



Recognizing

30

YEARS

Improving the lives
of workers through
biomedical and
occupational research



Oregon Institute of Occupational
Health Sciences

2017 - 2018

Biennial Report

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About Us

The Oregon Institute of Occupational Health Sciences is dedicated to improving the health and safety of the workforce. We work to promote health, and prevent disease and disability among working Oregonians and their families. We do so through basic and applied research, outreach and education.

Preventing Illness and Injury

We work to prevent illness and injury in partnership with labor, industry, government and the community. As part of Oregon Health & Science University — Oregon's only academic health center — we embrace the university's multifaceted mission of healing, teaching, discovery, and community service to improve the well-being of people in Oregon and beyond.

How We Accomplish This Mission

We conduct research, train health and safety professionals, provide consultation, and offer the public information on occupational health and safety through our Resource Center. The Oregon Institute of Occupational Health Sciences comprises more than 60 scientists and research staff exploring a range of questions relating to the prevention of injury and disease, and the promotion of health in the workforce.

Funding

We receive essential base funding through Oregon's Workers' Compensation system. We leverage this investment to obtain highly competitive federal grants that bring in more than twice the dollars provided by the Oregon base funding, substantially magnifying our impact on Oregon. While our research receives national and international acclaim, our goal is to create safe, healthy workplaces right here in Oregon. Our Advisory Committee ensures stakeholder input to the direction of the Institute and the use of its state funds.

Learn about the Oregon Institute of Occupational Health Sciences and Use Our Services

As part of our outreach, we want you to know about the work we do, and how it benefits workers and businesses in Oregon. We invite you to browse our website, meet our outreach team at conferences, attend our health and safety symposia, consider our scientific seminars by our research faculty, or visit the Institute to learn more and use us as a resource. But first, meet our Director, Professor Steven Shea, PhD.

A Message from Our Director



Steven A. Shea PhD

I am proud to present the 2017-2018 Biennial Report for the Oregon Institute of Occupational Health Sciences. In 1988, the State of Oregon followed its brave, pioneering roots in a highly innovative and far-sighted way by setting aside funds derived from workers' compensation reserves to provide base support for a new "Center for Research on Occupational & Environmental Toxicology" (CROET) at OHSU. Notably, in 2015 by Oregon Statute ORS 353.460 the name of the center was changed to the "Oregon Institute of Occupational Health Sciences" (Occ Health Sci), to better reflect our ongoing activities.

The purpose of the Institute includes *"reducing the incidence of disease and reducing the costs and dangers to employers and employees associated with occupational disease"*. Functions of the Institute were envisioned to encompass: *"Basic and applied research into the incidence and causes of occupational diseases; Epidemiology and other data collection; Design of programs for clinical management of occupational diseases; and Education and training programs"*. This Biennial Report marks 30 years of our accomplishments in these areas. Despite the name change, research on occupational exposures and toxicology continues, whereas there has been growth into additional areas too. Currently, our endeavors are aligned into five thematic areas:

- (1) Total Worker Health (i.e., combined safety and health interventions);
- (2) Exposure Biology: Role of Genome Instability in Human Disease;
- (3) Injury, Treatment, Recovery and Prevention;
- (4) Sleep and Shiftwork: Impact on Health and Safety; and
- (5) Outreach (including education).

Details of recent accomplishments in these areas are provided in the following pages and exemplified by our list of publications and awarded grants (pages 36-43). It should be evident that the Institute's faculty and staff are a devoted and nationally recognized team of scientists, whose work stretches from molecular-level research, to clinical studies, to programs in the workplace, to training health and safety professionals, and to offering the public information on all of these programs.

Over the past two years we have grown substantially. Due to increasing federal grant awards and additional support from OHSU and our base funding, we have been able to make a commitment to recruit four new faculty members: Xiaoquan Rao PhD, whose research focuses on the health effect of environmental pollutants such as particulate matter; Saurabh Thosar, PhD, OTR/L, who studies the physiology of sedentary behavior and physical activity as they relate to cardiovascular disease; and Caren Weinhouse, PhD, who studies the mechanisms for adverse or adaptive epigenetic changes in response to environmental exposures that are relevant to human health. The fourth new position in safety climate research will be filled in 2019.

Finally, although major progress has occurred over these 30 years, some things remain the same. Notable in that regard, Peter Spencer, Ph.D., FANA, FRCPath, the founding director of CROET is still affiliated with our Institute (see page 19). And W. Kent Anger, Ph.D. has been a mainstay at the Institute and currently serves as the Associate Director of Applied Research and Director of the Oregon Healthy Workforce Center housed in our Institute. The image on the cover of this Biennial report exemplifies Kent's contributions across those 30 years and show him making careful measurements in the field in 1988, whereas on page 27, you will see him enthusiastically engaging with a participant at the Oregon Governor's Occupational Safety & Health Conference (GOSH) this year.

By applying research discoveries and integrating these with workplace interventions we strive to make a significant contribution to human safety, health and wellbeing. We look forward to another 30 years of helping the workforce to avoid disease and accidents, to improve their overall health and wellbeing, and to thrive.

Respectfully submitted,

A handwritten signature in blue ink that reads "Steven A. Shea Ph.D.".

Steven A Shea, Ph.D.

Director

Our Mission

Improving the lives of workers through biomedical and occupational research



Your health doesn't exist in isolation from your work. The air you breathe, the food you eat, the quality of your sleep, your access to exercise, the likelihood of you succumbing to illness or injury -- all are affected by your working life. That's why we are here. Since 1988 we have stood firmly at the intersection of the workplace and well-being. We are an internationally recognized team of scientists, and our work stretches from molecular-level research, to clinical studies, to programs in the workplace. We are dedicated to making a significant contribution to human safety, health and well-being.

At the Oregon Institute of Occupational Health Sciences, we are applying research discoveries, integrating workplace safety, health and well-being, and creating actionable strategies to support the whole health of workers. Together with our network of partners, we are setting the stage for a thriving workforce and better health in Oregon and beyond.

Oregon Institute of Occupational Health Sciences

30 YEARS

Selected Highlights

1988 – Peter Spencer PhD, FANA, FRCPath appointed Director and Senior Scientist of Center for Occupational Disease Research (CODR).

1990 – Mahonia Hall and Workers' Compensation reforms inform CROET's growth.

1993 – CROET's Summer Internship program begins.

1988 – CODR renamed the Center for Research on Occupational and Environmental Toxicology (CROET).

1993 – CROET establishes Toxicology Information Center.

1995 – Joint graduate program between CROET and Oregon State University School of Veterinary Medicine becomes active.

1999 – CROET website expands to provide resource information and training to Occupational Health and Safety professionals, ultimately expanding to the comprehensive resource directory it is today.

2004 – CROET begins providing safety, health, and well-being training at all Oregon OSHA conferences.

2003 – Oregon joins 13 states in the NIOSH-sponsored Fatality Assessment and Control Evaluation (FACE) program. CROET leads the program in Oregon.

2008 – CROET scientists, R. Stephen Lloyd PhD and Amanda McCullough PhD, discover and characterize enzymes that can be used to repair UV-induced DNA damage in people excessively exposed to sunlight, such as outdoor workers.

2010 – Kent Anger, PhD identifies chlorpyrifos as a neurotoxic pesticide in workers, the 6th neurotoxic substance identified with cognitive behavioral tests.

2011 – Charles Allen, PhD receives Faculty Senate Award for Service at OHSU.

2013 – House Bill 2909 renames CROET to Oregon Institute of Occupational Health Sciences.

2015- Doris Kretzschmar, PhD and colleagues discover mutations in the human sws gene cause inherited diseases that range from childhood blindness to movement disorders.

2017 – Ryan Olson, PhD disseminates COMPASS, a Total Worker Health program for homecare workers, with the Oregon Home Care Commission.

2018 – Xiaoquan Rao, PhD establishes state-of-the-art whole-body air pollution exposure system at the Institute.

2011 – Oregon Healthy Workforce Center (OHWC), a NIOSH Center of Excellence in Total Worker Health® is established and housed within the Institute.

2012 – Steven Shea, PhD is appointed CROET Director.

2014 – Kent Anger, PhD receives Faculty Senate Award for Collaboration.

2016 – Leslie Hammer, PhD disseminates SHIP, a Total Worker Health program designed to reduce work-life stress and improve supportive supervisor behaviors.

2017 – Oregon Healthy Workforce Center receives GOSH Conference award for Safety and Health Advocate Team.

2018 – Steven Shea, PhD receives Faculty Senate Leadership Award to recognize substantial contributions towards achieving the missions of OHSU over the preceding 5-years.

Our Areas of Emphasis



Sleep and Shift Work:
Impact on Health and Safety



Exposure Biology:
Genome Instability and Human Disease



Injury, Treatment, Recovery and Prevention



Total Worker Health® Interventions



Outreach



Summer Internships



Sleep and Shift Work: Impact on Health and Safety

Adequate sleep is essential for a healthy life: our well-being, our safety and our productivity depend on it. But to get the most healthful sleep, it needs to occur within the context of our natural internal clock, which generates our circadian rhythms. Disruption of this natural rhythm, as often occurs during shift work, can result in a variety of common adverse health conditions over time, including obesity, diabetes, heart disease, and cancer. Our researchers have been studying sleep and circadian rhythms on many levels, from cells, whole animals, and in humans both in the laboratory and in the natural working environment.



