2012 Environmental and Occupational Health Technical Symposium

Regulating Environmental Pollutants: Perchlorates and Other Thyroid-Active Chemicals

February 16, 2012

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2012 Environmental and Occupational Health Technical Symposium

February 16, 2012

EOH Technical Symposium Team

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On behalf of the Environmental and Occupational Health (EOH) alumni, faculty, and students of California State University Northridge, and our sponsors, we welcome you to our annual EOH Technical Symposium. We hope that you will find today's program to be of great value.

In recent years, alarms have been raised about the potential effects of thyroid-active chemicals in our environment. Proper thyroid function is critical for brain development and pubertal onset early in life and impacts the development of chronic diseases later in life. The thyroid axis governs metabolic rates and a host of other physiologic functions.

Our 7th Annual EOH Technical Symposium brings together scientists, physicians, industry professionals, government consultants, and policy experts to consider the issue of thyroid-active chemicals in the environment. A stellar line-up for today's event promises an interesting and informative day. Proceeds from the EOH Technical Symposium are used to promote student educational events, scholarships, and the Department of Environmental and Occupational Health.

We hope you enjoy today's symposium and will join us for future events.

Antonio F. Machado, PhD	**Bob Finkelstein, MS**	**Elizabeth Chung**
Symposium Co-Chair	**President & Co-Chair**	**President & Co-Chair**
EOH Department	**EOH Alumni Chapter**	**EOH Student Association**

Program Schedule

7:30 - 8:00	**Registration and Refreshments**
8:00 - 8:15	**Regulating Environmental Pollutants; Perchlorates and Other Thyroid-Active Chemicals. Antonio F. Machado, Ph.D., REHS;** Associate Professor, Department of Environmental and Occupational Health, California State University Northridge.
8:15 - 9:05	**Function and Regulation of the Hypothalamus-Pituitary-Thyroid Axis. Gregory Brent, M.D.;** Professor of Medicine and Physiology, UCLA School of Medicine; Chair Department of Medicine, VA Greater Los Angeles Healthcare System.
9:05 - 9:55	**Thyroid Active-Chemicals: Exposure, Toxicity and Biological Health Effects. R. Thomas Zoeller, Ph.D.;** Professor and Chair, Department of Biology, University of Massachusetts.
9:55 - 10:15	**Break & Vendor Exhibits**
10:15 - 11:00	**Thyroid-Active Environmental Chemicals: Exposure during Pregnancy and Lactation. Ami Zota, Sc.D.;** Program on Reproductive Health and the Environment, University of San Francisco.
11:00 - 12:00	**Thyroid-Active Chemicals: Molecular Mechanisms of Action and Potential Health Implications.** Graduate Student Presentations.
12:00 - 12:45	**Lunch & Vendor Exhibits**
1:00 - 1:55	**Environmental Sampling, Analysis, and Remediation of Perchlorate in Soil. Dixie A. Hambrick, M.S.;** Principle Hydrogeologist, MWH Americas, Inc.
2:00 - 2:50	**Human and Ecological Risk Assessment: Perchlorate Case Studies. Michael Sullivan, Ph.D.;** Associate Professor, Department of Environmental and Occupational Health, California State University Northridge **.**
2:50 - 3:05	**Break, Vendor Exhibits, and Raffle**
3:05 - 3:35	**Perchlorate Contamination: Fate and Transport in Groundwater. Matt Becker Ph.D.;** California State University, Long Beach; Dept. of Toxic Substances Control Consultant.
3:35 - 4:20	**California's Green Chemistry Initiative: A New Landscape for Chemicals. Megan Schwarzman, M.D., MPH;** Research Scientist, University of California, Berkeley School of Public Health.
4:20 - 4:30	**Environmental Pollutants and Health Effects: What Will The Future Bring? Antonio F. Machado, PhD., REHS.**

This event qualifies for .8 contact hours (.8 CEU's) for professional continuing education.

Please see Technical Symposium staff if you have questions about receiving credit.

