, the environmental analogue to the genome. Dr. Miller founded the first exposome center in the U.S. and wrote the first book on the topic. He has helped develop high-resolution mass spectrometry methods to provide an omic-scale analysis of the human exposome. He serves as Co-Director of Columbia's Irving Institute Precision Medicine Resource, which supports integration of environmental measures into clinical and translational research projects, and is a member of the NIH All of Us Research Program Advisory Panel. Dr. Miller is the founding editor of the new journal Exposome, published by Oxford University Press.

Lisa Moses, VMD, DACVIM
Harvard Medical School

Lisa Moses is a veterinarian and animal focused bioethicist. After nearly 30 years as a practicing veterinary specialist for the MSPCA Animal Medical Center in Boston, Dr. Moses became a faculty member at Harvard Medical School's Center for Bioethics. Dr. Moses is the chair of both the Animal Ethics Study Group at Yale's Interdisciplinary Center for Bioethics and the Harvard-Yale Animal Ethics Faculty Seminar, and she holds a visiting scientist appointment at The Broad Institute of MIT and Harvard. She completed a fellowship in bioethics at the Harvard Medical School Center for Bioethics and received her veterinary degree from the University of Pennsylvania. She also holds a faculty fellow position at Cummings Tufts School of Veterinary Medicine Center for Animals and Public Policy.
Dr. Moses teaches and studies various aspects of veterinary medical and animal conservation ethics, most recently concentrating on research ethics where animals are both the subject and beneficiary of research investigations.

Elaine A. Ostrander, Ph.D.
National Institutes of Health

I am the Chief of the Cancer Genetics and Comparative Genomics Branch, and a Distinguished Senior Investigator at the National Human Genome Research Institute of the National Institutes of Health. I have published over 375 papers and won several awards, including 2013 Genetics Society of America Medal, and was elected to the National Academy of Sciences in 2019.

My lab is interested in understanding the role that genomic variation plays in canine aging, morphology, behavior and disease susceptibility. Our studies include evolution, genome architecture, breed formation, breed-specific disease, and the genetics of morphologic variation between breeds. Using genome sequencing, we show that most breed-defining traits, such as body size, leg length, etc., are

controlled by small numbers of genes of large effect, and that most are also relevant for human health and biology. Our studies of breed-enriched diseases reveal the genetic underpinnings of disorders such as cancer, and have advanced studies of similar human disorders, while demonstrating the utility of the dog system for studies of human health. Finally, our collaborative studies of aging reveal conserved changes centering on developmental gene networks, which are sufficient to translate age and the effects of anti-aging interventions across multiple mammals. These studies establish methylation as a cross-species translator of the physiological milestones of aging.

Rodney Page, DVM
Colorado State University Flint Animal Cancer Center

Dr. Page received his DVM from Colorado State University and completed specialty training in the field of medical oncology in NYC. Dr. Page is board-certified in Internal Medicine and Oncology. He was a faculty member at North Carolina State University prior to his appointment at Cornell University as the founding director of The Sprecher Institute for Comparative Cancer Research. In 2005 Dr. Page was appointed Chair of the Department of Clinical Sciences Dr. Page returned to Colorado as the Director of the Flint Animal Cancer Center in 2010 (FACC).

Dr. Page's research interests have focused on a 'One Medicine' approach to cancer. He has served as PI of the Golden Retriever Lifetime Study since 2008 (GRLS) and has led national efforts to bring translational and comparative oncology to a greater audience. He is the 2019 recipient of the AVMA/AKC Career Achievement Award in Canine Research.
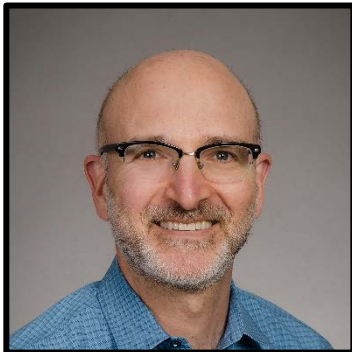
Daniel Promislow, DPhil
University of Washington

Dr. Promislow is a Professor in the Department of Biology and in the Department of Laboratory Medicine & Pathology at the University of Washington. Since receiving his D.Phil. in 1990 at the University of Oxford, he has focused on the study of aging. He began his career on faculty in the Department of Genetics at the University of Georgia from 1995-2013, when he moved to the University of Washington. His research uses evolutionary genetics and systems biology approaches to understand how genes and environment shape aging and age-related disease in natural populations. In addition to his lab-based research in *Drosophila*, Dr. Promislow is Principal Investigator and Co-Director of the Dog Aging Project, an NIH/National Institute on Aging U19-funded nationwide research program to understand the determinants of healthy aging in tens of thousands of companion dogs.

Peter Rabinowitz, **MD, MPH**
University of Washington

Dr. Peter Rabinowitz is a physician and Professor in the University of Washington Schools of Public Health and Medicine. He came to UW 8 years ago to found the UW Center for One Health Research. The Center conducts research and training to explore "One Health" connections between the health of humans, animals, and the environments we share with other species. A key mission of the Center is to find new ways that humans and animals can safely and sustainably coexist in a changing environment.

Audrey Ruple, DVM, MS, PhD, DipACVPM, MRCVS
Virginia Tech University

Dr. Audrey Ruple is an Associate Professor in the Department of Population Health Sciences in the Virginia-Maryland College of Veterinary Medicine at Virginia Tech. Her research focus is in the area of "One Health," the intersection of human, animal, and environmental health. She has a particular interest in comparative biomedical aspects of cancer and aging and she uses companion dogs as a model system to better understand why cancers occur and how we can all – humans and animals – age better. Dr. Ruple is a licensed, clinical veterinarian and is a Diplomate of the American College of Veterinary Preventive Medicine. She obtained her DVM, MS, and PhD degrees from Colorado State University and is a Member of the Royal College of Veterinary Surgeons in the United Kingdom.

Elizabeth Ryan, PhD
Colorado State University

Elizabeth Ryan received her PhD in Toxicology from the University of Rochester School of Medicine and is an Associate Professor in the Colorado State University College of Veterinary Medicine and Biomedical Sciences. She leads a multi-disciplinary lab team that studies environmental exposures, including those from foods for impacts on gut microbiota, mucosal immunity and for protection against infectious and chronic diseases. She conducts cancer research in laboratory models, companion animals and people in connection with cancer control and prevention initiatives at the University of Colorado Cancer Center. Her team implements dietary interventions with rice bran and legumes (e.g. beans, cowpeas) to understand the impacts of these nutrient dense, phytochemical and fiber-rich foods on gut microbiome metabolism. The lab utilizes cutting-edge technologies such as metabolomics to evaluate a suite of microbial and chemical exposures from the diet and environment. Her research on native gut probiotic metabolism of foods and gut associated microbiota in response to dietary interventions across the lifespan is currently supported by NIH, NIFA and the Thrasher Fund.

Norman E. "Ned" Sharpless, MD
National Cancer Institute

Norman E. "Ned" Sharpless, M.D., was officially sworn in as the 15th director of the National Cancer Institute (NCI) on October 17, 2017. Prior to his appointment, Dr. Sharpless served as the director of the Lineberger Comprehensive Cancer Center at the University of North Carolina (UNC).

Dr. Sharpless was a Morehead Scholar at UNC–Chapel Hill and received his undergraduate degree in mathematics. He went on to pursue his medical degree from the UNC School of Medicine, graduating with honors and distinction in 1993. He then completed his internal medicine residency at the Massachusetts General Hospital and a hematology/oncology fellowship at Dana-Farber/Partners Cancer Care, both of Harvard Medical School in Boston. After 2 years on the faculty at Harvard Medical School, he joined the faculty of the UNC School of Medicine in the Departments of Medicine and Genetics in 2002. He became the Wellcome Professor of Cancer Research at UNC in 2012.

Dr. Sharpless is a member of the Association of American Physicians and the American Society for Clinical Investigation, and is a Fellow of the Academy of the American Association of Cancer Research. He has authored more than 160 original scientific papers, reviews, and book chapters, and is an inventor on 10 patents. He cofounded two clinical-stage biotechnology companies: G1 Therapeutics and Sapere Bio (formerly HealthSpan Diagnostics). He served as Acting Commissioner for Food and Drugs at the US FDA for seven months in 2019, before returning to the NCI Directorship.

Wendy C. Shelton, DVM, MPH
Virtual Beast Consulting/Colorado State University

Wendy Shelton brings experience in clinical medicine, medical device, drug development, business development, public health, government policy and project management. She provides strategic expertise regarding the interrelationships of these sectors.

Dr. Shelton began her professional life as a practicing veterinarian after graduating from the University of California at Davis School of Veterinary Medicine in 1981. She was a small animal practitioner and small business owner for over 12 years.

In 1993, Dr. Shelton accepted a position on the Board of Directors of Integrated Surgical Systems, developers and manufacturers of the world's first computer guided surgical robot, ROBODOC®. She stayed with the company in numerous capacities (VP, Research and Development; VP, Medical Affairs; acting CEO) until it went public. There she gained experience: preparing applications for FDA approval, conducting animal and human clinical trials, creating an iso9000 manufacturing facility, and developing a European market for the device. The company was the recipient of the Computerworld-Smithsonian Award for Excellence in Medical IT, and the device was collected by the museum.

Dr. Shelton subsequently spent several years combining part-time equine practice and new therapeutic product development, and then earned her Master of Public Health degree from the UC Davis School of

Medicine. A brief position at the California Department of Health Services, Department of Infectious Diseases, Office of the Public Health Veterinarian, working on West Nile virus surveillance systems followed.

Dr. Shelton was a fully funded Congressional Fellow, sponsored by the American Veterinary Medical Association (AVMA) and placed by the American Association for the Advancement of Science (AAAS) in the office of Senator Joseph Lieberman of Connecticut in 2004-2005. While in the Senator's office, she participated in the genesis of Senate Bill 975, or BioShield II, the massive legislative initiative designed to create a countermeasures industry to address both bioterror and naturally occurring public health threats, and was primary author of several titles.

From Capitol Hill, Dr. Shelton was recruited to Fabiani & Company, a DC lobbying firm where she helped build a practice that matched growing life sciences companies with government funding sources. She advised dozens of healthcare, drug, device, and product companies and academic institutions regarding government and business relations and helped secure over $250 million in grants and contracts over five years.

More recently, Dr. Shelton worked in Silicon Valley developing veterinary applications for *in silico* biosimulation models. She served as Vice President of Corporate Communications, Government Relations, and Veterinary Applications at Entelos Holding Corporation in San Mateo for over two years - engaging Mars Petcare to create a virtual dog.

Dr. Shelton is the founding principal of Virtual Beast Consulting (VBC) based in Truckee, California. Areas of focus include promotion of the study of companion animals as research models to improve understanding of human and animal diseases and treatments – the embodiment of the One Medicine/One Health concept. An example of this is the National Cancer Policy Forum's 2015 workshop entitled "The role of Clinical Studies for Pets with Naturally Occuring tumors in Translational Cancer Research" initiated by VBC's principal on behalf of the Flint Animal Cancer Center at Colorado State University (CSU). Dr. Shelton continues to consult with CSU providing strategic support for Comparative Oncology and One Health, actively representing Flint in the recently formed CORC – the Comparative Oncology Research Consortium that pairs Veterinary Schools and National Cancer Institute(NCI) Designated Cancer Centers for research funding, and is now collaborating with the National Academies on another workshop: "The role of Companion Animals as Sentinels for Predicting Environmental Exposure Effects on Aging and Cancer susceptibility in Humans". Dr. Shelton also represents CSU with the CTSA One Health Alliance, serving on the Advocacy Subcommittee.