Charles N Allen, PhD

Professor, Oregon Institute of Occupational Health Sciences
Professor, Behavioral Neuroscience, OHSU School of Medicine

Human society has rigid schedules for work, school, and social activities. These schedules frequently require people to work and be active when their endogenous circadian clock is signaling that it is time to sleep. The master circadian clock, located in the suprachiasmatic nucleus (SCN) of the hypothalamus, maintains the proper phase relationship between circadian clocks located in the tissues and organs throughout the body and entrains the circadian system to the environment. The SCN is composed of individual neuronal oscillators linked into a network that generates a precise rhythm. The long-term goal of our research is to understand the signaling mechanisms that couple SCN neurons into a network that generates circadian rhythms so that these can be regulated to improve sleep and health.

Role of GABAergic Neurotransmission in SCN Neuronal Network Activity

GABA is the most abundant neurotransmitter in the SCN. However, it remains largely unknown how GABA regulates the activity and synchrony of the SCN neural network. We are using fluorescence imaging of circadian clock gene activity and electrophysiological methods to examine the effects of selective modulation of either the synaptic or tonic GABA current on the synchrony of SCN neurons.

Role of Chloride Transporters in Regulating GABA Neurotransmission

GABA may serve as both an inhibitory and excitatory neurotransmitter although the physiological significance of this change in the polarity of GABA neurotransmission remains poorly understood. We propose that the circadian clock uses intracellular second messenger systems to regulate the activity of the chloride (Cl⁻) cotransporters. We are testing whether circadian regulation of Cl⁻ cotransporter

activity alters the robustness of the circadian rhythm and the synchrony of the circadian clocks in SCN neurons. Single cell electrophysiological recording and Cl⁻ imaging techniques are being used to examine the signaling mechanisms that regulate Cl⁻ cotransporter activity.

Role of Astrocytes and GABA Transporter in SCN Network Activity

The complex network of SCN neurons and astrocytes, which also express molecular clocks, is required for a precise and stable circadian signal. Astrocytes regulate neuronal function in multiple ways, from buffering extracellular ion and neurotransmitter concentrations, to regulating blood oxygen and metabolism, and actively responding to external cues through intracellular signaling molecules such as calcium and inducing the release of neuromodulators such as ATP, glutamate, or adenosine. Astrocytes regulate circadian clock gene expression and neuronal synchrony in culture systems, but how astrocytes regulate neuronal function within the SCN remains largely unknown. SCN astrocytes respond to the light-dark cycle with changes in activity and morphology, which may be an essential modulator of synaptic transmission in the SCN. We are testing how astrocytes are a crucial component of the SCN network and astrocyte rhythmicity is necessary for proper photic entrainment and that astrocytes modulate the circadian period length.



Charles Allen Lab: Michael Modavan, PhD, Olga Cravetchi, PhD, Nate Klett, PhD, Charles Allen, PhD, Lauren Hablitz, PhD.



Matthew P Butler, PhD

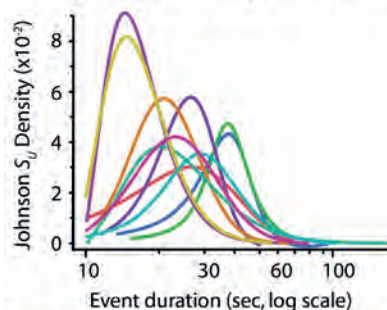
Assistant Professor, Oregon Institute of Occupational Health Sciences

In 2017-2018, Dr. Butler's laboratory was primarily focused on sex differences in how sleep and circadian rhythm disorders, like shift work, affect health. Using the Sleep Heart Health Study to study the long-term consequences of sleep apnea, they found that in addition to how many breathing interruptions occur, the durations of the apneas are also important. Surprisingly, the patients with the shortest apneas were more likely to die during the study's decade of follow-up. Importantly, this held true for both women and men – in contrast, the current diagnostic criteria based on the apnea-hypopnea index (AHI) turns out to not predict long term risk in women.

Epidemiological studies set the tone for targeted mechanism research in the Butler Lab. For example, to better understand how shift work reduces fertility in human populations, Dr. Butler's lab studies a model of shift work based on eating at the wrong time of day. Mice that eat when they should be sleeping have reduced fertility. They found that this stems from compromised mating behavior that could be due to desynchrony between circadian rhythms of rest and activity and circadian rhythms within the reproductive system.

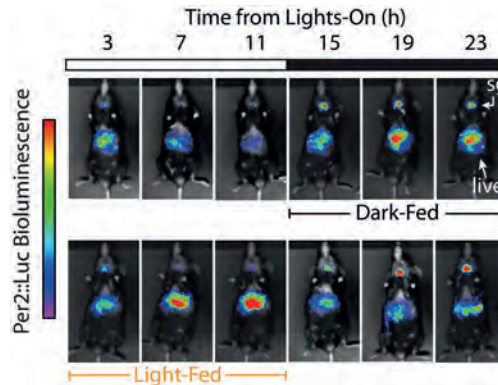
Finally, to determine how sex differences are coded in the brain, the Butler Lab continues to study how male and female hormones modulate the speed and timing of the brain's circadian clock. This occurs because different hormones change the sensitivity of the clock to light. By combining behavior, neural network modeling, and single cell neuronal physiology, the Butler Lab is investigating the fundamental question of how hormones shape how the brain works.

Sleep Heart Health Study (n=10, AHI=40)

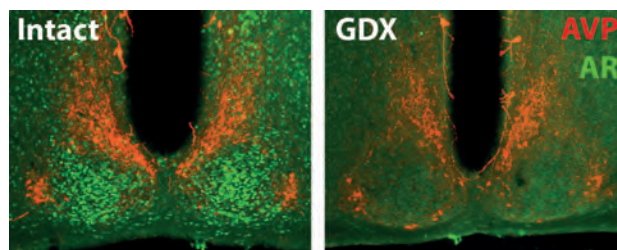


Respiratory event duration variability.

This figure shows the strong inter-individual variability in the duration of obstructive events. All ten subjects had an apnea hypopnea index of 40, but mean duration ranged from 19 to 41 sec. We have found that short events are significant predictors of mortality, independent of AHI.



By measuring the light emitted from living animals, we can track the timing of the circadian clock in multiple tissues, like the salivary gland (top panel) and the liver (bottom panel). In this model of night-eating, we find that food resets the clock in the liver but not the salivary gland.



To understand sex differences in the circadian rhythm, we study how androgens like testosterone act at androgen receptors (AR) in the brain clock. The area of the clock is demarcated by red arginine vasopressin (AVP) staining.



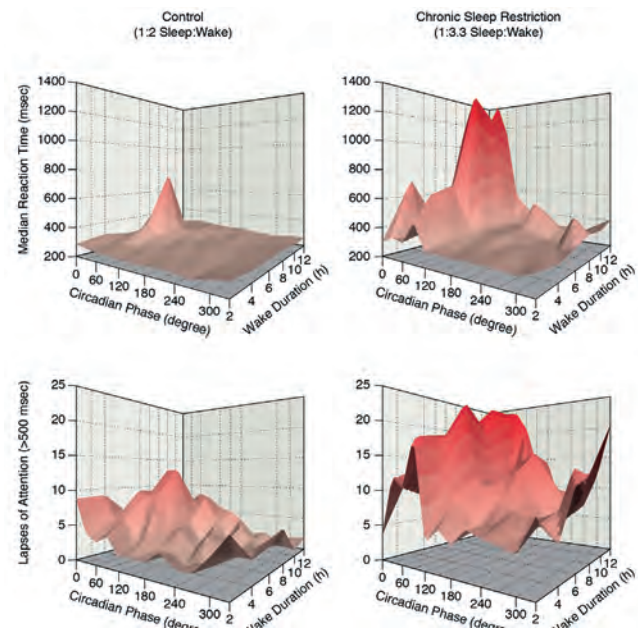
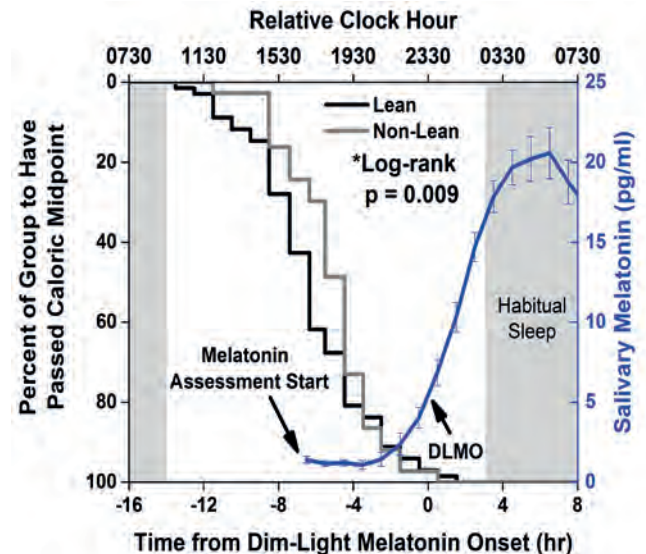
Andrew McHill, PhD

Research Assistant Professor, Oregon Institute of Occupational Health Sciences

Dr. McHill's laboratory focuses on understanding why insufficient sleep and being awake during the night leads to poorer health and impaired cognitive performance. In particular, Dr. McHill studies how eating when our body is promoting sleep influences energy expenditure, glucose metabolism, cardiovascular health, and overall body composition.