*Your opinion is important to us. Please complete and hand-in the **Attendee Survey Form** before you leave the event.*

Thyroid-Active Chemicals: Molecular Mechanisms of Action and Potential Health Implications.
Graduate Student Presentations

Thyroid-Active Chemicals in our Environment:*

Bisphenol A (BPA):

◊ **Breanne Puff, Robin Whitney, Nooshin Rahmat**

Hexachlorobenzene (HCB):

◊ **Breanne Puff, Robin Whitney, Nooshin Rahmat**

Perchlorate, Nitrate and Thiocyanate:

◊ **Jeannine Darrett, Yu Chin Chung**

Polybrominated Diphenyl Ethers (PBDEs):

◊ **Michelle Horwitz, Maggie Kong**

Polychlorinated Biphenyls (PCBs):

◊ **Frederick Huynh, Tiffany Tran**

Triclosan:

◊ **Lauren Walters, Michael Nardone**

Phthalates:

◊ **Bianca Lugo, Jennifer Vasquez**

***Presentations and materials prepared in collaboration with Dr. Machado.**

2012 Environmental and Occupational Health Technical Symposium

Speakers

Antonio Machado, PhD, REHS

Regulating Environmental Pollutants; Perchlorates and Other Thyroid-Active Chemicals.

Dr. Machado, PhD, REHS: A graduate of CSUN and UCLA, Dr. Machado's expertise is in molecular toxicology and teratology. A former student of Nobel Laureate Louis Ignarro, Doctor Machado's research focuses on gene-environment interactions. He is also the coordinator of our student group EOHSA. Dr. Machado recently served as chair of the California Registration Board for Environmental Health Specialists (an appointment approved by the California Governor).

Gregory Brent, PhD

Function and Regulation of the Hypothalamus-Pituitary-Thyroid Axis.

Dr. Brent completed a clinical endocrinology fellowship at the Brigham and Women's Hospital and a research fellowship in the Department of Genetics, Harvard Medical School. He is currently Professor in Residence of Medicine and Physiology, David Geffen School of Medicine at UCLA and Chair, Department of Medicine, VA Greater Los Angeles Healthcare System. His research interests include the molecular mechanisms of thyroid hormone and retinoic acid action, iodine transport in hormone-dependent cancers and thyroid disease in pregnancy. Dr. Brent has published over 100 papers, reviews, and chapters, mostly on thyroid hormone action and thyroid diseases. Dr. Brent is past President of the American Thyroid Association (ATA) and past Secretary/Chief Operating Officer and Board Chair of the ATA. Dr. Brent has organized and chaired a range of programs for the ATA on basic science and clinical topics, including thyroid disease in pregnancy, thyroid hormone and neural development, thyroid hormone regulation of metabolism, thyroid disease and aging, and the influence of environmental toxicants on the thyroid. He is an elected member of the American Society for Clinical Investigation and Association of American Physicians. He is past chair of the National Institutes of Health, Molecular and Cellular Endocrinology Study Section. He was previously on the editorial boards of Journal of Clinical Endocrinology and Metabolism, Molecular Endocrinology and Endocrinology, and formerly an Associate Editor of Thyroid. He was a member of the National Academy of Sciences panel for Assessment of the Health Implications of Perchlorate Ingestion. Dr. Brent has received the Van Meter Prize and Ingbar Award of the

R. Thomas Zoeller, PhD

Thyroid Active-Chemicals: Exposure, Toxicity and Biological Health Effects

Dr. R. Thomas Zoeller, Ph.D., is Professor of Biology at the University of Massachusetts, Amherst. He was trained in comparative endocrinology and molecular neuroendocrinology, and his current research focuses on the role of thyroid hormone in brain development with an emphasis on the fetal brain. Dr. Zoeller was appointed to the U.S. EPA's EDSTAC working group on Screening and Testing from 1996-1998, and became interested in the problem of endocrine disruption. His lab now also focuses on the mechanisms by which EDCs can interfere with thyroid hormone action in association with adverse effects on developmental events in the brain. Dr. Zoeller was a member of advisory committees evaluating human risk for the thyroid toxicant ammonium perchlorate at the state (Massachusetts) and federal levels. He has served on editorial boards of endocrine journals, various grant review panels at the NIH, NSF and EPA, and is currently a member of the US EPA's Science Advisory Board and chair of the Exposure and Human Health Committee. Dr. Zoeller received the "Scientist of the Year – 2002" from the Learning Disabilities Association and is a Conti Research Fellow at the University of Massachusetts.