Heather M. Stapleton, PhD
Duke University

Professor Heather Stapleton is an environmental chemist and exposure scientist in the Nicholas School of the Environment at Duke University. Her research interests focus on identification of halogenated and organophosphate chemicals in consumer products and building materials and estimation of human exposure, particularly in vulnerable populations such as pregnant women and children. Her laboratory specializes in analysis of environmental and biological tissues for organic contaminants to support environmental health research. Her research projects seek to understand how chronic exposure to

chemical mixtures impact human health, with an emphasis on elucidating effects on thyroid hormone dysregulation and associations with thyroid disease. She received an early career award from the NIEHS in 2008, called the Outstanding New Environmental Scientist (ONES) award which helped to propel her research career. In 2012 she testified in front of the US Senate Environment & Public Works committee on human exposure and toxicity of new-use flame retardant chemicals used in commerce and in 2014 she helped to develop a resource for the general public to support free testing for flame retardant chemicals in consumer products.   Currently serves as the Director for the Duke Superfund Research Center, and Director of the Duke Environmental Analysis Laboratory.

Anne Thessen, PhD
University of Colorado Anschutz Medical Campus

Dr. Anne Thessen is a Visiting Associate Professor at the University of Colorado Anschutz Medical Campus. She received her PhD in oceanography and shifted toward data science while working for the Encyclopedia of Life and the Census of Marine Life. Later she started her own data science consulting company and operated that for 5 years before joining the Translational and Integrative Sciences Lab under Dr. Melissa Haendel.

Frank A. von Hippel, PhD
University of Arizona

Frank A. von Hippel is a professor of environmental health sciences in the Mel & Enid Zuckerman College of Public Health and the lead of the One Health Research Initiative at the University of Arizona. Frank was born and raised in Alaska, received his A.B. in biology at Dartmouth College in 1989, and his Ph.D. in integrative biology at the University of California, Berkeley in 1996. He taught for Columbia University (1996-1999), the University of Alaska Anchorage (2000-2016), and Northern Arizona University (2016-2021) before moving to the University of Arizona in 2021. Frank has taught ecology field courses in over twenty countries, and conducted research in the Americas, Africa and Australia. He conducts research at the nexus of ecotoxicology, mechanisms of toxicity, and health disparities, with a focus on Indigenous and underserved communities. Frank is the author of *The Chemical Age* (University of Chicago Press, 2020; https://frankvonhippel.github.io/pubs.html) and he is the creator and host of the Science History Podcast (https://podcasts.apple.com/us/podcast/science-history-podcast/id1325288920).

Joseph Wakshlag, PhD, MS
Cornell University

Dr. Joseph Wakshlag started his academic career receiving a BS and MS from Montclair State University. He then attended Cornell College of Veterinary Medicine graduating in 1998. He continued his residency training in both pathology and nutrition, as well as receiving his PhD in Pharmacology in 2005. He is became a diplomate in the College of Veterinary Nutrition in 2008 and furthered his board certification as a diplomate in the College of Veterinary Sports Medicine and Rehabilitation in 2010 and is currently a Professor at Cornell University College of Veterinary Medicine. He has been teaching both basic veterinary nutrition and small animal clinical nutrition at the Cornell College of Veterinary Medicine for nearly 20 years since his residency in Small Animal Clinical Nutrition. He is current the Service Chief for Clinical Nutrition at the College and also does service work for the Sports Medicine and Rehabilitation Service at the Cornell University Hospital for Animals. His background in sports medicine and nutrition has produced many publications on working dogs, obesity, canine cancer cell biology, the canine GI microbiome and arthritis management.

Cheryl Lyn Walker, PhD
Baylor College of Medicine

Dr. Cheryl Lyn Walker holds the Alkek Presidential Chair in Environmental Health and is the founder and Director of the Center for Precision Environmental Health at Baylor College of Medicine in Houston, TX. She also directs the NIEHS P30 Gulf Coast Center for Precision Environmental Health (https://gc-cpeh.org). Dr. Walker has >200 publications in the scientific literature and is an elected member of the National Academy of Medicine. Her research on gene:environment interactions and environmental epigenomics has led to new insights into how early-life exposures reprogram the developing epigenome to alter disease susceptibility across the life-course. She has been recognized with the Roy O. Greep Laureate Award from the Endocrine Society, Leading Edge in Basic Science Award from the Society of Toxicology (SOT), and the Distinguished Scientist Award from the American College of Toxicology. In addition to her research accomplishments, she has held significant professional administrative and leadership positions including President of SOT, President of Women in Cancer Research for the American Association for Cancer Research (AACR), and was the founding Chair of the Systemic Injury from Environmental Exposures (SIEE) Study Section for the Center for Scientific Review of the NIH. Dr. Walker has also served on the Boards of Scientific Advisors and Scientific Councilors of the National Cancer Institute and National Toxicology Program.

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POSTER SESSION
FOR THE NATIONAL ACADEMIES WORKSHOP ON
THE ROLE OF COMPANION ANIMALS AS SENTINELS
FOR PREDICTING ENVIRONMENTAL EXPOSURE EFFECTS
ON AGING AND CANCER SUSCEPTIBILITY IN HUMANS

The poster session will have both virtual and in-person poster presentations.

VIRTUAL POSTER SESSION: during the workshop lunch breaks

- **12:15-1:30 pm ET on DECEMBER 1ST**
- **12:00-1:15 pm ET on DECEMBER 2ND**

Poster presenters will be available in Zoom breakout rooms for at least the first 30 minutes
of the virtual poster session.
https://nasem.zoom.us/j/95073801945

IN-PERSON POSTER SESSION: during the workshop receptions

- **5:30-7 pm ET on DECEMBER 1ST**
- **5:00-6:30 pm ET on DECEMBER 2ND**

Poster presenters will be available at their posters for at least the first 30 minutes
of the in-person poster session.

Poster recordings: https://bit.ly/3Dq9hca

POSTER TITLE

A Systemic Multidisciplinary Approach to Study Aging in Retired Sled Dogs

AUTHORS

Ekaterina Andrianova[1], Daria Fleyshman[1], Joseph Wakshlag[2], Heather Huson[2], John Loftus[2], Natasha Olby[3], Leonid Brodsky[4], Andrei Gudkov[1,5]

[1]Vaika, Inc., (Buffalo, NY) [2]Cornell University (Ithaca, NY); [3]North Carolina State University (Raleigh, NC); [4]University of Haifa (Israel); [5]Roswell Park Comprehensive Cancer Center (Buffalo, NY)

PRESENTING AUTHORS

Ekaterina Andrianova and Andrei Gudkov

ABSTRACT

Canines represent a valuable model for mammalian aging studies as large animals with short lifespans, allowing longitudinal analyses within a reasonable time frame. Moreover, they develop a spectrum of aging-related diseases resembling that of humans, are exposed to similar environments, and have been reasonably well studied in terms of physiology and genetics. To overcome substantial variables that complicate studies of privately-owned household dogs, we have focused on a more uniform population composed of retired Alaskan sled dogs that shared similar lifestyles, including exposure to natural stresses, and are less prone to breed-specific biases than a pure breed population. To reduce variability even further, we have collected a population of 103 retired (8-11 years-old) sled dogs from multiple North American kennels in a specialized research facility named Vaika. Vaika dogs are maintained under standardized conditions with professional veterinary care and participate in a multidisciplinary program to assess the longitudinal dynamics of aging. The established Vaika infrastructure enables periodic gathering of quantitative data reflecting physical, physiological, immunological, neurological, and cognitive decline, as well as monitoring of aging-associated genetic and epigenetic alterations occurring in somatic cells. In addition, we assess the development of age-related diseases such as arthritis and cancer. In-depth data analysis, including artificial intelligence-based approaches, will build a comprehensive, integrated model of canine aging and potentially identify aging biomarkers that will allow use of this model for future testing of antiaging therapies.

Canine Nasal Tumors as a Sentinel for Environmental Exposure and Human Cancer Risk in Kansas and Surrounding States

AUTHORS

Chieko Azuma, DVM, PhD, DACVR (Radiation Oncology), CPIA, Clinical Associate Professor, Department of Clinical Sciences, College of Veterinary Medicine, Kansas State University

Mary Lynn Higgnbotham, DVM, MS, DACVIM (Oncology), Associate Professor, Department of Clinical Sciences, College of Veterinary Medicine, Kansas State University

Raghavendra Amachawadi, BVSc, MS, PhD, Associate Professor, Department of Clinical Sciences, College of Veterinary Medicine, Kansas State University

Timothy Walsh, DVM, DACVP, Clinical Professor, Kansas State Veterinary Diagnostic Laboratory, College of Veterinary Medicine, Kansas State University

PRESENTING AUTHOR

Chieko Azuma (virtually)

https://bit.ly/3crIkZY

ABSTRACT

The nasal cavity is a common site for malignant tumor development in dogs and has potential to be a valid model for the study of environmental exposure effects and human cancer susceptibility. Dogs and humans share the same environment, but the route of exposure to chemicals may be different. Dogs aggressively sniff fields for long periods of time, especially working and herding breeds, potentially resulting in highly concentrated chemical exposure during their life-time. Kansas and surrounding States offer unique geography suitable for large-scale farming which may provide opportunities to examine effects of chemical use and cancer incidence. The purpose of this on-going study is to investigate geographic distribution and change of incidence of canine nasal tumors in the state of Kansas and surrounding areas.

We hypothesize that dogs that live in Kansas and near-by states have exposure to field chemicals and have an increased risk of developing nasal tumors. Dogs histologically diagnosed with nasal malignancy in the States of Kansas, Nebraska and Missouri were searched in the Kansas State Veterinary Diagnostic Laboratory (KSVDL) database and Veterinary Health Canter database between 2005 and September 2021. All histology reports were reviewed and clinical information was utilized to supplement patient information when available. Other data collected included breed of dog, age at tumor identification and zip code location of the owner. Nasal tumor cases were mapped using the zip code data using Geographic Information System (GIS) software (Esri Software). A total of 387 nasal tumor cases were identified. The study is ongoing and association between canine nasal tumor incident and GIS public information on chemical use, human cancer incidence and other environmental data will be examined to identify environmental exposure effects and cancer susceptibility.

Once-Daily Feeding is Associated with Better Cognitive Function and Health in Companion Dogs: Results from the Dog Aging Project

AUTHORS

Emily E. Bray – Postdoctoral Research Associate, University of Arizona and Canine Companions for Independence

Zihan Zheng – Graduate Student, University of Washington

M. Katherine Tolbert – Clinical Associate Professor, Texas A&M University

Brianah M. McCoy – Graduate Student, Arizona State University

Dog Aging Project Consortium

Matt Kaeberlein – Professor, University of Washington

Kathleen F. Kerr – Professor, University of Washington

PRESENTING AUTHOR

Emily E. Bray (virtually)

https://bit.ly/3Fwta23

ABSTRACT

A variety of diets have been studied for possible anti-aging effects. In particular, studies of isocaloric time-restricted feeding in laboratory rodents have found evidence of beneficial health outcomes. Companion dogs represent a unique opportunity to study diet in a large mammal that shares human environments. The Dog Aging Project has been collecting data on thousands of companion dogs of all different ages, sizes, and breeds since 2019. We leveraged this diverse cross-sectional dataset to investigate associations between feeding frequency and cognitive function (n = 10,474) as well as nine broad categories of health outcomes (n =24,238). Controlling for sex, age, breed, and other potential confounders, we found that dogs fed once daily rather than more frequently had lower mean scores on a cognitive dysfunction scale, and lower odds of having gastrointestinal, dental, orthopedic, kidney/urinary, and liver/pancreas disorders. Therefore, our findings suggest that once-a-day feeding in dogs is associated with improved health across multiple body systems.

POSTER TITLE

Dogs of Chernobyl: A Model for Human Health Effects Arising from Chronic Exposure to Radiation, Heavy Metals, and Other Environmental Toxins.