Obesity has reached epidemic proportions. Previous research has linked poor diet to high body fat, and eating later in the day has been described as a risk factor for weight gain. We found that the timing of food intake relative to melatonin onset is associated with higher percent body fat, whilst clock-hour, amount, or composition of calories are not associated with body composition. We also demonstrated that sleep restriction plays a limited role in the circadian variation in hormones that promote hunger and that eating at the wrong time can alter the plasma proteome.

We were also interested in the impact of chronic sleep restriction on cognitive performance. We found that chronically sleeping the equivalent of approximately 5.5 hours a night, without extending wakefulness duration, leads to almost five times the performance impairment as compared to an individual sleeping 8 hours a night. These results uncover a fundamental aspect of human biology: sleep duration is important, even without prolonged wakefulness. This work moves our field forward by revealing basic sleep physiology in humans, and has implications for the millions of individuals who chronically obtain insufficient sleep, the substantial population that works during the night, and all of us who depend on safety-sensitive occupations at all times of the day and night.



Interaction of circadian phase, hours of wakefulness, and psychomotor vigilance task (reaction time [RT]) performance. Higher median RT and number of lapses (RT >500 msec) indicate worse performance.



Steven A Shea, PhD

Director, Oregon Institute of Occupational Health Sciences
 Professor, Oregon Institute of Occupational Health Sciences
 Professor, OHSU-PSU School of Public Health

Professor Shea has over 30 years' experience performing clinical research, mainly focused on studies of circadian rhythms in humans and their impact on cardiovascular disease. The severity of many diseases varies across the 24-hour period. For example, heart attacks occur most frequently in the morning. The focus of Dr. Shea's research is to understand the biological basis behind these daily changes in disease severity, in particular, to determine the extent to which they are caused by the body internal clock (circadian pacemaker) or attributable to behaviors that occur on a regular daily basis, such as the sleep/wake cycle. These studies provide insight into the underlying causes of disease and could lead to better therapy (e.g. appropriate timing of medication), and countermeasures to reduce the adverse health effects of night shift work.

Over the past two years, Dr. Shea's research has been performed in specialized laboratories of the Oregon Clinical & Translational Research Institute at OHSU that permit precise control of behaviors and the environment while intensively monitoring physiological function across the day and night. Throughout this period, Dr. Shea has closely collaborated with three post-doctoral fellows: Nicole Bowles, PhD, Andrew McHill PhD and Saurabh Thosar, PhD. Notably, Dr. McHill and Dr. Thosar were recently promoted to faculty and are now building their own research programs (as described on other pages of this biennial report). All three post-doctoral fellows brought in grants to cover their own salaries from the NIH, the Ford Foundation and National Space Biomedical Research Institute. In addition, Dr. Shea's group received four multi-year awards from the NIH, totaling almost \$9M, which are being used to answer a number of sleep and circadian-related questions in vulnerable populations, as follows:

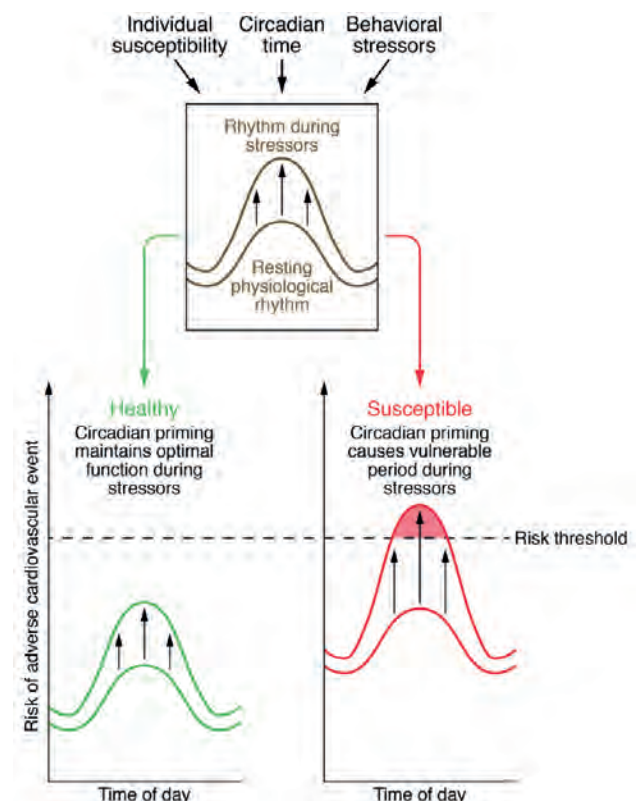
Circadian Rhythms and Cardiovascular Risk: to determine if the internal body clock affects cardiovascular function differently in those with sleep apnea compared to healthy people, perhaps explaining the different timing of adverse events in this population.

Chronotherapeutic Use of Vitamin C to Reduce Morning Cardiovascular Risk: to test whether a nutritional supplement - Vitamin C - can reduce cardiovascular risk markers and improve vascular endothelial function across the vulnerable morning period.

Circadian Mechanisms of Cardiovascular Risk in Obesity (with Jeanne Link, PhD): using cardiac imaging to determine whether circadian rhythms of cardiovascular physiology predispose obese individuals to risk for adverse cardiovascular events.

Sleep and Circadian Mechanisms Contributing to Disparity in Prevalence of Hypertension Between Black and White Americans: to understand to what degree sleep and circadian factors explain racial disparities in blood pressure regulation and hypertension.

In 2017-18 Dr. Shea published 14 peer-reviewed papers with colleagues related to: the effects of the circadian system on cardiovascular risk markers; chronotherapy for hypertension; effect of sleep disturbances after traumatic brain injury; activity patterns predicting Alzheimer's disease; the importance of the circadian system and sleep for bone health; daily patterns of perceived exertion; interactions between sleep and work; resident physician extended work hours and burnout; and the effects of recent legalization of cannabis use on sleep, health, and workplace safety. Dr. Shea is the Founding Editor-in-Chief of *Nature & Science of Sleep*. In 2018, Professor Shea was selected as the winner of the OHSU Distinguished Faculty Award for Outstanding Leadership based on performance across the prior 5 years.



Conceptual model showing interactions between behavioral stressors, circadian timing, and individual susceptibility to cardiovascular risk. From Thosar, Butler and Shea, *Journal of Clinical Investigation*, 2018.



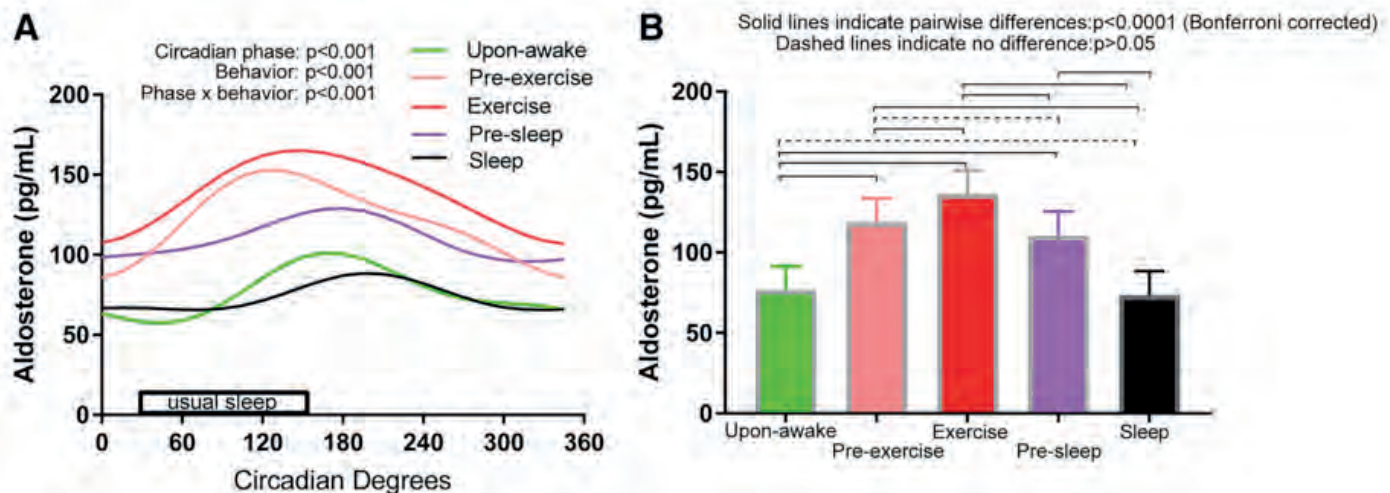
Saurabh S Thosar, PhD, OTR/L
Assistant Professor, Oregon Institute of Occupational Health Sciences

Dr. Thosar was a postdoctoral scholar within the institute and joined the faculty in July 2018. During the past two years, he has implemented protocols to study the contrasting effects of sleep loss combined with physical inactivity, as well as circadian rhythms, on cardiovascular risk markers in health and disease. Along with Dr. Shea, he has discovered that the morning impairment in vascular endothelial function (VEF) measured as brachial artery flow mediated dilation (FMD), is not due to the effects of prior sleep, or inactivity that accompanies sleep, but rather due to the effects of the endogenous circadian system.