2012 Environmental and Occupational Health Technical Symposium

Speakers

Ami Zota, Sc.D

Thyroid-Active Environmental Chemicals: Exposure during Pregnancy and Lactation

As an environmental health scientist at the Program on Reproductive Health, Dr. Zota conducts human exposure assessment and epidemiological studies on endocrine-disrupting environmental chemicals. Her current research is centered on addressing the cumulative impacts of social and environmental factors on reproductive outcomes, with a focus on early life exposures. She recently received a career development award from the National Institutes of Health to examine the independent and potentially synergistic effects of PBDE flame retardants and chronic psychosocial stress on thyroid-mediated outcomes during pregnancy.

Dixie Hambrick, MS

Environmental Sampling, Analysis, and Remediation of Perchlorate in Soil

Dixie A. Hambrick is a California Registered Professional Geologist who works as a Principal Hydrogeologist for MWH Americas, Inc. in Arcadia, California. She received her B.S. in Geology from Pennsylvania State University and her M.S. in Geology from the University of Arizona. She has over 20 years of experience consulting for industrial clients directing and implementing soil and groundwater contamination investigations, groundwater-supply studies, and mineral resource evaluations. She has acted as program manager for large remedial projects requiring multidisciplinary teams, and has managed cleanups for a variety of contaminants including VOCs in groundwater, and PAHs, PCBs, dioxins, pesticides/herbicides, heavy metals, and perchlorate in soils.

Michael Sullivan, PhD

Human and Ecological Risk Assessment: Perchlorate Case Studies

Dr. Sullivan is Professor of Environmental and Occupational Health at California State University at Northridge. He teaches in the areas of industrial hygiene, toxicology, epidemiology, hazardous waste, statistical-based environmental sampling and risk assessment. His areas of research are on understanding variability in environmental data and historical dose reconstruction. He has recently published papers on heavy metals in bottled water and developing parameters for unique exposure scenarios. Dr. Sullivan has a B.S. in Environmental Toxicology from the University of California at Davis and a M.Sc. and Ph.D. in Toxicology from the University of Michigan. He did post-doctoral research on the effects of heavy metals on the developing otocyst at Albert Einstein College of Medicine in New York City. He is a California Registered Environmental Assessor and a Certified Industrial Hygienist.

Dr. Sullivan also maintains a professional practice in the areas of industrial hygiene, risk assessment, community outreach, and historical dose reconstruction. He has served as an expert witness in numerous cases related to public and worker exposures to chemicals that took place decades earlier. Dr. Sullivan is the current President of the Southern California Chapter of the American Industrial Hygiene Association and serves on the Risk Assessment Committee of the American Industrial Hygiene Association where he teaches

2012 Environmental and Occupational Health Technical Symposium

Speakers

Matt Becker, PhD

Contamination: Fate and Transport in Groundwater

Matt Becker is the Conrey Chair in Hydrogeology and Professor in the Geological Sciences Department at California State University Long Beach. With 20 years of experience in hydrology, he has held positions at Los Alamos National Labs, NASA Goddard Space Center, and was a Fulbright scholar at the University Trento, Italy. Prior to arriving at the CSULB he was an Associate Professor of Geology at the University of Buffalo, New York. Dr. Becker has worked in diverse areas related to hydrology including, tracer and hydraulic characterization of bedrock systems, remote sensing, hydrogeophysics, and numerical modeling.