AUTHORS

Megan N. Dillon[1], Norman J. Kleiman, PhD[2], Martha O. Burford Reiskind, PhD[1], Tim Mousseau, PhD[3], Matthew Breen, PhD[4,5,6]

[1] Department of Biological Sciences at North Carolina State University, Raleigh, NC 27695, USA

[2] Department of Environmental Health Sciences, Mailman School of Public Health, ColumbiaUniversity Irving Medical Center, New York, NY 10032, USA

[3] Department of Biological Sciences, University of South Carolina, Columbia, SC 29208, USA

[4] Department of Molecular Biomedical Sciences, College of Veterinary Medicine, ComparativeMedicine Institute, Center for Human Health and the Environment North Carolina State University, Raleigh, NC 27695, USA

[5] Cancer Genetics, UNC Lineberger Comprehensive Cancer Center, Chapel Hill, NC 27514, USA

[6] Duke Cancer Institute, Durham, NC 27710, USA

PRESENTING AUTHOR

Megan N. Dillon

https://bit.ly/3Hrp5xl

ABSTRACT

In 1986, a steam explosion at the Chernobyl Nuclear Power Plant (NPP) destroyed reactor 4, releasing hundreds of tons of radioactive debris into the atmosphere, and contaminating surrounding regions of Ukraine, Belarus, and Russia with more than 10^{18} Bq of various radioisotopes. Within 48 hrs, authorities evacuated ~50,000 residents of Pripyat, and thousands of others from dozens of towns and villages within a 30 km radius of the NPP. To limit the spread of radiation, teams of "Liquidators" eliminated agricultural livestock and pets left behind. Nevertheless, some dogs escaped destruction. Today, a population of several hundred semi-domesticated animals live around the NPP and Chernobyl City, receiving handouts from several thousand workers still employed there. The region is still heavily contaminated by 137-Cs, 90-Sr, heavy/toxic metals, organics, and chemicals left over from decontamination efforts, deconstruction, and 35 years of decay of this former industrial complex as well as a nearby military base. Genetic effects of these toxic exposures on the resident canine population are still unclear. Two populations of semi-feral dogs; one living around the NPP and another living ~18 km away in Chernobyl City are being studied. Preliminary analyses highlight genetic differences between these populations. We hope to 1) identify local adaptations, methylation differences, and differential expression across the exposure gradient and, 2) relate these genetic impacts of chronic exposures on animal health. The subsequent Fukushima nuclear disaster, as well as potential future large-scale nuclear or industrial accidents, highlights an urgent need to better understand how such exposures can adversely impact the genome and epigenome. Findings from the dogs of Chernobyl study are likely to provide vital insights concerning identification of biomarkers of human exposure that can predict subsequent adverse health outcomes after future environmental disasters.

A Study of Citizen Science Supported Wearable and Non-Contact Systems for Quantifying Canine Behavioral and Physiological Response Profiles to Potential Risk Factors of Cancer and Aging in Humans

AUTHORS

Timothy Holder, Emily Summers, Evan Williams, Marc Foster, Zach Cleghern, James Dieffenderfer, Parvez Ahmmed, David Roberts, Alper Bozkurt

PRESENTING AUTHORS

Timothy Holder and Emily Summers (virtually)

https://bit.ly/3wWY40i

ABSTRACT

Animal companions are becoming increasingly common in human life and carry great potential to serve as sentinels to detect potential risk factors for aging and cancer complications, especially in oncology units. Some canines are even reported to detect cancer in patients and many pet dogs can sense decreased health or affect in their owners. This detection can lead to increased sniffing and licking in addition to other behavioral and physiological responses in the dog. These response profiles from the dog can warn the dyad to potential early warning signs and, if given access to the relevant information, alert medical staff to an incipient risk event.

There is a critical need for engineering methods and novel technologies that can enable a quantified understanding of human and canine physiological states. These allow us to objectively probe the dog's ability to identify the aforementioned potential risk behaviors more accurately and efficiently. Here, we present our preliminary efforts towards the development of wireless sensor systems to simultaneously detect the related behavioral (activity level, movement, vocalizations), physiological signals (heart rate, respiratory rate and their variability), and environmental factors (ambient sound, light, temperature and humidity levels, barometric pressures) around and of humans and animals during their normal interactions. These systems are comprised of both wearable and non-contact electronic devices and provide three categories of signals (i.e. behavioral, physiological, environmental) that have profound immediate and potential implications for detecting aging and cancer related phenomena. In our preliminary exploration, we assessed these relevant parameters successfully and identified the design challenges towards deployment of these systems in larger clinical studies aimed at instrumenting animals to act as sentinels.

Golden Retriever Lifetime Study: Progress and Prospects

AUTHORS

Julia Labadie[1], Mara DePena[2], Rodney Page[3], Kathy Tietje[4], Janet Patterson-Kane[5]

[1]Veterinary Epidemiologist, Morris Animal Foundation, Denver, CO; presenting author

[2]Veterinary Research Manager, Morris Animal Foundation, Denver, CO

[3]Director, Flint Animal Cancer Center, Colorado State University, Fort Collins, CO

[4]Vice President of Scientific Operations, Morris Animal Foundation, Denver, CO

[5]Chief Scientific Officer, Morris Animal Foundation, Denver, CO

PRESENTING AUTHOR

Julia Labadie (virtually)

https://bit.ly/3oCigkt

ABSTRACT

The Golden Retriever Lifetime Study is the largest, most comprehensive longitudinal veterinary cohort study, following 3,044 golden retrievers in the contiguous United States. The primary aim of the study is to investigate nutritional, environmental, lifestyle, and genetic risk factors for cancer and other common diseases in dogs, with an emphasis on four cancer types: lymphoma, osteosarcoma, hemangiosarcoma, and high-grade mast cell tumors. Rolling enrollment of dogs aged 6 months through 2 years was conducted from June 2012 through April 2015. Extensive annual questionnaires completed by owners and veterinarians obtain information about lifestyle, environmental exposures, physical activity, reproductive history, behavior, diet, medications, and diagnoses. Dogs also have annual veterinary examinations and biospecimen collection (whole blood, serum, hair, nails, feces, urine) for laboratory analysis and biobanking. As of June 1, 2021, there have been 224 diagnoses of the primary cancers of interest: 120 hemangiosarcomas, 85 lymphoma/leukemias, 10 high-grade mast cell tumors, and 8 osteosarcomas. Many other disorders common in golden retrievers have also been diagnosed, such as otitis externa, atopy, hypothyroidism, cataracts, and orthopedic disorders. The study has had high retention, with 2,251 dogs remaining in the study, 441 lost to follow-up, and 352 deceased. Among the deaths, 70% (n=248) have been attributed to cancer and 62% (n=218) have had a full or partial necropsy. The biorepository currently contains baseline DNA for all participants as well as approximately 19,000 of each sample collected: whole blood, serum, urine, feces, hair, and nails. A subset of questionnaire data is freely available to researchers with approved credentials who agree to a data use agreement. In addition, both academic and private sector researchers can apply to access data and/or biospecimens through our request for proposal process. More information can be found at https://www.morrisanimalfoundation.org/golden-retriever-lifetime-study.

The Link Between Environment, Age, and Health in a Large Cohort of Companion Dogs from the Dog Aging Project

AUTHORS

Brianah M. McCoy (Ph.D. Student) – School of Life Sciences, Arizona State University, Tempe, AZ, USA
Layla Bressington (Masters Student) – School of Life Sciences, Arizona State University, Tempe, AZ, USA
Dr. Kelly Jin – Allen Brain Institute, Seattle, WA, USA,
Devin Collins (Masters Student) – Department of Sociology, University of Washington, Seattle, WA, USA
Dr. Matthew Dunbar – Center for Studies in Demography & Ecology, University of Washington, Seattle, WA, USA
Sandi Shrager – Collaborative Health Studies Coordinating Center Department of Biostatistics,   University of Washington, Seattle, WA, USA
Dr. Noah Snyder-Mackler – School of Life Sciences, Arizona State University, Tempe, AZ, USA

PRESENTING AUTHOR

Brianah McCoy

https://bit.ly/3FqVx1j

ABSTRACT

Exposure to social environmental adversity strongly predicts health and survival in many species such as non-human primates, wild mammals, and humans. However, little is known about how the health and mortality effects of these social determinants vary across the lifespan. Using the companion dog, which serves as a powerful comparative model for human health and aging due to our shared biology and environment, we examined which components of the social environment impact health, and how the effects vary with age, in dogs. We first drew on detailed survey data from owners of 27,547 dogs from the Dog Aging Project and identified six factors that together explained 27% of the variation in dog's social environment. These factors all predicted measures of health, disease, and mobility, when controlling for dog age and weight. Factors capturing measures of financial and household adversity were linked to poorer companion dog health, while factors associated with social companions, like dogs and adults, were linked to better health. Interestingly, some of these effects differed across a dog's lifespan: for instance, the effect of owner age on general health was strongest in younger dogs. Together, our findings point to similar links between adversity and health in companion dogs and set up future work on the molecular and biological changes associated with environmental variation in order to identify ways to mitigate or even reverse the negative environmental effects.

Poster Title

Subjective Assessment of Companion Dog Vision Shows an Age-Related Decline: Preliminary Findings

Authors

Freya Mowat, BVSc. Ph.D., Assistant Professor[1,2,]
Leah Russell[1], Ceylan Ersoz[1], Michele Salzman, BS, MS[1]

[1]Surgical Sciences, School of Veterinary Medicine, University of Wisconsin-Madison, Madison, WI
[2]Ophthalmology and Visual Sciences, School of Medicine and Public Health, University of Wisconsin-Madison, Madison, WI

Presenting Author

Freya Mowat

https://bit.ly/3npxzNY

Abstract

There are well-validated visual function questionnaires for humans that are associated with a clinically measurable decline in visual ability with age, most notably in low luminance vision. The purpose of our study was to examine the association between companion dog age and subjective assessment of visual function using a previously validated human owner canine visual function questionnaire and a novel human owner canine visual function questionnaire that enquired about dog visually mediated behavior in different lighting conditions.

We disseminated a questionnaire by mail or digital means to previous participants in a human longitudinal study of aging. Of the 899 responses to-date, 53% (n = 487) disclosed they did not currently own a dog, and 24% (n = 212) consented to participate. In this preliminary analysis, we performed multivariate analysis (JMP 15.0) comparing age with visual function questionnaire scores.

Purebred dogs represented 45% of the sample, and females represented 50% of the sample. Median age was 92 months (7.7 years; range 6-202 months). The previously validated canine visual function questionnaire score positively correlated with age (R^2 0.2, $P < 0.0001$). The newly developed visual function questionnaire scores for behavior in different lighting intensities also correlated with age (overall score R^2 0.15, $P<0.0001$). The association between age and owner assessment score in bright lighting conditions (R^2 0.11, $P<0.0001$) was poorer than that in dim lighting conditions (R^2 0.13, $P < 0.0001$) and dark lighting conditions (R^2 0.15, $P<0.0001$).

In this preliminary analysis, subjective human-owner assessment of canine visual function declines in association with dog age. Similar to aging humans, dim light vision in dogs subjectively declines with age. Future studies will examine the age-related decline in clinically measurable visual ability, retinal structure and function, in addition to exploring potential environmental risk factors that might exacerbate visual decline with aging.

Dog Size and Patterns of Disease History Across the Canine Age Spectrum

AUTHORS

Yunbi Nam, Department of Biostatistics, University of Washington, Seattle, WA, USA. (Presenting author)
Michelle White, Program in Molecular Medicine, University of Massachusetts Medical School, Worcester, MA, USA., The Broad Institute of Harvard and MIT, Cambridge
Elinor Karlsson, Bioinformatics and Integrative Biology, University of Massachusetts Chan Medical School, Worcester, MA, USA., Broad Institute of MIT and Harvard, Cambridge, MA, USA.
Kate E. Creevy, Department of Small Animal Clinical Sciences,Texas A&M University College of Veterinary Medicine & Biomedical Sciences, College Station, TX, USA.
Daniel Promislow, Department of Laboratory Medicine and Pathology, University of Washington School of Medicine, Seattle, WA, USA., Department of Biology, University of Washington, Seattle, WA, USA.
Robyn McClelland, Department of Biostatistics, University of Washington, Seattle, WA, USA.