They also discovered an endogenous circadian rhythm in rate of perceived exertion during exercise. Recently, using two separate multi-day protocols in middle-aged adults, Dr. Thosar and colleagues discovered that the morning rise in plasma aldosterone is due to the effects of the internal body

clock and not due to effects of sleep or other behaviors. This paper received an award from the American Physiological Society (APS) as one of the top articles across all APS journals. In collaboration with researchers from the Knight Cardiovascular Institute (KCVI), Dr. Thosar also discovered that wearable activity devices do not independently increase physical activity in sedentary office workers.

Dr. Thosar is currently the recipient of the Sleep Research Society's Career Development Award and, in collaboration with Dr. Jonathan Lindner, he is studying the effects of the circadian system on the microvessels of the heart.



Effects on plasma aldosterone of the circadian cycle (A), standardized behaviors (B), and their interaction (B). From Thosar et al, American Journal of Physiology: Regulatory, Integrative and Comparative Physiology.

Exposure Biology: Genome Instability and Human Disease

Our researchers are using cutting edge science to characterize the adverse effects of occupational exposures, determine the basic mechanisms by which these exposures produce adverse effects. The eventual goal is to apply that information to develop therapies to help prevent the exposures in the first place and to reduce the adverse consequences if exposures do occur.





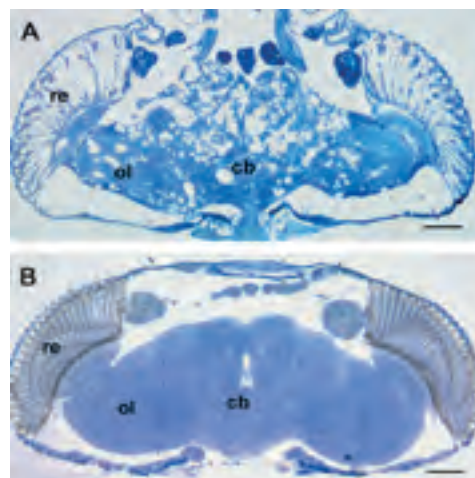
Doris Kretzschmar, PhD

Associate Professor, Oregon Institute of Occupational Health Sciences
Associate Professor, Molecular and Medical Genetics, OHSU School of Medicine

Dr. Kretzschmar is using the fruit fly (*Drosophila melanogaster*) to study the mechanisms that lead to age-dependent neurodegenerative diseases like Alzheimer's Disease. Her studies include identifying genetic and environmental factors that aggravate or ameliorate the phenotypes associated with these diseases and she is investigating the mechanism that leads to the pathogenesis in these diseases.

Investigating pathogenic mechanisms in Neuropathy Target Esterase-related diseases

It has been shown by Dr. Doris Kretzschmar and others that organophosphate exposure and genetic changes in a protein called Neuropathy target esterase (NTE) cause movement problems, neuronal degeneration, as well as altered growth and intellectual disability. However, the molecular mechanisms that lead to these pathogenic phenotypes are unknown. Generating transgenic flies expressing human NTE with mutations that have been shown to cause disease, the Kretzschmar lab is investigating how these mutations affect the function of the protein and how this may lead to the disease. Dr. Kretzschmar also recently found that changes in NTE produce a cellular stress response called apoptosis that causes cells to die and that genetic or drug interventions can delay this. Therefore, it is hoped that similar drugs could eventually be used for the treatment of NTE-related disorders, including neurodegeneration.



Head sections from a mutant fly with a neurodegenerative phenotype (A) and from wild type (B).



Doris Kretzschmar Lab: Shubeena Chib, Doris Kretzschmar, Dani Long, Alexander Law



R. Stephen Lloyd, PhD
Associate Director for Basic Research
Professor, Oregon Institute of Occupational Health Sciences
Professor, Molecular and Medical Genetics, OHSU School of Medicine

The Lloyd laboratory focuses on examining mechanisms through which cells respond to toxicants from a variety of sources including the workplace, an individual's environment and medical treatments. Even though the specifics of the exposure may vary, they are inter-related in that all of these result in DNA damage and disruption of normal cellular functions. This manifests in a variety of human diseases including cancer, diabetes, cardiovascular disease, and obesity. Since DNA damage is a causative agent in these diseases, the efficiency through which DNA is repaired is critical to maintaining optimal human health.

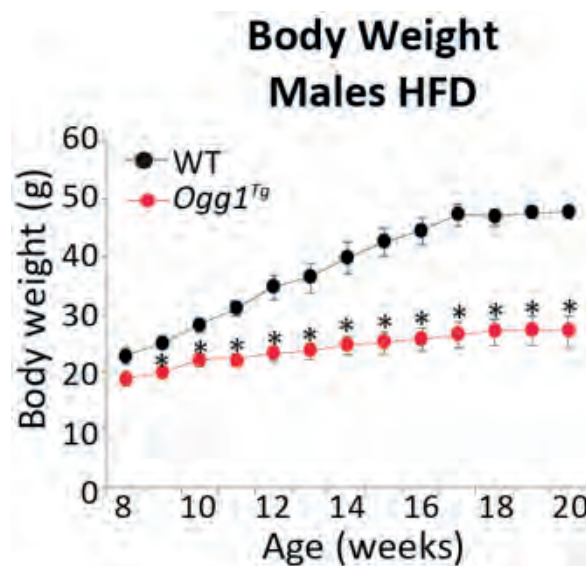
Our focus is primarily on disease prevention through DNA repair enhancement, since eliminating the onset of disease is far preferable to treatment of pre-existing disease. For example, we are investigating prevention of weight gain, diabetes and insulin-resistance by enhancing a cell's capacity to repair oxidative damage. Additionally, in collaboration with Dr. McCullough and her group, we have made fundamental discoveries which demonstrate that improving the DNA repair capacity of skin cells can confer protection from sunlight-induced skin cancers. This was recently demonstrated in mouse models and human clinical trials are being designed. In addition to these prevention strategies, and also in collaboration with Dr. McCullough, we are leveraging our fundamental knowledge of these pathways to determine if standard chemotherapies can be augmented by modulating the cancer's DNA repair capacity.

Discovery of a Mechanism to Prevent High Fat Diet-induced Obesity

Oxidative damages to both genomic and mitochondrial DNA are mainly repaired via an internal mechanism called "base excision repair", a pathway that is catalyzed by the DNA glycosylase, OGG1. While OGG1 has been implicated in maintaining genomic integrity and preventing tumors, we discovered a novel role for OGG1 in altering cellular and whole body energy homeostasis. We demonstrated that increasing the DNA repair capacity in mitochondria confers nearly complete protection from diet-induced obesity, insulin resistance, and adipose tissue inflammation. These favorable metabolic phenotypes are mediated by an increase in whole-body energy expenditure driven by metabolic adaptations.

Genetic Basis of Increased Liver Cancer

Human dietary exposures to toxins and viral infections are major contributing factors to the formation of human liver cancers that account for over 700,000 deaths annually. These toxins and increased inflammation lead to many forms of DNA damage. To identify any genetic basis for liver cancer susceptibility, we carried out an extensive study in which we presented three major lines of evidence that repair initiated by the DNA glycosylase NEIL1 is the major contributor in maintaining genomic stability following certain toxin exposures. These findings demonstrate that NEIL1 is functioning to suppress tumors and may identify humans who have increased cancer susceptibilities.



Mice with enhanced mitochondrial DNA repair capacity (shown in red) are highly resistant to weight gain while on a high fat diet relative to control mice (shown in black). These mice are also resistant to insulin sensitivity and adverse blood lipid increases.



Amanda K McCullough, PhD

Associate Professor, Oregon Institute of Occupational Health Sciences

Associate Professor, Molecular and Medical Genetics, OHSU School of Medicine

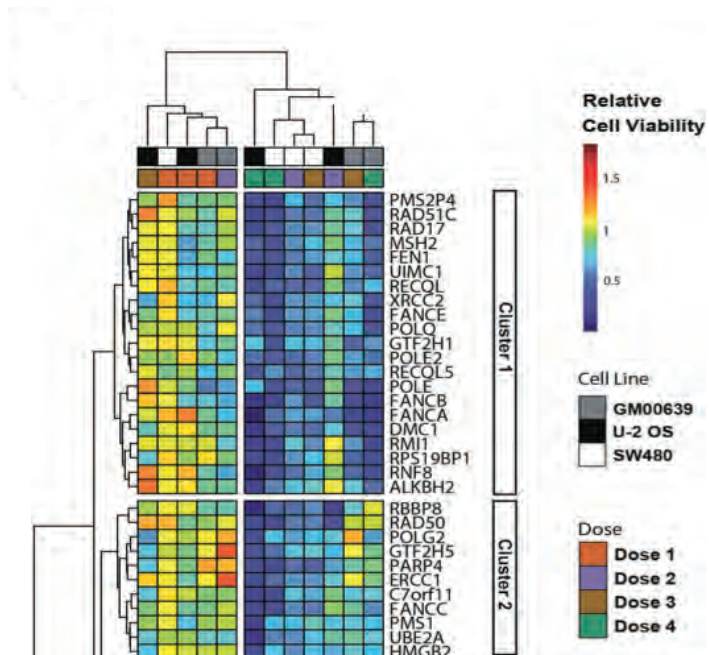
The research focus of the McCullough laboratory is on the biochemical mechanisms of DNA repair systems and the regulation and roles of DNA repair in cellular responses to environmental stress. The ultimate goal of this research is to translate basic science discoveries related to the cellular DNA damage response pathways into actionable clinical interventions and improved therapeutic responses. Specifically, Dr. McCullough investigates both how alterations in DNA repair and tolerance networks affect the initiation and progression of human carcinogenesis, and how these fundamental principles and acquired genetic instabilities can be used to leverage tumor-specific therapeutics. Areas of current investigation include: 1) cellular pathways for the tolerance and repair of DNA-protein crosslinks; 2) biochemical mechanisms and therapeutic applications of ultraviolet (UV) light-induced DNA damage-specific glycosylases; 3) mechanisms and regulation of human oxidative DNA damage-specific repair and the development of small inhibitors for these pathways; and 4) studies on cellular pathways that limit mutagenesis and improve patient outcome following chemotherapeutic treatments.