Megan Schwarzman, PhD,

Megan Schwarzman, PhD, MD

California's Green Chemistry Initiative: A New Landscape For Chemicals

Dr. Schwarzman's work focuses on endocrine disrupting substances, reproductive environmental health, U.S. and European chemicals policy, and how to use environmental health knowledge to design safety and sustainability into the chemical building blocks of materials. She works to extend this knowledge to inform education, the research community, and public policy.

Dr. Schwarzman is a research scientist at the Center for Occupational and Environmental Health (COEH), in UC Berkeley's School of Public Health and serves as Associate Director of Health and Environment for the interdisciplinary Berkeley Center for Green Chemistry. She earned her medical degree from the University of Massachusetts, completed her specialty training in Family Medicine at the University of California, San Francisco, and earned a master's of public health from the University of California, Berkeley. Dr. Schwarzman also practices family medicine part time at San Francisco General Hospital. Key publications: New Science for Chemicals Policy. Schwarzman M and Wilson M. *Science,* 326, 20 November, 2009. Pathways to Breast Cancer: A Case Study for Innovation in Chemical Safety Evaluation. Schwarzman M, and Janssen S. Regents of the University of California. July, 2010. Toward a New U.S. Chemicals Policy: Rebuilding the Foundation to Advance New Science, Green Chemistry and Environmental Health. Wilson M and Schwarzman M. *Environmental Health Perspectives.* 117 August, 2009 in Chemical Engineering.

Speaker Abstracts

Function and Regulation of the Hypothalamus-Pituitary-Thyroid Axis. Gregory Brent, M.D.; Professor of Medicine and Physiology, UCLA School of Medicine; Chief, Endocrinology and Diabetes Division, VA Greater Los Angeles Healthcare System.

Thyroid hormone synthesis and secretion, as well as iodide uptake mediated by the sodium/iodide symporter (NIS), is regulated by thyrotropin (TSH). TSH is a glycoprotein hormone produced from the anterior pituitary with an α subunit, common to all anterior pituitary releasing hormones, and a unique β subunit. TSH is secreted in a pulsatile manner and circadian pattern, with its levels highest at night when cortisol is lowest. TSH secretion is precisely controlled by the hypothalamic peptide thyrotropin-releasing hormone (TRH) and by the concentration of free thyroid hormones in the circulation. Although both the prohormone, thyroxine (T4), and the active hormone, triiodothyronine (T3), inhibit TSH, T4 is the primary physiologic regulator. This is because the primary source of T3 in the pituitary and hypothalamus is local production from T4 by the action of the Type 2 5'-deiodinase (D2). T4 is also preferentially taken up in the pituitary by the monocarboxylic acid transporter 8 (MCT8). Thyroid hormone inhibits transcription of both the TRH gene and the genes encoding the α and β subunit of thyrotropin, which suppresses the secretion of TSH and causes the thyroid to become inactive and regress. Somatostatin, dopamine, and pharmacological doses of glucocorticoids inhibit TRH-stimulated TSH secretion. Any reduction in the normal rate of thyroid hormone secretion by the thyroid, due to conditions such as iodine deficiency, external radiation, or thyroid autoantibodies, evokes an enhanced secretion of TSH to stimulate the thyroid to secrete more hormone. Secretion of TSH in excess results in the thyroid becoming hyperplastic and enlarged. The enlarged and stimulated thyroid becomes remarkably efficient at extracting the residual traces of iodide from the blood and can compensate for modest iodine deficiency or other insults to thyroid function. Models of impairments of thyroid function provide insights into the modes and effectiveness of thyroid compensation and inform studies of the impact of thyroid toxicants.

THYROID ACTIVE-CHEMICALS: EXPOSURE, TOXICITY AND BIOLOGICAL HEALTH EFFECTS. R. Thomas Zoeller, Ph.D.; Professor, Department of Biology, University of Massachusetts-Amherst.