PRESENTING AUTHOR

Yunbi Nam

https://bit.ly/3CuRr6G

ABSTRACT

It is widely known that both age and size are major predictors of risk of many diseases in dogs. However, more studies on which conditions manifest differently across age and size has been needed. The Dog Aging Project provides a unique opportunity to address these issues in a large community-based population of companion dogs. We used data from the curated 2020 release of the data containing 27,541 survey records collected on or before December 31st, 2020. Dog owners are asked questions if their dogs have ever been diagnosed with various medical conditions. Among those conditions asked, we focused on thirteen conditions of interest that were present in 500 or more dogs. For skin conditions, each SD increment (4 years) of age was associated with a 29% greater relative prevalence of a reported history of skin conditions (PR 1.29, 95% CI 1.27-1.31, p<0.001). Prevalence also increased with the owner-reported weight of the dog, with each SD increment (13 kgs) associated with 12% higher relative prevalence of skin condition history (PR 1.12, 95% CI 1.10-1.14, p<0.001). There was no significant interaction between age and weight (p=0.02) indicating that larger dogs reported skin conditions more often by a similar relative margin across the age spectrum. On the other hand, dog weight was inversely associated to prevalence of a history of cardiac conditions, with each SD increment in size reducing prevalence by a third (PR 0.67, 95% CI 0.63-0.71, p<0.001). Additionally, we observed a significant interaction where the prevalence was not only higher for smaller dogs but was associated with a significantly steeper increase in prevalence across age groups. Several disease categories and individual diagnoses vary in prevalence across size groups. These differences will help us understand the trend of decreasing longevity with increasing size in the domestic dog.

Detecting Low-Frequency Precancerous Mutations in Companion Dogs Using Duplex Sequencing Technology.

AUTHORS

Ashley Paynter, Maria Partida-Aguilar, Rosana Risques, Scott Kennedy, Daniel Promislow
Institution: University of Washington

PRESENTING AUTHOR

Ashley Paynter

ABSTRACT

Neoplastic disease is the leading cause of canine mortality in the United States. The most common type of cancer is lymphoma, with ~ 80,000 cases diagnosed annually. Breeds vary tremendously in the relative risk of cancer. However, we are far from understanding the underlying causes of this variation despite considerable effort to identify the genetic determinants of cancer risk and progression in dogs. Cancer typically arises from the accumulation of somatic mutations. However, variation among breeds in cancer risk could be due to breed-specific variation in the types of mutations, the rate of accumulation of mutations, or the downstream effects of mutations in healthy dogs. Lack of clear support from a specific hypothesis represents a major gap in our understanding. Here we took advantage of cutting-edge Duplex Sequencing technology to test the hypothesis that breed-specific variation in lymphoma risk is due to variation in the frequency and type of rare precancerous mutations. Normally, detecting these very low-frequency mutations is beyond the range of sensitivity of standard sequencing technology. This technology will allow us to compare precancerous mutation frequency in blood lymphocytes of healthy high-risk versus low-risk companion dogs. Duplex Sequencing is an extremely high-accuracy sequencing approach with an error rate of approximately 5×10^{-8}/base, a more than 10,000-fold improvement over standard sequencing technologies. This work has the potential to shed light on the mechanisms that underlie breed-specific variation in lymphoma risk, and in the long term, could lead to the development of novel tests for the early diagnosis and prognosis of canine lymphoma.

Dogs and Humans Share Unique Gene Expression Signatures in the Macular and Peripheral Retina

AUTHORS

Michele M. Salzman[1], Tetsuya Takimoto[2], Melanie Foster[3], and **Freya M. Mowat[1,4]**

[1]Surgical Sciences, School of Veterinary Medicine, University of Wisconsin-Madison, Madison, WI

[2]Medical Genetics, University of Wisconsin-Madison, Madison, WI

[3]College of Veterinary Medicine, North Carolina State University, Raleigh, NC

[4]Ophthalmology and Visual Sciences, School of Medicine and Public Health, University of Wisconsin-Madison, Madison, WI

PRESENTING AUTHOR

Michele M. Salzman

https://bit.ly/32iEMaF

ABSTRACT

BACKGROUND
The macula is a photoreceptor-enriched region of the central retina in humans, critical for high quality vision, and susceptible to age-related disease. The tissues that support the retina include the retinal pigmented epithelium (RPE) and choroid. Previous work using normal human donor eyes determined the macula has unique gene expression signatures compared to the periphery, with 2,051 differentially expressed (DE) genes in the macular retina and 926 DE genes in the macular RPE/choroid. We have shown that the dog also has a central photoreceptor-enriched macula-like region, whereas laboratory rodents lack a similar region. We hypothesized that the dog macula would also have unique gene expression signatures.

METHODS
We performed RNASeq on dog macular and peripheral retina and supporting tissues from post-mortem eyes (n = 4 eyes), then performed quantitative RT-PCR of key pathway genes that were differentially expressed (n = 5 eyes).

RESULTS
The photoreceptor-enriched macula-like region in the dog has unique gene expression signatures, with 1,490 DE genes in the macular retina and 767 DE genes in the macular RPE/choroid. The majority of DE genes were up-regulated in the macula compared to the periphery. In both the retina and RPE/choroid, the top KEGG pathway (DAVID-WS) was neuroactive ligand-receptor interaction. In addition, genes involved in drug metabolism and the visual cycle were DE. Quantitative RT-PCR confirmed the up- or down-regulation of key genes important for vision, including cytochrome P450 (*CYP24A1*), and genes involved in retinol recycling (*ALDH1A1, RDH10*).

CONCLUSIONS
Our work adds to the growing body of evidence drawing similarities between canine and human neurologic tissues. Future directions include the study of structural and functional decline in the canine visual system with aging and in association with environmental neurodegenerative risk factor exposure such as heavy metals.

Lifetime Prevalence of Malignant and Benign Tumors in Companion Dogs: Analysis of Dog Aging Project (DAP) Baseline Survey

AUTHORS

Stephen M. Schwartz, [1,2] PhD, MPH; **Silvan R. Urfer,** [3] Dr. med. vet.; **Michelle White,** [4,5] DVM, PhD; **Kate Megquier,** [5] DVM, PhD; **Sandi Shrager,** [6] MSW; **The Dog Aging Project Consortium;** [3] **Audrey Ruple,** [7] DVM, MS, PhD

[1] Epidemiology Program, Fred Hutchinson Cancer Research Center, Seattle, WA, 98115

[2] Department of Epidemiology, University of Washington, Seattle, WA, 98195

[3] Department of Laboratory Medicine and Pathology, University of Washington, Seattle, WA, 98195

[4] Program in Molecular Medicine, University of Massachusetts Medical School, Worcester, MA, 01605

[5] The Broad Institute of Harvard and MIT, Cambridge, MA, 02142

[6] Department of Biostatistics, University of Washington, Seattle, WA 98195

[7] Department of Population Health Sciences, Virginia-Maryland College of Veterinary Medicine, Virginia   Tech, Blacksburg, VA 24061

PRESENTING AUTHORS

Stephen M. Schwartz (virtually) and Audrey Ruple (in-person)

https://bit.ly/3FqvOGr

ABSTRACT

Although cancer is a major contributor to canine morbidity and mortality, its frequency in companion dogs has not been robustly characterized. We analyzed data from the baseline survey of owners of 27,541 living companion dogs enrolled in the Dog Aging Project as of December 31 2020 to estimate the lifetime prevalence of malignant and non-malignant tumors and several potentially-associated characteristics. Survey questions elicited information on history of "cancer or tumors" including organ site and histologic type. Owners reported 819 malignant tumors (56% sited in the skin, muscle, or other soft tissue) and 404 benign tumors (69% sited in the skin, muscle, or other soft tissue). The lifetime prevalence of malignant tumors (29.7/1000 dogs) was approximately double the lifetime prevalence of non-malignant tumors (14.7/1000 dogs). Lifetime prevalence of both malignant and non-malignant tumors increased with dog age at survey completion. There were no statistically discernable differences in age-adjusted lifetime prevalence of malignant (prevalence ratio (PR) = 0.93 [95% confidence interval (CI) 0.82, 1.07] or non-malignant tumors (PR=1.10, 95% CI 0.91, 1.34) in mixed vs. purebred dogs. The lifetime prevalence of malignant tumors increased with increasing dog size class; compared to toy and small dogs, the age-adjusted PRs (95% CIs) for medium, standard, large, and giant dogs were 1.65 (1.28, 2.11), 2.92 (2.35, 3.64), 3.67 (2.92, 4.62) and 2.99 (1.23, 4.02), respectively. Similar though less pronounced patterns in relation to dog size were observed for non-malignant tumors. Our reliance on owner-reported histories of their dog's tumor organ site and histologic type most likely underestimates lifetime prevalence, particularly for animals with "internal" malignancies for which no definitive diagnostic procedure was performed or that were not successfully treated. Ongoing prospective data collection for these dogs (and additional dogs to be enrolled in the Dog Aging Project) will permit future studies on risk factors for canine tumor incidence.

Mutagenic Environmental Chemical Exposures in the Urine of Dogs and People Sharing the Same Households

AUTHORS

Kaitlyn Craun,[1] Hannah Peterson,[1] Kristofer Ross Luethcke,[1] Martin Shafer,[2] Noel Stanton,[2] Chen Zhang,[2] James Schauer,[2] Kristen Malecki,[3] Lauren Trepanier[1]

[1] Department of Medical Sciences, School of Veterinary Medicine;

[2] Wisconsin State Laboratory of Hygiene;

[3] Department of Population Health Sciences, School of Medicine and Public Health, University of Wisconsin-Madison

PRESENTING AUTHOR

Lauren Trepanier

https://bit.ly/3codSQ6

ABSTRACT

Urothelial carcinoma (UCC) develops in both humans and dogs and tracks to regions of high industrial activity. We hypothesize that dogs with UCC may act as sentinels for human urothelial carcinogen exposures. The aim of this study was to determine whether healthy people and dogs in the same households share urinary exposures to potentially mutagenic chemical carcinogens. We measured urinary concentrations of acrolein (as its metabolite 3-HPMA), arsenic species, 4-aminobiphenyl, and 4-chlorophenol (a metabolite of the phenoxy herbicide 2,4-D) in healthy dogs and their owners. Biomarkers of urinary exposure to acrolein, arsenic, and 4-chlorophenol were found in the urine of 42 pet dogs and 42 owners, with 4-aminobiphenyl detected sporadically. Creatinine-adjusted urinary chemical concentrations were significantly higher, by 2.8- to 6.2-fold, in dogs compared to humans. Correlations were found for 3-HPMA ($r = 0.32$, $P = 0.04$) and monomethylarsonic acid ($r = 0.37$, $P = 0.02$) between people and their dogs. Some healthy individuals (3 of 42; 7.1%) and dogs (2 of 42; 4.8%) had evidence of urinary exposure to concentrations of acrolein or inorganic arsenic that led to DNA damage, as measured by the H2AX assay, in human (HT-1376) and canine (K9TCC) urothelial cell lines *in vitro.* We conclude that healthy people and their pet dogs share urinary exposures to known mutagenic chemicals, with significantly higher levels in dogs. Higher urinary exposures to acrolein and arsenic in dogs correlate to higher exposures in their owners, and some individuals of both species reached concentrations that are mutagenic to urothelial cells. Ongoing studies will evaluate these chemicals in the urine of dogs with UCC as well as their owners.