Genotoxic Consequences of Formaldehyde Exposure

Formaldehyde is a human carcinogen, and there is growing concern over the possible adverse health effects from occupational and environmental human exposures. Although formaldehyde-induced DNA and protein structural changes have been identified, mechanisms that cause genomic instability and cellular tolerance to this damage are not fully characterized. In 2018, the McCullough lab published an article on their studies that identified the genes necessary to mitigate formaldehyde toxicity following chronic exposure in human cells. These results provide a foundation for further studies aimed at understanding human cellular responses to formaldehyde exposures.

Enhanced DNA Repair as a Skin Cancer Prevention Strategy

Oregon has one of the highest rates of skin cancer in the United states. Sunlight induced DNA damage is a major contributing factor to the initiation of skin cancers. The McCullough and Lloyd laboratories have developed a strategy to enhance DNA repair in human cells to remove the deleterious DNA damage. By introducing a new DNA repair enzyme into skin cells, the labs have demonstrated in several models of human skin that the DNA damage is rapidly removed. In 2018, the labs published an article demonstrating that one of their topically applied enzymes can reduce the occurrence of non-melanoma skin cancers in an animal model. This research lays the foundation for further pre-clinical studies and drug development for the prevention of skin cancer.



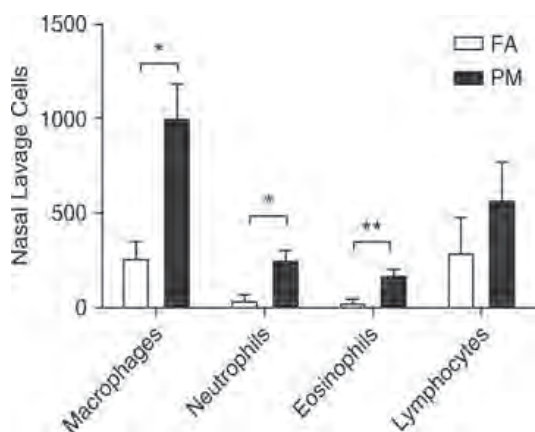
Relative cell proliferation reveals global and cell-line specific patterns of formaldehyde sensitivity. Heatmap of relative cell proliferation suppression for a given formaldehyde dose across cell lines. Each map cell represents proliferation relative to an untreated control for a given gene and cell line. Hierarchical analyses of genes identified six clusters.



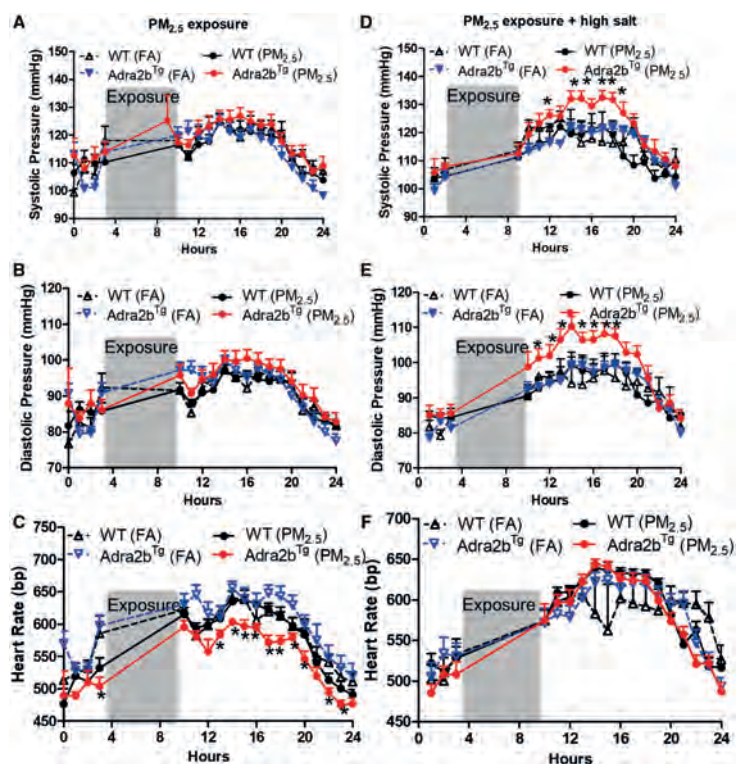
Xiaoquan Rao, PhD
Assistant Professor, Oregon Institute of Occupational Health Sciences

Dr. Rao is a new faculty member recruited from the University of Maryland. Her laboratory focuses on the health effects of environmental pollutants such as particulate matter. Air pollution has been confirmed as an important risk factor for global mortality and cardiovascular disease.

Our current projects aim to investigate the underlying mechanisms by which air pollutants promote diabetes and cardiovascular diseases. The laboratory utilizes state-of-the-art whole-body mouse exposure systems and various molecular, physiologic, immunologic, and imaging approaches to dissect the role of inflammatory regulation and lipid oxidation in air pollution-associated cardiometabolic diseases.



Chronic airborne fine particulate matter exposure induces sinonasal inflammatory cell accumulation in nasal airway lavage fluid. Differential cell analysis of nasal lavage fluid from filtered air (FA) and polluted air (PM) exposed mice.



Effects of Adra2b on the sensitivity to air pollution-induced blood pressure elevation: A–F, WT and Adra2bTg mice were exposed to FA or PM_{2.5} for 11 weeks, then fed with 4% high salt diet simultaneously with exposure for 1 week (week 12). Systolic (A and D), diastolic (B and E) blood pressure, and heart rate (C and F) were examined before (A–C) and after (D–F) high salt diet feeding.

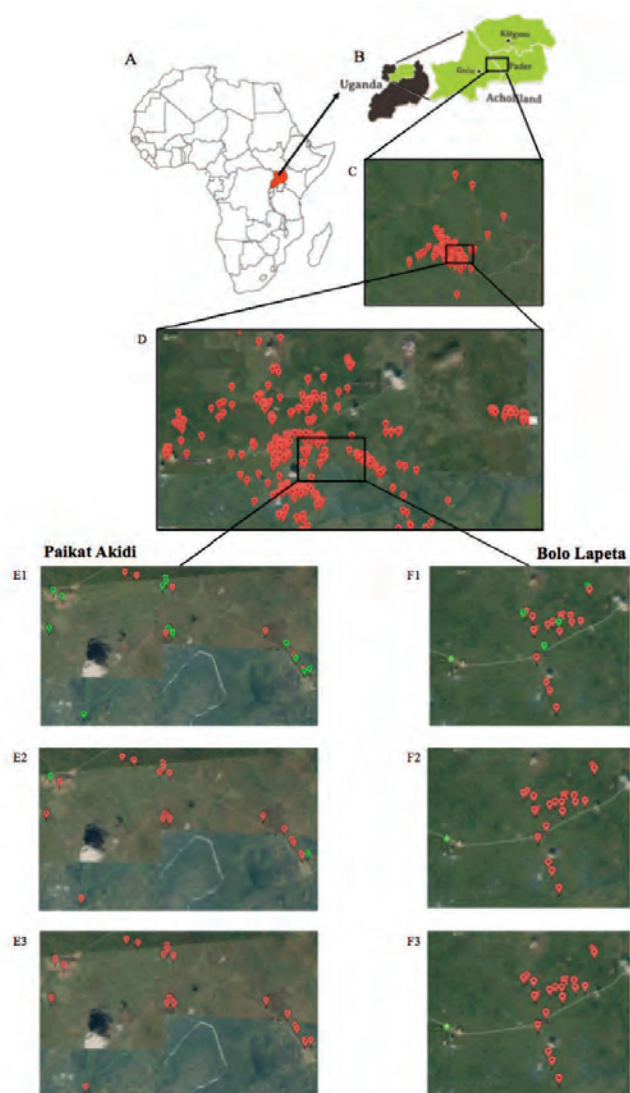


Peter Spencer, PhD, FANA, FRCPath
Professor, Neurology, OHSU School of Medicine
Professor, Oregon Institute of Occupational Health Sciences

Peter S. Spencer, PhD, FANA, FRCPath, Professor of Neurology and Occupational Health Sciences, founded and directed for over twenty years the Center for Research on Occupational and Environmental Toxicology (CROET), the forerunner of the Oregon Institute of Occupational Health Sciences. From CROET, he led the development of the OHSU Global Health Center and served as its founding director through 2013. Over the past 40 years of funded research, his interests have included the control of axonal regeneration and myelination, molecular mechanisms underlying neurotoxic injury, and the role of occupational and environmental factors in neurological and neurodegenerative diseases. Current research interests include the etiology and pathogenesis of high-incidence pockets of epilepsy in East Africa, neurodegeneration in Guam, Indonesia and Japan, and pediatric encephalopathy in Asia, Africa and the Caribbean.