Endocrine disrupting chemicals (EDCs) can be defined as exogenous chemicals or mixtures that can interfere with any aspect of hormone action. Recent studies demonstrate that EDCs can interfere with thyroid hormone action in two general ways: by interacting directly with the thyroid hormone receptor(s), or by interacting directly with some aspect of the system that delivers biological active hormone to the target cells. These data indicate that some mechanisms of thyroid disruption may also disrupt the relationship between circulating levels of thyroid hormone and downstream effects. Identifying the consequences of this disruption requires an appreciation for the pleiotropic nature of thyroid hormone effects, and the role of timing in hormone action. A large literature exists evaluating the effects of polychlorinated biphenyls (PCBs) on thyroid hormone action. This literature should help guide us as we evaluate the public health implications of similar lipophilic compounds that bioaccumulate. Chemicals like perchlorate are more challenging in some ways because they have such a short half-life in the body and linking temporally specific exposure to effects is difficult. Because of the role of thyroid hormone in development, risk assessments should explicitly focus on fetal and neonatal life stages.

Thyroid-Active Environmental Chemicals: Exposure During Pregnancy and Lactation. Ami Zota, Sc.D., MS. Postdoctoral Fellow, Program on Reproductive Health and the Environment, Department of Obstetrics, Gynecology, and Reproductive Sciences, University of California, San Francisco.

Many of the modern synthetic chemicals used in our personal care products, home furnishings, food packaging, and building materials are hormonally active and able to disrupt the thyroid system. Human exposure to thyroid-disrupting environmental chemicals is ubiquitous in the US population including pregnant women. Pregnant women may be particularly vulnerable to the effects of thyroid toxicants since pregnancy represents a period of increased demand on the thyroid gland. Environmental exposures occurring during sensitive periods of prenatal development can contribute to thyroid-mediated adverse health outcomes such as maternal thyroid hormone disruption and impaired neurodevelopment in children.

This presentation will examine the public health implications of human exposure to thyroid-active chemicals during pregnancy. We will focus on several classes of thyroid-disrupting environmental chemicals including perchlorate, phthalates, polychlorinated biphenyl ethers (PCBs), polybrominated diphenyl ethers (PBDEs), and perfluorinated chemicals (PFCs). By the end of the presentation, attendees will be familiar with: sources of chemicals in our everyday living; primary routes of human exposure; chemical biomonitoring data for pregnant women and the developing fetus; and epidemiologic evidence linking chemical exposures during pregnancy and thyroid-mediated adverse health outcomes in pregnant women and children.

Speaker Abstracts

Environmental Sampling, Analysis, and Remediation of Perchlorate in Soil. Dixie A. Hambrick, M.S.; Principle Hydrogeologist, MWH Americas, Inc. Presentation based on materials co-authored by Dixie A. Hambrick, M.S., MWH Americas, Inc., Arcadia, CA and Elizabeth A. Wessling, M.S., MEC^{x} LP, Denver, CO.

Perchlorate is a highly mobile chemical with unique characteristics that require specialized approaches for field sampling, laboratory analysis, data review, and remediation. Characterization strategies for perchlorate in soil focus on source area depositional patterns, as well as groundwater and surface water migration pathways since it is highly soluble. Specialized sampling methods have been used to enhance the likelihood of detecting perchlorate in soil. Investigation approaches for both soil and groundwater may also have to account for the presence of perchlorate 'background' since it is present at low concentrations in soils throughout the arid southwest and in municipal water supplies.

Specialized analytical laboratory protocols for reliably detecting low perchlorate concentrations have evolved over time as regulatory and risk-based cleanup goals changed. Perchlorate analysis began as a simple anion analysis, but has expanded to include an ion chromatography method specific to perchlorate mass spectrometry analysis with parent and daughter isotope ratios, bioassay methods, and a specialized isotope ratio analysis to differentiate naturally occurring perchlorate from anthropogenic perchlorate. The more common, relatively inexpensive ion chromatography methods are susceptible to interferences and require data review to identify false positives. Mass spectral methods are useful for confirmatory analysis, but are more expensive and not available at all laboratories.