Canine Fur: An Underutilized Specimen to Advance Companion Animals as Sentinels for Monitoring Environmental Exposure and Disease Susceptibility in Humans

AUTHORS

Robert J. Turesky[1,2], Jingshu Guo[1,2], Joe Koopmeiners[1,3], Scott J. Walmsley[1,4], Paari Murugan[5], Jaime F. Modiano[1,6], and Christopher J. Weight[7,8]

[1]Masonic Cancer Center

[2]Department of Medicinal Chemistry,

[3]Division of Biostatistics,

[4]Institute for Health Informatics,

[5]Department of Laboratory Medicine and Pathology,

[6]Animal Cancer Care and Research Program, College of Veterinary Medicine, and

[7]Department of Urology, University of Minnesota, Minneapolis, MN,

[8]Department of Urology, Cleveland Clinic, Cleveland, OH

PRESENTING AUTHOR

Robert J. Turesky (virtually)

https://bit.ly/30DHbfb

ABSTRACT

Hair is a non-invasive long-lived biospecimen that accrues illicit drugs and hazardous chemicals in the environment, foods and beverages, personal care products, packaging materials, pesticides, and herbicides. Some of these chemicals are neurotoxic, endocrine disruptors, or cancer-causing agents. We developed a sensitive mass spectrometry-based method to measure 2-amino-1-methyl-6-phenylimidazo[4,5-b]pyridine (PhIP), a cooked meat carcinogen in the hair of omnivores. PhIP is a multisite rodent carcinogen. PhIP's target organs include the pancreas, colorectum, prostate, and mammary gland. Several epidemiological studies report that frequent consumption of well-done cooked meats containing PhIP increases the risk of developing human cancers at some of these target sites.

PhIP hair levels are significantly higher in prostate cancer patients than those with benign prostatic hyperplasia (BPH) or bladder cancer under treatment at the University of Minnesota. When prostate pathology biomarkers were categorized as binary variables, PhIP-hair levels were significantly higher in patients with elevated prostate-specific antigen blood levels above 4.0 ng/mL (p = 0.030) and higher in patients with intermediate and high-risk Gleason scores of 7 - 10 compared to patients with a lower-risk Gleason score of 6 and BPH patients (p = 0.021). The PhIP hair biomarker data support the paradigm for the role of cooked meat in PC risk.

PhIP is also present in the fur of dogs consuming high-temperature processed kibble pet foods, often occurring at higher levels than found in human hair. High-density fur covers approximately 90% of the body surface area of dogs. In contrast, high-density terminal hair covers significantly less of the body surface area of humans, encompassing primarily the scalp and pubis. The follicular binding data on PhIP is promising, suggesting that canine fur can serve as a biospecimen for screening other environmental toxicants, expanding the role of canines as sentinels for monitoring exposures in disease susceptibility in humans.

Cats as Canaries? Exploring the Connection Between Genetics, Environment, IBD, and GI Lymphoma

AUTHORS

Tracy L. Webb, DVM, PhD, Research Scientist, Colorado State University
Emily Rout, DVM, PhD, DACVP, Research Scientist, Colorado State University
Anne Avery, VMD, PhD, Professor, Colorado State University
Craig B. Webb, DVM, PhD, DACVIM, Professor, Colorado State University

PRESENTING AUTHOR

Tracy L. Webb

ABSTRACT

Inflammatory bowel disease (IBD) is the most common cause of gastrointestinal (GI) signs in middle-aged to older cats. Anecdotal evidence suggests that in many cats, IBD progresses to low-grade alimentary lymphoma (fLGAL), which is the most common feline cancer. The causes of either disorder have not been elucidated, nor has the mechanism of progression from IBD to cancer. fLGAL may serve as a useful model for understanding the pathogenesis of two human intestinal T cell neoplasms. Human enteropathy-associated T cell lymphoma (EATL) progresses from refractory celiac disease. Understanding the environmental and genetic risk factors that drive progression from IBD to fLGAL may inform this process in human EATL. Monomorphic epitheliotropic intestinal T cell lymphoma (MEITL) also shares some features with fLGAL, including a recently described activating mutation in STAT5. Case reports suggest that MEITL may also be preceded by IBD. In order to investigate the cat as a translational model, we have prospectively collected GI biopsies from 105 cats with suspected IBD or lymphoma (gastric, duodenal, ileal, and colonic) for gene expression profiling and mutation analysis. 56% of these cats were diagnosed histologically with fLGAL, but 73% of cases harbored clonal T cell populations. Remarkably, a subset of these cats carry different clonal populations in different sites, suggesting an intestinal environment that is conducive to the development of lymphoma. We have developed a comprehensive REDCap questionnaire to collect health history, medications, diet, environment, and lifestyle information from these cats and healthy controls. Blood is also being collected for the study of potential genetic risk factors. Through this work, the team hopes to better characterize feline IBD and fLGAL, explore the connection between chronic inflammation and cancer development in the intestinal tract, and identify environmental exposures that contribute to the development of gastrointestinal disease in cats and humans.

POSTER TITLE

Community-Partnered Study Utilizing Passive Environmental Sampling and Blood Biopsy to Evaluate Risk Factors for Cancer in Pet Dogs

AUTHORS

Michelle E. White[1,2,], Kate Megquier[1], Marjie Alonso[3], Kim A. Anderson[4], Cheryl A. London[5], Elinor K. Karlsson[1,2]

[1]Broad Institute of MIT and Harvard; Cambridge, MA 02142, USA.

[2]University of Massachusetts Medical School; Worcester, MA 01655, USA.

[3]The International Association of Animal Behavior Consultants, Cranberry Township, PA 16066, USA.

[4]Department of Environmental and Molecular Toxicology, Oregon State University, Corvallis, OR 97331, USA

[5]Cummings School of Veterinary Medicine, Tufts University, Grafton, MA 01536, USA

PRESENTING AUTHOR

Michelle E. White (virtually)
https://bit.ly/3xi3WkW

ABSTRACT

Cancer is a complex disease caused by genetic and environmental factors and their interaction. However, identifying exposures that increase cancer risk in human patients is difficult due to long latencies between exposure and disease development. Pet dogs offer a powerful model system for assessing contributions of environmental exposures and gene/environment interactions to carcinogenesis. Dogs develop many of the same cancers that humans do, with many clinical and genomic similarities to human cancers, while sharing an environment with humans. The shorter lifespan of dogs and shorter length of time to disease development makes the study of the impact of environmental exposures on disease risk more feasible than in human patients.

We have developed a community science approach to enable rapid enrollment of dogs and large-scale data collection, including owner-reported health information. We will soon begin enrolling dogs in our pilot study investigating environmental exposures and their correlation with cancer incidence and progression. Enrolled dogs will wear a silicone dog tag to enable passive sampling of environmental chemicals. These measurements will be used to estimate accuracy of environmental survey response, and to identify any correlations with cancer type and outcome.

In addition, to enable exploration of gene/environment interactions and mutational signatures associated with environmental exposures, we have developed a direct-to-dog owner process allowing for a blood biopsy to be taken by the dog's owner and shipped directly to the Broad Genomics Platform for sequencing of cell-free DNA and identification of tumor-derived somatic variants.

With methods designed to maximize sample size, we will assemble a cohort large enough to represent the diversity in environmental exposures, genetic variation, and clinical outcomes within canine cancers and thus greatly improve our understanding of canine and human cancers.

Analysis Of PBDEs in Canine Placental Tissues: Pet Dogs as a Model for Diseases of Developmental Origin

AUTHORS

Catherine F. Wise [1], Claire A. Wiley[2], Matthew Breen[2,3,4,5] and **Heather M. Stapleton[1,2]**

[1] Nicholas School of the Environment, Duke University, Durham, NC 27708, USA.

[2] Duke Cancer Institute, Durham, NC, USA.

[3] Department of Molecular Biomedical Sciences, College of Veterinary Medicine, North Carolina State University, 1060 William Moore Drive, Raleigh, NC 27607, USA.

[4] Comparative Medicine Institute, North Carolina State University, Raleigh, NC 27607, USA.

[5] Center for Human Health and the Environment, North Carolina State University, Raleigh, NC 27607, USA.

PRESENTING AUTHOR

Catherine F. Wise

ABSTRACT

Early life exposures to endocrine disrupting chemicals such as, polybrominated diphenyl ethers (PBDEs) can disrupt crucial developmental processes leading to chronic health issues later in life such as neurodevelopmental disorders and diabetes. Gestation is a critical window for development and the placenta is increasingly recognized as a key player in mediating fetal exposures to environmental contaminants. Previous human studies have shown that PBDEs accumulate in the placenta in a sex-and tissue-specific manner. Understanding the later-life consequences of early life exposures can be challenging due to the long latency periods for chronic human diseases. Pet dogs offer a unique opportunity to serve as a sentinel species for human environmental health studies because they share our environment, have similar genomes and diseases with similar clinical and biological features.

Importantly, dogs have a significantly reduced lifespan compared to humans, offering an accelerated path to investigate environmental exposures in utero and their potential associations with health outcomes that stem from developmental origins. We have previously demonstrated that people and their pet dogs have significant and positive correlations in their exposure to PBDEs in indoor environments. Our objective in this study is to demonstrate that pet dogs can act as a sentinel species to evaluate real-world environmental exposures in placental tissues. During the summer and fall of 2021, we collected 22 placenta samples from routine cesarean sections from five different dog litters.

Preliminary data from one placenta sample revealed the presence of PBDEs in canine placenta at a concentration of 0.8 ng/g and TBB at a concentration of 0.1 ng/g. Interestingly, we observed higher concentrations of BDE-209 in the fetal placenta tissue compared to maternal placenta tissue, which is similar to trends in human placenta. Our hypothesis is that sex-dependent and tissue-specific accumulation of PBDEs observed in human placental tissues is a conserved phenomenon and would be also found in canine placentas. Dogs are increasingly recognized for their value in translational research in cancer and aging, and thus we think are likely to offer similar value for chronic conditions of developmental origin.

Canaries in the Coal Mine, Canines on the Couch - A Model for Investigating Contaminant Exposures to Support Human Health Research

AUTHORS

Catherine F. Wise[1,2], Stephanie C. Hammel[3], Nicholas Herkert[3], Jun Ma[4,5], Alison Motsinger-Reif[6], Heather M. Stapleton[3,7], Matthew Breen[1,2,7,8,9]

[1]Program in Toxicology, Department of Biological Sciences, North Carolina State University, Raleigh, North Carolina, 27606, USA

[2]Department of Molecular Biomedical Sciences, College of Veterinary Medicine, North Carolina State University, Raleigh, North Carolina, 27607, USA

[3]Nicholas School of the Environment, Duke University, Durham, North Carolina 27708, USA

[4]Department of Statistics, North Carolina State University, Raleigh, North Carolina 27607, USA

[5]Bioinformatics Research Center, North Carolina State University, Raleigh, North Carolina 27607, USA

[6]Biostatistics and Computational Biology Branch, National Institute of Environmental Health Sciences, Durham, North Carolina 27709, USA

[7]Duke Cancer Institute, Durham, North Carolina, USA

[8]Comparative Medicine Institute, North Carolina State University, Raleigh, North Carolina 27607, USA

[9]Center for Human Health and the Environment, North Carolina State University, Raleigh, North Carolina 27607, USA

PRESENTING AUTHOR

Catherine F. Wise

ABSTRACT

Only 5-10% of human cancers can be explained by genetics alone, suggesting the environment plays a strong role in disease etiology. Quantifying the impacts of exposures remains challenging due to latency issues that can take years to manifest after exposure. Dogs may provide valuable insights as a sentinel species for exposure-related human disease because they experience similar environment exposures, have a 6-8 fold shorter lifespan, share many clinical and biological behaviors, and have closely related genomes. We evaluated individual exposures among pet dogs and their paired human companions using silicone dog-tags and wristbands as personal passive samplers (n=30 pairs). Silicone samplers were analyzed for a suite of chemicals across multiple compound classes, including organophosphate esters (OPEs), polybrominated diphenyl ethers, polychlorinated biphenyls, phthalates, and pesticides. As a validation pilot study, we collected urine samples from each study participant and dog, and measured levels of OPE metabolites. 32 of the 41 compounds measured, with a detection frequency >50%, were significantly correlated between dog and human wristbands (r_s = 0.38-0.90; p <0.05), indicating the dog could be a valuable One Health model and potential sentinel species for examining how exposure to consumer product chemicals impact health. The concentrations of several OPEs parent compounds measured on the dog tags were significantly correlated with their respective metabolites in urine (r_s = 0.50-0.71; p <0.01). These data support the value of using the domestic dog as a sentinel species to investigate the potential long-term health impacts on humans from shared exposures.