Dr. Spencer carried out research on an epileptic brain disorder (Nodding syndrome, NS) of unknown cause that affects children in East Africa. Findings in Uganda, the origin of “Slim disease” that spread worldwide under the name HIV, suggested the operation of an unidentified non-HIV neurotropic virus. Children with NS were mapped and followed using multiple cell phone reporting by lay workers resident in disease-affected villages. Data integration provided a real-time spatial-temporal disease geography of NS, an innovative method that can be used for the early detection and continuous monitoring of many other health conditions at home and abroad. This work received a 2018 prize from the American Neurological Association (<https://home.magpi.com/disease-mapping/>).

Another key research area focused on the causes and mechanisms underlying late-life degenerative disease of the brain. Dr. Spencer’s research in Japan focused on the cause of a disappearing environmental neurodegenerative disorder in Western Pacific populations (Guam, Japan, New Guinea). This revealed the structure of chemicals in the workplace and environment at home for possible relationship with related degenerative brain diseases. Additional collaborative basic science research with colleagues in China used advanced laboratory techniques (neuroproteomics) to illuminate the relationship between specific chemical exposures and the vulnerability of the brain in normal, toxic and disease states.



A, B, C. Geo-localized visualization of the surveillance area in northern Uganda. D. Close-up of a surveillance area section. E, F. Realtime electronic map of child health, injury and illness relating to NS in Paikat Akidi village (Angole parish, Awere sub-county, Pader district) and Bolo Lapeta village (Bolo parish, Awere sub-county, Pader district) at week 6 of data collection. Color coding: Red - Households with at least 1 child with NS; Green - Households with at least 1 child with NS who did not have medication (E1 and F1); was injured (E2 and F2); or died (E3 and F3) that week.



Caren Weinhouse, PhD, MPH
Assistant Professor, Oregon Institute of Occupational Health Sciences

Dr. Weinhouse is a new faculty member recruited to the Institute in 2018 from Duke University. Dr. Weinhouse studies the mechanisms by which environmental cues, like chemical pollutants, induce changes in epigenetic marks, which control gene expression. Epigenetic marks act like dimmer switches to change settings on individual genes. Environmental stressors that change gene settings can change how active those genes are, and subsequently affect health. Dr. Weinhouse focuses on chemical specificity, life-course persistence, and population variability in epigenetic responses to chemical pollutants. Unlike genetic mutations, epigenetic changes are reversible, and may be mitigated by positive health behaviors, like healthy diet, which suggests potential lifestyle interventions or therapies to mitigate the effects of unhealthy exposures. The goal of the Weinhouse lab is to translate basic science findings in cell culture and mice to human population settings, or “bench to community.” Two current projects are described below.

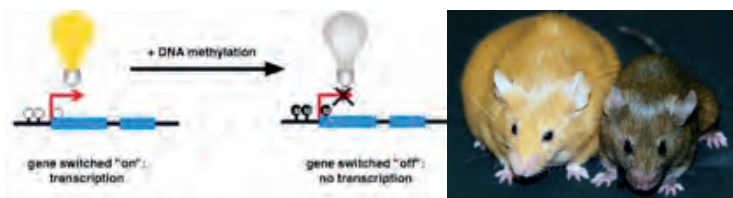
What is the role of genotype in determining inter-individual epigenetic responses to early life methylmercury exposure?

Methylmercury is a potent neurotoxicant that is known to cause gross neuromuscular dysfunction in both adults and children at high doses (e.g., Minamata Disease, so named for the famous methylmercury poisoning event in Minamata Bay, Japan) and learning and memory deficits in animals exposed in utero to low doses. However, human birth cohort data on methylmercury have not reported unequivocal neurotoxicity. In fact, the two largest and most well-established developmental methylmercury birth cohort studies reported conflicting results. The birth cohort in the Faroe Islands (exposure via high pilot whale consumption) reported cognitive deficits in children exposed in utero, but a similar study with comparable exposures in the Republic of Seychelles (high ocean fish consumption) did not. In this project, we leverage emerging evidence that genetic background strongly influences epigenetic patterns, which suggests that epigenetic changes in response to methylmercury may occur in some genotypes, but not in others. This project is an excellent example of “reverse translation,” in which human population outcomes are known and researchers explore the biological underpinnings of these effects in an experimental setting.

This approach avoids the concern that results reported in animals will not be relevant to human health, since the human health relevance is known from the start of the project and informs the design of the basic science research. We anticipate that the combination of genetic and epigenetic risk factors will better predict which individuals are highest risk and inform clinical recommendations to pregnant women regarding fish consumption. In addition, because epigenetic changes are reversible and “draggable,” identification of high risk individuals will enable research into prevention and therapy for children exposed to methylmercury.

Progressive loss of chemical resistance in pollution-adapted killifish

This project leverages a “natural experiment” in which Atlantic killifish living in a highly contaminated Superfund site in the Elizabeth River, Virginia, showed rapid evolutionary adaptation to high industrial pollution, including polycyclic aromatic hydrocarbons (PAHs). These fish are highly resistant to toxic effects of PAHs, including cancer and cardiac deformities, partly through loss of sensitivity of a response network controlled by the aryl hydrocarbon receptor (AHR). However, when these fish are caught in the wild and reared for one generation in clean water in a laboratory setting, this response network becomes re-sensitized to PAH toxicity, suggesting a non-genetic form of adaptation. We are exploring whether reversible epigenetic changes underlie the “rescue” of system sensitivity in clean water-reared killifish that showed adaptive resistance in prior generations. This project will inform how populations respond to chronic exposure to pollutants using multiple biological strategies, which will inform our understanding of human adaptive responses to pollution.



Differences in epigenetic marks, like DNA methylation, can lead to different health outcomes. In this example of genetically identical mouse sisters, mice with silencing DNA methylation at a coat color gene are brown, thin, and healthy, but mice without methylation are yellow, obese, diabetic and cancer-prone. (Schematic from www.epigenecare.org. Photograph courtesy of Dr. Randy Jirtle.)



Mitchell Turker, PhD, JD

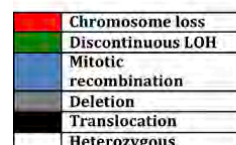
Professor, Oregon Institute of Occupational Health Sciences

Professor, Molecular and Medical Genetics, OHSU School of Medicine

Graduate Faculty, Environmental and Molecular Toxicology, Oregon State University

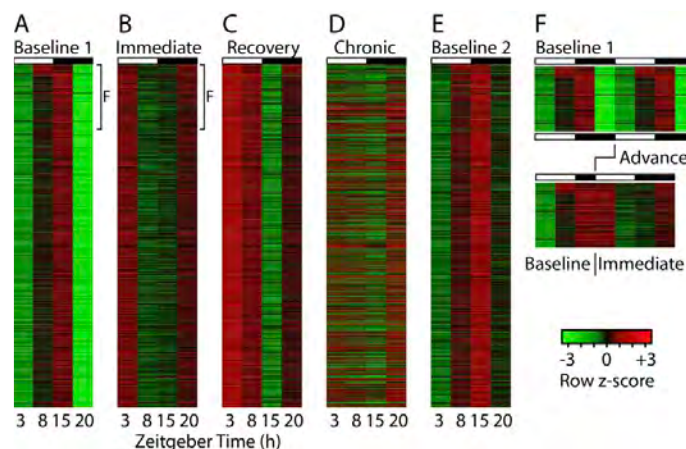
Environmental exposures can lead to cancer by causing persistent changes in expression of genes that are required to prevent uncontrolled cell growth. Gene expression changes occur via two broad classes of events, DNA mutation and gene silencing. The goal of the Turker laboratory is to understand how environmental exposures cause these events and to identify normal cellular processes that can block them from occurring. A better understanding of the continuous interaction between the environment and the cellular genome will aid in the development of strategies to reduce aberrant events that can convert a normal cell to a cancerous cell. The Turker lab focused on three research topics in 2017-2018. The first project was on a type of radiation found in deep-space. Their results showed that the genomes of some kidney cells in mice exposed to this radiation carried a high level of mutations suggesting a cancer risk.

In a second project with colleagues at OHSU, the Turker lab showed that the brains of exposed mice exhibited changes to DNA methylation, which is a modification to the DNA that can change gene expression. These studies suggest health risks to astronauts on a deep-space mission, such as to Mars and back. The third research topic examined whether inappropriate light exposes affected liver circadian rhythms. In this study, which was conducted with other Institute members (Drs. Allen and Butler), mice maintained on a 12 hour of light, 12 hour dark schedule were exposed to light 6 hours into the dark period (termed a phase shift) one or more times. The results showed that liver circadian rhythms were altered immediately after a single phase shift, took more than a week to recover, and were severely affected by 8 weekly phase shifts. These results suggested that persons who constantly change work schedules, such as shift workers, could suffer metabolic consequences.



Genetic changes in kidney cells removed from mice expose to simulated space radiation. Each colored box represents a genetic change.

Daily changes in a protein that marks active genes are affected by phase advances.





Injury, Treatment, Recovery and Prevention

Physical injury is the largest contributor to workers' compensation costs in Oregon. To reduce this burden on worker wellbeing and productivity, our scientists conduct innovative research on the causes, treatment, recovery, and prevention of workplace injuries.



Ryan Olson, PhD

Associate Professor, Oregon Institute of Occupational Health Sciences
Associate Professor, OHSU-PSU School of Public Health
Associate Director, Oregon Healthy Workforce Center

Dr. Olson's research focuses on Total Worker Health® interventions for isolated workers like commercial drivers and home care workers. His team also studies behavioral self-management methods.