Remedial methods for perchlorate in soil include excavation and offsite disposal, as well as more sustainable *in-situ* bioremediation technologies. Challenges of *in situ* remediation for soil depend on the type and scale of the project, but may include water or nutrient delivery, effective treatment depths, and local permitting requirements.

Human and Ecological Risk Assessment of Perchlorate in Soil: A Case Study. Michael J. Sullivan, Ph.D., CIH, REA; Professor of Environmental and Occupational Health, California State University Northridge.

Once released into the environment, perchlorate can distribute into various environmental media. The presence of perchlorate in these media can pose an unacceptable risk to human health and ecological receptors due to their contact with these contaminated media. Cleanup of perchlorate-contaminated sites would have the goal of reducing environmental concentrations to levels which do not pose an unacceptable health risk.

Human health and ecological risk assessments therefore play a central role in the determination of the need and extent of cleanup of perchlorate-contaminated soil. The first step is to develop a comprehensive and accurate Conceptual Site Model (CSM). The CSM shows the relationships between perchlorate release, migration, media contamination, and ultimately human and ecological exposures. The CSM is central to the risk assessment process in that it informs the risk assessor about applicability of characterization data, identification of exposure scenarios to evaluate, and where information gaps exist.

A case study is presented for a site with perchlorate soil contamination. Human exposure scenarios include the residential future land use with the potential for backyard gardening. A second human exposure scenario is for future recreational land use. The ecological risk assessment includes evaluation of small burrowing mammals, carnivores, birds, and the mule deer. The risk assessment addresses the issue of varying exposure areas for the human and ecological receptors. The scientific data on perchlorate uptake from soil into plants is discussed. In locations where perchlorate concentrations are above acceptable levels, cleanup is recommended and post-cleanup residual concentrations are evaluated for residual health risk. A proposed strategy to balance the results of the human and ecological risk assessments is discussed.

Speaker Abstracts

Perchlorate Contamination: Fate and Transport in Groundwater. Matt Becker Ph.D.; California State University, Long Beach; Dept. of Toxic Substances Control Consultant.

Detection of perchlorate in groundwater has been increasingly frequent across the United States. Often, the appearance of perchlorate in a drinking water well is followed by finger pointing at neighboring industrial and/or agricultural activities which employ perchlorate containing compounds. However, designation of a potentially responsible party is a serious matter and should not be based upon solely on the presence of potential releases of chlorate to the environment. Investigations of groundwater fate and transport may help localize the potential sources of perchlorate contamination and provide a reality check on investigation of potentially responsible parties. Perchlorate is very soluble in water, resistant to chemical and biological attenuation, and does not strongly adsorb to natural mineral surfaces. As a result, it is considered to be a highly mobile contaminant and can potentially travel great distances through the subsurface. Transport can only occur in the direction of groundwater flow, however. This transport is extremely slow and physical and chemical processes can slow perchlorate relative to groundwater velocity. Thus, for suspected source zone to be responsible for contamination some distance away, certain physical conditions must be satisfied. The purpose of this presentation is to introduce the concept and practice of groundwater fate and transport prediction as it pertains to perchlorate exposure from groundwater. The case of the Santa Susana Field Laboratory will be used as an example to explore public pressure and the scientific response to perchlorate detection in the nearby Simi Valley, California.

California's Green Chemistry Initiative: A New Landscape for Chemicals. Megan Schwarzman, M.D., MPH; Research Scientist, University of California, Berkeley School of Public Health.

Four years ago, California launched the Green Chemistry Initiative, an ambitious program to transform the state's approach to managing chemicals and products. Legislation enacted under the Initiative seeks to embed the search for safer alternatives into the process of chemical regulation, with potential benefits for workers, consumers, and the environment. While the full impact of the new program is still to play out, this session will explore how the regulations incorporate the science of endocrine disrupting chemicals, and how they could alter the landscape of chemicals and products in California.

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