Canines on the Couch: Using Silicone Passive Samplers to Evaluate Pesticide Concurrent Exposures in People and Their Pet Dogs

AUTHORS

Catherine F. Wise[1], Stephanie C. Hammel[1], Nicholas Herkert[1], Matthew Breen[2,3,4,5] and **Heather M. Stapleton[1,2]**

[1] Nicholas School of the Environment, Duke University, Durham, NC 27708, USA.

[2] Duke Cancer Institute, Durham, NC, USA.

[3] Department of Molecular Biomedical Sciences, College of Veterinary Medicine, North Carolina State University, 1060 William Moore Drive, Raleigh, NC 27607, USA.

[4] Comparative Medicine Institute, North Carolina State University, Raleigh, NC 27607, USA.

[5] Center for Human Health and the Environment, North Carolina State University, Raleigh, NC 27607, USA.

PRESENTING AUTHOR

Catherine F. Wise

ABSTRACT

People are chronically exposed to various pesticides through the diet, but also through herbicide applications in lawns and pesticide treatments around the home. Chronic household exposure to pesticides affects people and their pets, and some studies suggest pesticide exposure in dogs may be associated with cancer. Companion animals are recognized for their value in comparative health studies, and their shared daily environment with people suggests they are valuable in supporting environmental health research. In this study, we used wearable silicone passive samplers to support a comparative exposure assessment. We recruited 30 people and their pet dogs (living in the same household) to participate in a study to determine how well silicone wristbands (for human) and dog tags (worn on dog collars) can predict urinary pesticide biomarkers of exposure. Participants wore the silicone samplers for 5 days. They collected urine from themselves and their dogs on Days 1, 3 and 5 of the study. Urine samples were pooled for analysis of pesticide biomarkers. Using targeted GC-MS analyses, we quantified 8 pesticides in silicone samplers. Using a suspect screening approach, we additionally identified N,N-diethyl-m-toluamide (DEET), promecarb, flamprop-methyl and fipronil on the silicone samplers with high detection frequencies. DEET and fipronil were confirmed with authentic analytic standards and had statistically significant correlations between wristbands and dog tags (r_s=0.86 and 0.67, respectively, $p<0.01$). Pooled urine samples were quantified for 15 pesticide metabolite biomarkers. Several pesticides, including permethrin, DEET and chlorpyrifos, were detected with high frequency (>70%) in wristbands and urine of both humans and dogs, as corresponding biomarkers. Compared to adults evaluated in the U.S. g eneral population, these dog-owners had higher urinary pesticide metabolite concentrations. Significant and positive correlations were observed between silicone sampler levels of permethrin and DEET with their corresponding urinary metabolites (r_s= 0.50-0.96, $p<0.05$) in both humans and dogs. Dogs had significantly higher urinary concentrations of 2,4-D and *para*-nitrophenol compared to humans in our study. Owners that reported using flea and tick products containing fipronil on their dog had significantly higher levels of fipronil in wristbands (~10X) and dog tags (~100X) compared to those who did not ($p<0.01$). This study demonstrates that pet dogs can act as proxies for human pesticide exposures in the home environment, potentially providing a new way to study relationships between environmental exposures and disease etiology.

The National Cancer Policy Forum serves as a trusted venue in which experts can identify emerging high-priority policy issues in cancer research and cancer care and work collaboratively to examine those issues through convening activities focused on opportunities for action. The Forum provides a continual focus within the National Academies on cancer, addressing issues in science, clinical medicine, public health, and public policy that are relevant to the goal of reducing the cancer burden, through prevention and by improving the care and outcomes for those diagnosed with cancer. Forum activities inform the cancer community and the public about critical policy issues through published reports and often inform consensus committee studies. The Forum has members with a broad range of expertise in cancer, including patient advocates, clinicians, and basic, translational, and clinical scientists. Members represent patients, federal agencies, academia, professional organizations, nonprofits, and industry.

The Forum has addressed a wide array of topics, including:

- enhancing collaborations to accelerate research and development;

- improving the quality and value of care for patients who have been diagnosed with or are at risk for cancer;

- developing tools and technologies to enhance cancer research and care; and

- examining factors that influence cancer incidence, mortality, and disparities.

Upcoming and Recent Workshops

Family Caregiving for People With Cancer and Other Serious Illnesses

May 16-17, 2022

This workshop will examine opportunities to better support family caregivers for people with cancer or other serious illnesses. This collaborative workshop is being convened by the Roundtable on Quality Care for People with Serious Illness, the National Cancer Policy Forum, and the Forum on Aging, Disability, and Independence. The workshop will feature presentations and discussions on topics including:

- Strategies to better capture, understand, and act on family caregiver input and experience to improve patient care and to support family caregivers.
- Research gaps and opportunities to improve the evidence base to guide caregiving for patients with serious illnesses.
- Potential policy opportunities to support family caregivers and advance family-centered care for serious illness, including new models of care delivery and payment.
- Opportunities to better embed a health equity focus across family caregiving research, policy, and practice.
- Lessons learned from the COVID-19 pandemic (e.g., use of telehealth and other remote technologies) that could be applied in the context of caregiving for people with cancer and other serious illnesses.

Workshop website in development.

Innovation in Electronic Health Records for Oncology Care, Research, and Surveillance

February 28 - March 1, 2022

Electronic health records (EHRs) affect clinician and practice efficiency and safety, quality of care, patient satisfaction, and data acquisition. This workshop, convened by the Forum in collaboration with the Computer Science and Telecommunications Board, will examine potential opportunities to improve patient care and outcomes to enhance innovation in the development, implementation, and use of EHRs in oncology care, research, and surveillance. Invited presentations and panel discussions may include:

- Challenges and opportunities to optimize EHRs in oncology care, and governance structures needed to prioritize and implement these improvements.
- Standardization of oncology EHR documentation and data and initiatives to enhance EHR interoperability.
- Opportunities to capture and integrate data on social determinants of health and patient reported outcomes into EHRs to produce real-time or more timely data to guide cancer care, research, and surveillance.
- Use of computing technologies to enhance EHRs.
- Opportunities to align incentives to ensure that EHRs offered by vendors meet the needs of users in oncology.
- Examples of collaborations and innovations in EHRs, and policies to foster redesign of EHRs as a functional component of surveillance systems in oncology care.

Workshop website

The Role of Companion Animals as Sentinels for Predicting Environmental Exposure Effects on Aging and Cancer Susceptibility in Humans

December 1-3, 2021

Companion animals have a potential role as sentinels of relevant, shared environmental exposures that may affect human aging and cancer. This workshop will examine the opportunities and challenges for using this novel translational approach to exposure science as a way to accelerate the knowledge turn in this evolving field. Presentations and discussions will examine:

- History and current state of the science of environmental exposure effects on aging and cancer susceptibility.
- Methods and current studies.
- Relevance of companion animal exposures to human cancer and aging.
- Opportunities and challenges to accelerating cross-species comparisons to enhance data sources, collection, storage, codeling, and sharing.
- Equity, ethics, and policy.
- Identifying research gaps and setting a research agenda.

Workshop website

Promoting Health Equity in Cancer Care

October 25-26, 2021

The Forum, in collaboration with the Roundtable on the Promotion of Health Equity, convened a workshop to examine opportunities to improve health equity across the cancer care continuum. Workshop speakers discussed:

- Opportunities to improve patient access to affordable, high-quality care.
- Strategies to identify and address the intersectionality of structural racism and implicit bias in cancer care delivery.
- The potential for quality measurement and payment mechanisms to incentivize health equity in cancer care delivery.
- Clinical practice data collection efforts to better assess and care for patients with cancer.

Workshop videos and presentations

Webinar Series: Addressing Social Needs in Cancer Care
In advance of the workshop, *Promoting Health Equity in Cancer Care,* the Forum convened a webinar series focusing on opportunities to better assess and address the social needs of patients with cancer.

- May 10, 2021: Food Insecurity among Patients with Cancer
- August 9, 2021: Housing Insecurity among Patients with Cancer
- September 21, 2021: Transportation Needs among Patients with Cancer

Upcoming and Recent Workshops

Cancer Care and Cancer Research in the Context of the COVID-19 Pandemic

July 26-27, 2021

The COVID-19 pandemic has led to dramatic adjustments in cancer care delivery and cancer research. This workshop examined these changes, and considered lessons learned in order to improve the delivery of high-quality cancer care and the conduct of cancer clinical trials in the post-pandemic era. The workshop convened experts to discuss topics such as:

- Clinical practice changes and their impact on cancer research and cancer care.
- Opportunities to retain and build on beneficial changes to advance high-quality cancer care delivery.
- Strategies to improve the conduct of cancer clinical trials, including efforts to facilitate inclusive, community-based clinical trials, and to leverage digital technologies.
- Potential policy and regulatory modifications to continue beneficial changes in cancer care and clinical trials.

Workshop videos and presentations

Impact of the Affordable Care Act on Cancer Prevention and Cancer Care

March 1-2, 2021

This workshop examined the evidence base on how the Patient Protection and Affordable Care Act (ACA) has altered the landscape of cancer prevention and care delivery. Invited presentations and panel discussions included:

- Effects of coverage expansions under the ACA on access to cancer care, patient outcomes, and health disparities.
- Impact of new organizational infrastructure and their relevance to cancer research and effects of payment reform demonstration projects on patient outcomes and the quality and efficiency of oncology care delivery.
- Remaining evidence gaps and policy challenges.
- Lessons learned from the design and implementation of the ACA that could inform future health care efforts.

.Workshop videos and presentations

Addressing the Adverse Consequences of Cancer Treatment

November 9-10, 2020

Cancer treatment can lead to an array of significant short- and long-term physical, mental, and socioeconomic consequences for patients and their families. The National Cancer Policy Forum, in collaboration with the Forum on Aging, Disability, and Independence, convened this workshop to examine opportunities to prevent and mitigate the adverse effects of cancer treatment and improve quality of life for cancer survivors and their families.

Workshop videos and presentations
Proceedings

WORKSHOP SERIES: OLDER ADULTS

Collaborative series convened by:
National Cancer Policy Forum
Forum on Drug Discovery, Development, and Translation
Forum on Aging, Disability, and Independence

Improving the Evidence Base for Treatment Decision Making for Older Adults with Cancer

January 22, 25, and 27, 2021

Older adults represent the majority of patients diagnosed with cancer and cancer-related deaths. However, the evidence base to guide treatment decision making among older adults with cancer is sparse, primarily because older adults are underrepresented in clinical trials, and trials designed specifically for older adults are rare. This FDA-sponsored workshop examined challenges and opportunities to improve the evidence base for treating older adults with cancer. The workshop examined strategies for improved inclusion of older adults across the drug development continuum.

Workshop videos and presentations
Proceedings-in-Brief

Drug Research and Development for Adults Across the Older Age Span

August 5-6, 2020

This workshop convened experts to discuss the lack of evidence about the appropriate use of drugs in older adult populations, which hampers decision making about how to optimize care for older adults. Workshop presentations and discussions highlighted opportunities to better engage older adults in clinical research and strategies to generate evidence-based prescribing information for older adult populations.

Workshop videos and presentations
Proceedings

Opportunities and Challenges for Using Digital Health Applications in Oncology

July 13-14, 2020

The National Cancer Policy Forum, in collaboration with the Forum on Cyber Resilience, convened a workshop to examine the role of digital health applications in oncology research and care. Workshop speakers discussed topics such as exemplars of novel digital health applications; regulatory priorities; ethical, security, governance, and payment considerations; and opportunities to improve data availability and use in EHRs and large databases.