Organizational and behavior change tactics he has studied include:

- Policy changes to reduce job stress
- Physical alteration of the sleeping environment for truck drivers
- Leadership training to increase supportive supervision
- New employee training and onboarding
- Social support groups to advance workplace safety and health
- Gamified social competition to increase health behaviors
- Motivational interviewing
- Goal setting and behavioral self-monitoring

New Funding to Support the Health and Job Success of New Bus Operators

In 2018 Dr. Olson and his colleagues were awarded new funding from the National Heart Lung and Blood Institute to study and improve the health and job success of new bus operators. Being new in any job is stressful, and transitioning into a job like bus driving that includes shiftwork and long hours of sitting can present additional health challenges. Researchers will be studying new bus operators as they enter the profession to try to identify working conditions that might be more or less favorable to operator health and success. They will also evaluate an enhanced new employee onboarding program, informed by their past work with truck drivers, to protect new bus operators against health hazards and support their performance and success. The Amalgamated Transit Union 757 and Trimet have provided support for the grant proposal and project, as well as many other union locals and transit authorities located in the Pacific Northwest and West.

What Helps Truck Drivers who are Attempting to Manage or Lose Weight?

Commercial truck drivers who participated in Dr. Olson's SHIFT randomized controlled trial lost a significant and medically meaningful amount of weight (about -7.3 lbs difference between intervention and control groups). The SHIFT program involved a group-based weight loss competition, where individual drivers were asked to log their body weight and behaviors on the program website each week, complete four online training topics, and engage in four sessions with a health coach. With Dr. Brad Wipfli and other collaborators, Dr. Olson found that the factor most strongly related to weight loss outcomes was the number of times drivers logged their body weight and behaviors on the program website. Participating in this log was also the only program component significantly associated with better exercise outcomes. However, participation in each type of program component (logging, training, and health coaching) had beneficial associations with drivers' dietary changes.

COMPASS Program Adopted by the Oregon Home Care Commission

Dr. Olson's COMPASS program for home care workers is effective in advancing both safety and health outcomes for caregivers. In recent qualitative research, home care workers reported that COMPASS helped address some resource gaps they experienced as isolated workers. This included having a chance to share with and support one another. One worker reported, "I had been holding it all in, [but after sharing with my group], I felt good. Sometimes ... you're just thinking you're going to scream, but you cannot scream. I felt that way ... I felt like I got rid of something."

COMPASS was developed in partnership with the SEIU Local 503 and the Oregon Home Care Commission, and integrates elements of effective social support groups with scripted team-based health promotion tactics. After working with researchers for many years on COMPASS, and after observing the benefits for workers, in 2017-18 the Oregon Home Care Commission adopted the program into its training system. Home care workers throughout Oregon can now sign up for COMPASS and experience its resources and benefits. Initial attendance and training evaluation data for these groups have been very positive.

Flexibility and Supportive Supervision Produces Long-Term Sleep Benefits for Information Technology Workers

Dr. Olson helped develop components of the historic Work, Family, and Health Network intervention, and has been involved with follow-up research on the benefits of sleep. The intervention was called STAR (Support. Transform. Achieve. Results.) and involved a policy change that granted information technology workers flexibility regarding when and where they worked. The intervention also included training for supervisors to provide family and performance support for their employees, goal setting, and self-monitoring of supportive behaviors. In a study of long-term benefits of the program for employees' sleep, Dr. Olson and colleagues found that 18 months after the study started, those employees who participated in the intervention had an average of more than an hour and a half more sleep per week than employees in the control group. And this sleep benefit was shown to be sustained.



SHIFT participants received support in achieving personal well-being goals.

OR-FACE

Directed by Dr. Ryan Olson, Oregon Fatality Assessment and Control Evaluation (OR-FACE) is a project of the Oregon Institute of Occupational Health Sciences at Oregon Health & Science University (OHSU). OR-FACE is supported by a cooperative agreement with the National Institute for Occupational Safety and Health (NIOSH) through the Occupational Public Health Program (OPHP) of the Public Health Division of the Oregon Health Authority. OR-FACE conducts surveillance, investigation, and assessment of traumatic occupational fatalities in Oregon, and produces safety materials to promote worker safety. OR-FACE investigations of fatal occupational incidents assess risk factors that include the working environment, the worker, activity, tools, energy exchange, and role of management.

Core Research Activities

- Surveillance and assessment of traumatic occupational fatalities in Oregon
- Investigation of selected traumatic fatalities
- Educational outreach and partnering to disseminate fatality prevention information and resources in high risk industries
- Field studies to develop and recommend interventions
- Collaboration with other FACE states and NIOSH to advance fatality prevention efforts

Total Worker Health Interventions

Faculty members in the Institute of Occupational Health Sciences are developing, testing, and disseminating workplace intervention programs that integrate safety, health and wellbeing into single or associated programs that reduce injuries and improve wellbeing by improving work organization and individual behavior, such as exercise, while improving lifestyle behaviors and reducing stress.



Oregon Healthy Workforce Center

Established in 2011, the Oregon Healthy Workforce Center (OHWC), is a National Institute for Occupational Safety and Health (NIOSH) Center of Excellence in Total Worker Health®.

Ensuring a healthy worker necessitates a holistic view that is geared toward protecting the worker from workplace hazards as well as enhancing the employee's well-being at work and outside of work; this is the "Total Worker Health"™ strategy.

Our work is focused on designing, developing, and disseminating effective Total Worker Health® interventions.

Visit Oregon Healthy Workforce Center's new website, *YourWorkpath.com* to access and download our evidence-based Total Worker Health® toolkits and tools. YourWorkpath.com houses and delivers our robust tools and comprehensive toolkits, to lead and help employers find a path towards a healthier and safer workplace.



Oregon Healthy Workforce Center faculty and staff.



W. Kent Anger, PhD
Associate Director for Applied Research
Professor, Oregon Institute of Occupational Health Sciences
Professor, OHSU-PSU School of Public Health
Director, Oregon Healthy Workforce Center

Dr. Kent Anger, Director of the Oregon Healthy Workforce Center (OHWC) is creating effective Total Worker Health® interventions to improve safety, health and well-being in the Oregon workforce. The OHWC is a NIOSH-funded Center of Excellence in Total Worker Health®. Dr. Anger's lab develops computer-based training that uses behavioral education principles for hazard prevention, skills acquisition, and well-being at the organizational and individual levels. The training is supported by practice activities that create new habits or desired changes in behavior.

In 2017, Dr. Anger published a study for a computer-based training intervention, with and without peer-led practice, which taught de-escalation and self-care techniques to home care workers to respond to workplace violence and harassment. After the intervention, the workers reported fewer incidents of workplace violence and harassment and greater confidence to respond to violence and harassment in the homes where they worked. The computer-based training alone was as effective as the training with peer-led practice in a randomized trial.



Dr. Anger engages with a participant at the GOSH Conference.

Dr. Anger developed a Total Worker Health® intervention conducted in four Oregon-based construction companies that led to increased family-supportive supervisory behaviors, team cohesion sleep duration and exercise, and decreased sugary drink and snack consumption and systolic blood pressure. The intervention was rated favorably by supervisors and employees participating in the training, self-tracking and healthy lifestyle education activities. Study results were published in 2018 in the *Journal of Occupational and Environmental Medicine*.



Dr. Anger's computer-based trainings have shown to be effective tools for hazard prevention and well-being for workers in agriculture, such as this hops farm.



Leslie B Hammer, PhD
Professor, Oregon Institute of Occupational Health Sciences
Associate Director, Oregon Healthy Workforce Center

Dr. Hammer has expertise in Occupational Health Psychology and specializes in the health effects of supportive supervision at work, and on the health consequences of work-family conflict. She has extensive experience in designing, implementing, and evaluating worksite interventions and supervisor training. Her research focuses on ways in which organizations can help reduce work and family stress and improve positive spillover by facilitating both formal and informal workplace supports. Dr. Hammer is also an Associate Director of the Oregon Healthy Workforce Center, Centers of Excellence, funded by the National Institute for Occupational Safety and Health. She was the Principal Investigator of the Phase I and Phase II Work, Family & Health Network (WFHN) Portland State University projects involving developing and evaluating a work-family intervention, namely Family Supportive Supervisor Behavior Training.

SERVE (Study for Employment Retention of Veterans)

Military service members sometimes have trouble re-integrating into the civilian workforce. SERVe is a Department of Defense funded intervention study aimed at improving the health and well-being of service members and their families by targeting the workplace experiences of Veterans and Service Members who are members of the civilian workforce. Conducted as a randomized control trial, SERVe is an ongoing investigation into the effects of an intervention which combines training and behavior tracking to improve the knowledge and skills of supervisors with service members in their employ in order to foster a supportive workplace environment. This study is among the first to examine and show significant health and well-being differences between those who separated from military service and those still serving in the National Guard/Reserve.



The Veteran Supportive Supervisor Training was evaluated in 32 organizations across the state of Oregon and demonstrated that when civilian supervisors went through the training it improved their positive attitudes towards service members.