Workshop videos and presentations
Proceedings

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University of Pennsylvania Perelman School of
Medicine

Stanton L. Gerson, M.D.
Case Comprehensive Cancer Center/University
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Julie R. Gralow, M.D., FACP, FASCO
American Society of Clinical Oncology

Roy S. Herbst, M.D., Ph.D.
Yale School of Medicine

Hedvig Hricak, M.D., Ph.D.
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USC Norris Comprehensive Cancer Center

Roy A. Jensen, M.D.
The University of Kansas Cancer Center

Randy A. Jones, Ph.D., R.N., FAAN
University of Virginia School of Nursing

Beth Y. Karlan, M.D.
UCLA Jonsson Comprehensive Cancer Center

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Georgetown University

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Foundation Medicine

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UCSD Moores Cancer Center

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Hospital; and Dana-Farber Cancer Institute

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Penn Medicine Lancaster General; Association of
Community Cancer Associations

Cleo A. Samuel-Ryals, Ph.D.
University of North Carolina at Chapel Hill

Richard L. Schilsky, M.D., FASCO
University of Chicago

Julie Schneider, Ph.D.
Food and Drug Administration

Susan M. Schneider, PhD, RN, AOCN, FAAN
Duke University School of Nursing

Lawrence N. Shulman, M.D., MACP, FASCO
University of Pennsylvania Abramson
Cancer Center

Heidi Smith, M.H.S., B.A.
Novartis Oncology

Lara Strawbridge, M.P.H.
Centers for Medicare & Medicaid Services

George J. Weiner, M.D.
University of Iowa Holden Comprehensive
Cancer Center

Robert A. Winn, M.D.
Virginia Commonweath University Massey
Cancer Center

Phylicia L. Woods, J.D, M.S.W.
Cancer Support Community

FORUM STAFF

Sharyl Nass, Ph.D.
Forum Co-Director and
Director, Board on Health Care
Services

Erin Balogh, M.P.H.
Forum Co-Director

Francis Amankwah, M.P.H.
Program Officer

Rachel Austin, B.A.
Senior Program Assistant

Lori Benjamin Brenig, M.P.H.
Research Associate

Annalee Gonzales, B.A.
Administrative Assistant

Micah Winograd, M.A.
Senior Finance Business
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WORKSHOP PROCEEDINGS

2021

Promoting Health Equity in Cancer Care (In Process)

Cancer Care and Cancer Research in the Context of the COVID-19 Pandemic: A Workshop on Lessons Learned (In Process)

Impact of the Affordable Care Act on Cancer Prevention and Cancer Care: Proceedings of a Workshop (In Process)

Addressing the Adverse Consequences of Cancer Treatment: Proceedings of a Workshop

Opportunities and Challenges for Using Digital Health Applications in Oncology: Proceedings of a Workshop

Improving the Evidence Base for Treatment Decision Making for Older Adults with Cancer: Proceedings of a Workshop—in Brief

Advancing Progress in the Development and Implementation of Effective, High-Quality Cancer Screening: Proceedings of a Workshop

Drug Research and Development for Adults Across the Older Age Span: Proceedings of a Workshop

2020

Reflections on Sharing Clinical Trial Data: Challenges and a Way Forward: Proceedings of a Workshop

Applying Big Data to Address the Social Determinants of Health in Oncology: Proceedings of a Workshop

Health Literacy and Communication Strategies in Oncology: Proceedings of a Workshop

Enhancing Scientific Reproducibility in Biomedical Research Through Transparent Reporting: Proceedings of a Workshop

2019

Developing and Sustaining an Effective and Resilient Oncology Careforce: Proceedings of a Workshop

Advancing Progress in the Development of Combination Cancer Therapies with Immune Checkpoint Inhibitors: Proceedings of a Workshop

Improving Cancer Diagnosis and Care: Clinical Application of Computational Methods in Precision Oncology: Proceedings of a Workshop

2018

Improving Cancer Diagnosis and Care: Patient Access to Oncologic Imaging and Pathology Expertise and Technologies: Proceedings of a Workshop

Establishing Effective Patient Navigation Programs in Oncology: Proceedings of a Workshop

Long-Term Survivorship Care After Cancer Treatment: Proceedings of a Workshop

2017

The Drug Development Paradigm in Oncology: Proceedings of a Workshop

Cancer Care in Low-Resource Areas: Cancer Treatment, Palliative Care, and Survivorship Care: Proceedings of a Workshop

Implementation of Lung Cancer Screening: Proceedings of a Workshop

Incorporating Weight Management and Physical Activity Throughout the Cancer Care Continuum: Proceedings of a Workshop
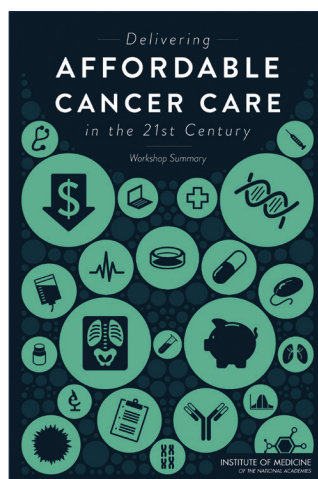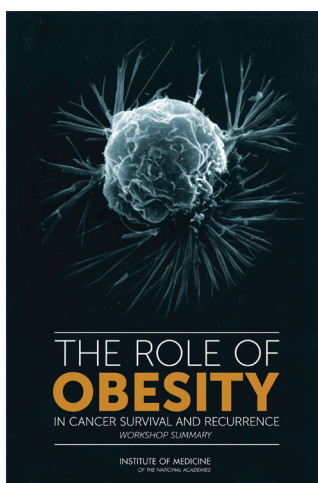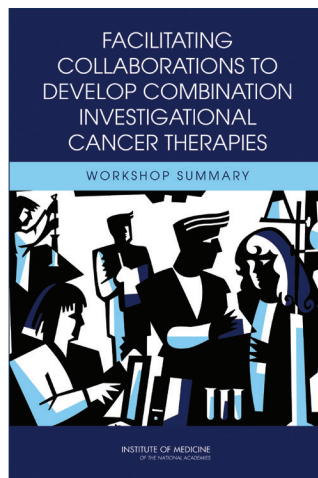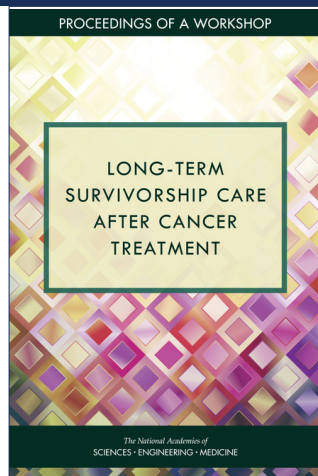
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nationalacademies.org/NCPF

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WORKSHOP PROCEEDINGS

2016

Policy Issues in the Clinical Development and Use of Immunotherapy for Cancer Treatment: Proceedings of a Workshop

Cancer Care in Low-Resource Areas: Cancer Prevention and Early Detection: Workshop Summary

Appropriate Use of Advanced Technologies for Radiation Therapy and Surgery in Oncology: Workshop Summary

2015

Comprehensive Cancer Care for Children and Their Families: Summary of a Joint Workshop by the Institute of Medicine and the American Cancer Society

Policy Issues in the Development and Adoption of Biomarkers for Molecularly Targeted Cancer Therapies: Workshop Summary

Assessing and Improving the Interpretation of Breast Images: Workshop Summary

Role of Clinical Studies for Pets with Naturally Occurring Tumors in Translational Cancer Research: Workshop Summary

2014

Ensuring Patient Access to Affordable Cancer Drugs: Workshop Summary

Contemporary Issues for Protecting Patients in Cancer Research: Workshop Summary

2013

Identifying and Addressing the Needs of Adolescents and Young Adults with Cancer: Workshop Summary

Implementing a National Cancer Clinical Trials System for the 21st Century: Second Workshop Summary

Sharing Clinical Research Data: Workshop Summary

Delivering Affordable Cancer Care in the 21st Century: Workshop Summary

Reducing Tobacco-Related Cancer Incidence and Mortality: Workshop Summary

2012

The Role of Obesity in Cancer Survival and Recurrence: Workshop Summary

Informatics Needs and Challenges in Cancer Research: Workshop Summary

Facilitating Collaborations to Develop Combination Investigational Cancer Therapies: Workshop Summary

2011

Implementing a National Cancer Clinical Trials System for the 21st Century: Workshop Summary

Patient-Centered Cancer Treatment Planning: Improving the Quality of Oncology Care: Workshop Summary

The National Cancer Policy Summit: Opportunities and Challenges in Cancer Research and Care

Nanotechnology and Oncology: Workshop Summary

2010

Genetic Testing (with the National Research Council): Summary of a Workshop

Extending the Spectrum of Precompetitive Collaboration in Oncology Research: Workshop Summary

A Foundation for Evidence-Driven Practice: A Rapid Learning System for Cancer Care: Workshop Summary

Policy Issues in the Development of Personalized Medicine in Oncology: Workshop Summary

2009

Assessing and Improving Value in Cancer Care: Workshop Summary

Ensuring Quality Cancer Care Through the Oncology Workforce: Sustaining Care in the 21st Century: Workshop Summary

Multi-Center Phase III Clinical Trials and the NCI Cooperative Group Program: Workshop Summary

2008

Implementing Colorectal Cancer Screening: Workshop Summary

Improving the Quality of Cancer Clinical Trials: Workshop Summary

2007

Cancer-Related Genetic Testing and Counseling: Workshop Proceedings

Cancer in Elderly People: Workshop Proceedings

Implementing Cancer Survivorship Care Planning: Workshop Summary

2006

Effect of the HIPAA Privacy Rule on Health Research: Proceedings of a Workshop

Developing Biomarker-Based Tools for Cancer Screening, Diagnosis, and Treatment: Workshop Summary

RELATED WORK

CONSENSUS STUDY REPORTS BUILDING ON NCPF WORK

Childhood Cancer and Function Impacts Across the Care Continuum (2021)
Report: nap.edu/catalog/25944/

Diagnosing and Treating Adult Cancers and Associated Impairments (2021)
Report: nap.edu/catalog/25956

Guiding Cancer Control: A Path to Transformation (2019)
Report: nap.edu/catalog/25438

Making Medicines Affordable: A National Imperative (2017)
Report: nap.edu/catalog/24946

Biomarker Tests for Molecularly Targeted Therapies: Key to Unlocking Precision Medicine (2016)
Report: nap.edu/catalog/21860

Ovarian Cancers: Evolving Paradigms in Research and Care (2016)
Report: nap.edu/catalog/21841

Delivering High-Quality Cancer Care: Charting a New Course for a System in Crisis (2013)
Report: nap.edu/catalog/18359

Evolution of Translational Omics: Lessons Learned and the Path Forward (2012)
Report: nap.edu/catalog/13297

A National Cancer Clinical Trials System for the 21st Century: Reinvigorating the NCI Cooperative Group Program (2010)
Report: nap.edu/catalog/12879

Evaluation of Biomarkers and Surrogate Endpoints in Chronic Disease (2010)
Report: nap.edu/catalog/12869

Beyond the HIPAA Privacy Rule: Enhancing Privacy, Improving Health Through Research (2009)
Report: nap.edu/catalog/12458

Cancer Biomarkers: The Promises and Challenges of Improving Detection and Treatment (2007)
Report: nap.edu/read/11892

INDIVIDUALLY AUTHORED PUBLICATIONS BUILDING ON NCPF WORK

Independent, individually authored articles* arising from NCPF workshops—and consensus studies building on NCPF work—include:

2021

- Nekhlyudov L., G.B. Campbell., K.H. Schmitz, G.A. Brooks, A.J. Kumar, P.A. Ganz, D. Von Ah. Cancer-related impairments and functional limitations among long-term cancer survivors: Gaps and opportunities for clinical practice. Cancer. 2021 Sep 16. doi: 10.1002/cncr.33913. Epub ahead of print. PMID: 34529268.

- Bertagnolli, M.M. and Singh, H. 2021. Treatment of older adults with cancer - addressing gaps in evidence. N Egl J Med. https://www.nejm.org/doi/full/10.1056/NEJMp2106089

- Housten, A.J., C.M. Gunn, M.K. Paasche-Orlow, and K.M. Basen-Engquist. 2021. Health Literacy Interventions in Cancer: A Systematic Review. J Canc Educ. 36(2):240-252. doi: 10.1007/s13187-020-01915-x.
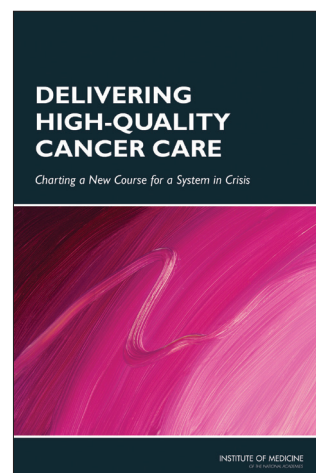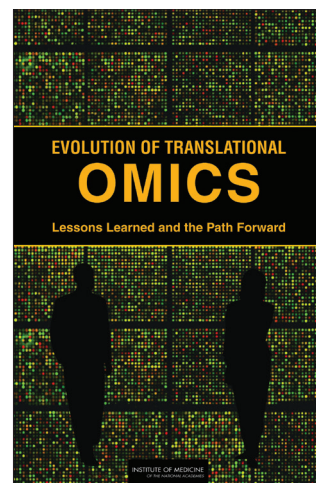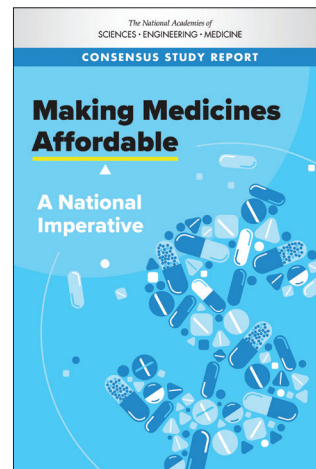
2020

- Schilsky, R.L., S. Nass, M.M. Le Beau, and E.J. Benz, Jr. 2020. Progress in Cancer Research, Prevention and Care. N Engl J Med. https://www.nejm.org/doi/full/10.1056/NEJMp2007839?query=featured_home.

- Shulman, L. N., L. K. Sheldon, and E. J. Benz. 2020. The Future of Cancer Care in the United States—Overcoming Workforce Capacity Limitations. JAMA Oncology. doi:10.1001/jamaoncol.2019.5358 https://jamanetwork.com/journals/jamaoncology/article-abstract/2758839.

- Panagiotou, O. A., L. Hoffman-Högg, H. Hricak, S. N. Khleif, M. A. Levy, D. Magnus, M. J. Murphy, B. Patel, R. A. Winn, S. J. Nass, C. Gatsonis, and C. R. Cogle. 2020. Clinical Application of Computational Methods in Precision Oncology: A Review. JAMA Oncol. https://jamanetwork.com/journals/jamaoncology/article-abstract/2765757.

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- Balogh, E. P., A. B. Bindman, S. G. Eckhardt, S. Halabi, R. D. Harvey, I. Jaiyesimi, R. Miksad, H. L. Moses, S. J. Nass, R. L. Schilsky, S. Sun, J. M. Torrente, and K. E. Warren. 2019. Challenges and opportunities to updating prescribing information for longstanding oncology drugs. The Oncologist 24: 1-7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7066705/.

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*Accessed date for all articles is November 18, 2021.

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Innovation in Electronic Health Records for Oncology Care, Research, and Surveillance: A Workshop
February 28 – March 1, 2022

Statement of Task

An ad hoc planning committee will plan and host a 1.5-day public workshop that will examine opportunities to improve patient care and outcomes through collaborations to enhance innovation in the development, implementation, and use of electronic health records (EHRs) in oncology research and care. The workshop will feature invited presentations and panel discussions on topics that may include:

- Challenges and opportunities to optimize the functionality and usability of EHRs in oncology care, such as efforts to standardize essential data, data presentation, and decision support, as well as the need to address governance structures and processes to prioritize and implement these improvements.
- Standardization of oncology EHR documentation to facilitate care and communication among clinicians and patients.
- Capture of data on social determinants of health.
- Opportunities to collect and integrate patient reported outcomes measures into EHRs and produce real-time or more timely data to guide cancer care and facilitate cancer research and surveillance.
- Ongoing initiatives to enhance EHR structure, data standardization, and interoperability with the goal of improving care and real-world clinical data collection for research, surveillance, and improvement of care quality. This may include essential data to be collected, and methods to do so, as well as integration of genomics data.
- Use of computing technologies such as artificial intelligence to enhance EHRs and facilitate the use of EHRs to improve clinical care and enhance oncology research.
- Opportunities to better align incentives to ensure that EHRs offered by vendors meet the needs of the various users in oncology (e.g., patients, clinicians, payers, researchers).
- Past and ongoing examples of collaborations to conceptualize and implement innovations in EHRs for cancer care, research, and surveillance.
- Policies to foster redesign of EHRs to serve as a functional component of surveillance systems to advance oncology care.

The planning committee will develop the agenda for the workshop sessions, select and invite speakers and discussants, and moderate the discussions. A proceedings of the presentations and discussions at the workshop will be prepared by a designated rapporteur in accordance with institutional guidelines.

In Collaboration with: Computer Science and Telecommunications Board (CSTB)

Planning Committee:
Mia Levy (Co-chair), Foundation Medicine, Inc.
Lawrence N. Shulman (Co-chair), University of Pennsylvania Abramson Cancer Center
Robert W. Carlson, National Comprehensive Cancer Network
Nicole F. Dowling, Centers for Disease Control and Prevention
Mimi Huizinga, Rafael Holdings, Inc.
Bradley Malin, Vanderbilt University Medical Center
Neal Meropol, Flatiron Health
Etta Pisano, Beth Israel Deaconess Medical Center
Julie Schneider, Food and Drug Administration
Robert Winn, Virginia Commonwealth University Massey Cancer Center
Robin Yabroff, American Cancer Society

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HEALTH AND MEDICINE DIVISION

Project Staff:
Francis K. Amankwah, Program Officer
Rachel Austin, Senior Program Assistant
Lori Benjamin Brenig, Research Associate
Annalee Gonzales, Administrative Assistant
Erin Balogh, Senior Program Officer; Co-Director, National Cancer Policy Forum
Sharyl Nass, Senior Director, Board on Health Care Services; Co-Director, National Cancer Policy Forum
Jon Eisenberg, Senior Board Director, Computer Science and Telecommunications Board

Project Website: https://www.nationalacademies.org/event/02-28-2022/innovation-in-electronic-health-records-for-oncology-care-research-and-surveillance-a-workshop

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HEALTH AND MEDICINE DIVISION

Forum on Aging, Disability, and Independence

The National Academies of Sciences, Engineering, and Medicine have formed the Forum on Aging, Disability, and Independence to foster dialogue and address issues of interest and concern related to aging and disability. This includes aging and the related disabling conditions that can occur, as well as aging with an existing disability. The Forum seeks to promote bridging of the research, policy, and practice interests of the aging and disability communities to accelerate the transfer of research to practice and identify levers that will effect change for the benefit of all. Of particular concern is promoting healthy aging, independence, and community living for older adults and people with disabilities.

PERSON-CENTERED/PARTICIPANT-DIRECTED MODEL

Underpinning all aspects of achieving health and community living goals is a holistic, well-coordinated, person-centered, and participant-directed planning and implementation process. As depicted in the model below, this process should be directed by the individual in need, or by someone who either the individual has chosen or has been appropriately designated to direct and coordinate the process. The main factors that need to be coordinated include home and community settings; services and support; workforce; and financing. All of these factors exist within an environment that includes several key elements: quality; technology; research and evaluation; and policy. The Forum is focused on improving the understanding of the relationships that exist among all of these factors and examining ways to improve policies and environments that will ultimately promote independence and quality of life for older adults and people who have disabling conditions.

COORDINATION

Many systems need to work together successfully to support healthy aging, independence, and community living for people with disabilities and older adults. While both medical and social services are key to keeping older adults and individuals with disabilities in the setting of their choice in the community, these two systems are not always well connected. Similarly, in many communities there is a divide between service systems for those who are under age 65 and those who are over age 65. A goal of the Forum is to improve system integration and access to person-centered supports and services that can improve quality of

life for both populations. For some individuals, this could be in the form of a designated care coordinator, whereas for others it may mean ensuring that they have information about all available resources because they choose to be their own care coordinator.

HOME AND COMMUNITY SETTINGS

Being an active member of a community is a priority for many people. A primary goal of the Forum is to foster access to services and supports that allow people with disabilities and older adults to live safely in the setting of their choosing and have the supports they need in the workplace if they would like to continue working.

SERVICES AND SUPPORT

Having access to services and supports can be critical to improving quality of life, maximizing independence, and preventing hospital re-admission. Services and supports can include assistance with dressing or cooking, social engagement,

Model for Promoting Healthy Aging, Independence, and Community Living for People with Disabilities and Older Adults

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or provision of medical care. It is important to ensure that potential beneficiaries are aware of available resources and take advantage of them as appropriate.

WORKFORCE

The nation faces a growing imbalance between the supply of and demand for its health care system as the number of older adults with complex health needs increasingly outpaces the number of workers with the knowledge and skills to adequately care for them. Similarly, health care professionals are often not well-informed about proper care for people with disabilities or the problems these individuals face as they age. Fundamental reforms are needed in the ways these populations receive care, including changes to workforce education and training so that the workforce can be utilized efficiently and effectively while also providing high-quality care.

FINANCING

Although there are various sources of financing to support healthy aging and independent living services, they can be insufficient and difficult to access. Financing sources range from federal and state programs to non-profit foundations and philanthropic organizations. In addition, the private sector offers insurance (medical and long-term), and many commercial companies provide programs that can offset costs for assistive products under specified conditions. However, the individual (or family members) often finances some or, in some cases, all services that are received. Innovations in financing are needed. Preventive services are underdeveloped and "under-offered," resulting in greater expense in the long run, even though some services have found ways to cut costs while maintaining or even improving quality. The Forum examines ways to increase use of prevention strategies and provide financing that is more transparent and usable by people desiring these services.

TECHNOLOGY

Technology products have improved functioning and quality of life for people with disabilities of all ages. They can range in complexity from a calendar to coordinate which days of the week different services will be provided to devices that facilitate mobility and beyond. This is an area with many possibilities to connect the needs of consumers, regulators, businesses, and product developers. It also involves assistance in a myriad of settings, such as home, transport vehicles, medical facilities, workplaces, and community venues.

POLICY

Numerous social inequities and other barriers prevent older adults and people with disabilities, particularly those with multiple chronic conditions, from realizing their full potential for social and economic participation. The Affordable Care Act offers new opportunities, both to improve the service delivery system and to provide coverage for workers who become disabled. Yet the need for policy improvements involving equitable financing for health care, access to affordable, person-centered long-term supports and services, and workplace accommodation still remains.

RESEARCH AND EVALUATION

As policy changes are made, new technologies are developed, and the workforce adapts, evaluation and research are needed to determine whether these changes are beneficial and to validate best practices and inform future directions. Given that there are limited resources, wise use of existing data and effective coordination of research by all sectors of the nation are essential.

QUALITY

Quality is a key characteristic that encompasses all elements of the Forum's model. It is needed in any system supporting healthy aging, independence, and community living. If the systems in place are not of good quality, then they could break down, coordination could be lost, or individuals may lose trust in the people, research, and devices that are intended to help them achieve personal goals.

FORUM GOVERNANCE AND ACTIVITIES

The Forum is self-governing. Thus, the Forum membership identifies the topics it wishes to address, and with assistance from staff, develops meeting agendas and identifies workshop topics. The Forum meets 2-3 times annually and also has working groups that plan workshops and other activities. Products include workshop proceedings; cooperative projects initiated by Forum members; independently authored articles concerning Forum topics; and derivative consensus studies.

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FORUM DIRECTOR

Tracy Lustig, DPM, MPH
202-334-2574
tlustig@nas.edu

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