Participating employers include:

- Bend Research
- Blue Sun, Inc.
- Cintas
- City of Hillsboro
- City of Keizer
- City of Oregon City
- City of Salem
- Clackamas County
- Columbia Distributing
- Dignity Memorial
- Eastern Oregon University
- Eid Passport, Inc.
- Hampton Lumber
- Haney Truck Line
- Hoffman Construction
- Hoffman Structures
- Intel
- Interpath Laboratory
- Kaady Car Wash
- Lin-Benton Community College
- Multnomah County
- Multnomah County Sheriff's Office
- Oil Can Henry's
- Oregon Aero
- Oregon Dept. of Administrative Services
- Oregon Dept. of Corrections
- Oregon Dept. of Environmental Quality
- Oregon State Police
- Pioneer Wiping Cloth
- Oregon Dept. of Human Services
- Oregon Dept. of Transportation
- Portland Bureau of Transportation
- Portland State University
- Rip City Management/ Trailblazers
- Salem Health
- Samaritan Health Services
- Securitas
- Southwest Oregon Community College
- Standard TV & Appliance
- U.S. Forest Service Region 6



Leslie Hammer Lab (L to R): Jason Malach-Fuller, Marjaana Sianoja, Phoenix Rain Bird, Lev El-Askari, Leslie Hammer, Krista Brockwood, Shalene Allen, Luke Mahoney, MacKenna Perry, Jacquelyn Brady (June 2018)

Oregon MESH (Military Employee Sleep and Health) Study

The Oregon MESH Study is a Department of Defense funded intervention study which will tackle the issue of sleep-related health concerns that are increasingly the focus of research in the military domain. The adverse effects of sleep loss are known to cause a variety of negative health and family issues. This study will test the effects of an intervention designed to improve the sleep of full-time National Guard members.



David A Hurtado, ScD

Assistant Professor, Oregon Institute of Occupational Health Sciences
Assistant Professor, OHSU-PSU School of Public Health

Dr. Hurtado is a social and behavioral scientist who investigates social determinants of workers' health. In particular, he examines how work-time control, coworker support and employment conditions contribute to occupational health and safety, especially in high-risk industries such as health care. His research focuses on how modifiable workplace conditions relate to risk factors for mental illnesses, musculoskeletal disorders, and non-communicable diseases.

The Positive Influence of Safety Champions

Peers influence health-related information, attitudes and behavior in the workplace. With seed funding from the Oregon Healthy Workforce Center and the Oregon Institute of Occupational Health Sciences, Dr. Hurtado conducted a pilot study to substantiate extramural grant applications to develop effective peer-based programs that improve occupational health and safety. The pilot program had a quasi-experimental, pre/post design. Social Network Analysis (SNA) was applied to identify potential safety champions, and those who volunteered to serve as champions completed training sessions on ergonomic and communication skills and attended quarterly meetings with hospital leaders to address safety issues. After 12 months, the program was effective in improving several self-reported safety outcomes (e.g., use of patient handling equipment, safety participation), increasing reporting of safety incidence and reducing patient-assist injuries.

In 2017, Dr. Hurtado was co-awarded (with Dr. J. Goodman and Dr. D. Richardson) a pilot grant from the OHSU-PSU School of Public Health to evaluate the paid parental leave policy for employees of Multnomah County. This grant award applied a multiple method approach, analyzing administrative records, employees' survey results and focus group data. Results highlighted that a paid parental leave policy increased leave duration for non-birth parents, and provided more financial security for birth mothers. Supervisors and co-workers play a critical role supporting working parents while on leave and after returning to work.



Sociogram depicting peer-based advice-seeking nominations about safe-patient handling in a sample of patient-care workers (n=38). Peer leaders identified by Social Network Analysis, by supervisors or by both supervisors and workers are depicted by different symbols.



David Hurtado Lab: Sam Greenspan, Lisset Dumet Poma, David Hurtado, Gregory Heinonen



Outreach

We are proactively engaged in providing timely occupational health and safety information to employees, employers, health and safety professionals, doctors, nurses, and the public.

Outreach Team



Fred Berman, DVM, PhD, answers citizen and professional inquiries about hazards of exposure to chemicals and other agents. Dr. Berman handled hundreds of requests from occupational safety and health professionals, business owners, government agencies, physicians and nurses, the media, and the general working public. In addition, Dr. Berman serves as consultant to the Oregon Department of Agriculture's Pesticide Analytical and Response Center and is a co-investigator with the National Pesticide Information Center, a U.S. Environmental Protection Agency-sponsored project operated cooperatively with Oregon State University.



Nichole Guilfooy, BS, joined the Outreach Team in 2018 with strengths in workforce safety, health and well-being. Nichole leads the development and implementation of the Institute's consultative service model to organizational and community partners, develops and delivers education and training, evaluates workplace needs and adapts interventions to satisfy these needs in Oregon workplaces. An experienced Total Worker Health practitioner and consultant, Nichole brings expertise in human resources and well-being, risk management and safety, organizational development, leadership and communication, and training and development.



Dede Montgomery, MS, CIH, leads the Institute's Occupational Health and Safety Information Center, provides technical expertise on industrial hygiene to the Institute's research projects and directs the Outreach component of the NIOSH-funded Oregon Healthy Workforce Center. Dede's key outreach responsibilities include connecting with our stakeholders through conferences, events and coalitions, instructing on occupational health, safety and Total Worker Health, creating continuing education opportunities, managing social media blogs and channels, and supporting the Occupational Health and Safety Information Center.



Anjali Rameshbabu, PhD, is Center Manager at the Oregon Healthy Workforce Center, where she coordinates its administrative functioning, provides research support, and helps to facilitate cohesiveness between the Center's diverse projects. As an advocate of moving research to practice, she serves as one of the principle investigators of the Outreach Core of the Center, which is responsible for the Center's evidence-based resources within organizations and builds education opportunities for students and the worker community. Among her outreach, dissemination, and education activities, she co-produces "What's Work Got to Do With It", a podcast series geared toward sharing the public health relevance of workplace factors that impact our work and home lives.



Helen Schuckers, MPH, is the Dissemination Specialist for the Institute and the Oregon Healthy Workforce Center. She helps translate research into practice, where she is the link between scientists and potential adopters of safety, health and well-being toolkits and tools. Helen engages with human resources, consultants, and wellness professionals around Oregon to expand efforts in disseminating resources and research developed by the institute. Other efforts include the development and management of the Center's newest resource, YourWorkpath.com and promoting and disseminating safety, health, and well-being toolkits and tools.



The Outreach team participates in a variety of conferences and events to share resource information and best practices developed by Faculty members.



Dede Montgomery provides education and training at the Western Pulp, Paper, and Forest Products Safety and Health Conference.

2018 Event Name	Location
Oregon Construction Summit	Bend, OR
Oregon Construction Advisory Committee	Oregon OSHA Salem
O[yes] General Meeting	Salem/Portland
Discover OHSU!	OHSU
Portland Wellness Network	Portland
ASSP Columbia Willamette meeting	Tualatin
Cascade Occupational Safety and Health Conference	Eugene
Portland NW Youth Expo	Oregon Convention Center
SafeBuild Alliance	Portland
OHSU Safety Break	Portland OR
NIOSH Total Worker Health® Symposium	Bethesda MD
American Heart Association Wellness Summit	Portland, OR
Central Oregon Occupational Safety and Health Conference	Bend, OR
Southern Oregon Occupational Safety and Health Conference	Ashland, OR
NOHC	Bremerton, WA
Oregon Institute of Occupational Health Sciences Fall Symposium	Portland, OR
Western Pulp, Paper, and Forest Products Safety and Health Conference	Jantzen Beach OR
Mid-Oregon Construction Safety Summit	Bend, OR
Blue Mountain Occupational Safety and Health Conference	Pendleton, OR
Oregon Workers Compensation Conference	Portland, OR
Oregon Public Health Conference	Corvallis, OR
Oregon Association of Minority Entrepreneurs Conference	Portland, OR
2017 Event Name	Location
Oregon Construction Summit	Bend, OR
Oregon Construction Advisory Committee	Oregon OSHA Salem
O[yes] General Meeting	Salem/Portland
Discover OHSU!	OHSU
Portland Wellness Network	Portland
ASSP Columbia Willamette meeting	Tualatin
GOSH	Portland
Portland NW Youth Expo	Oregon Convention Center
Oregon State Association of Occupational Health Nurses Conference	Woodburn OR
SafeBuild Alliance	Portland
OR Educators Wellness Conference	Bend, OR
American Heart Association Wellness Summit	Portland, OR
WA GISH	Tacoma, WA
Central Oregon Occupational Safety and Health Conference	Bend, OR
Southern Oregon Occupational Safety and Health Conference	Ashland, OR
NOHC	Spokane, WA
BHS Business Services	Woodburn, OR
Oregon Institute of Occupational Health Sciences Fall Symposium	Portland, OR
Western Pulp, Paper, and Forest Products Safety and Health Conference	Jantzen Beach OR
Mid-Oregon Construction Safety Summit	Bend, OR

Alliance on Total Worker Health®

In February 2017, The Oregon Institute of Occupational Health Sciences (including the Oregon Healthy Workforce Center), Oregon OSHA, and SAIF signed the first alliance of its kind to expand the knowledge and application of Total Worker Health® principles by leveraging the strengths of these three state-based organizations.

Over the years, these three partners have collaborated on many issues and initiatives impacting occupational safety, health and well-being. Now, however, we are specifically targeting how we can work together to move the needle in Oregon to improve health, safety

and well-being for all workers, utilizing concepts, evidence and data related to Total Worker Health principles.

The Alliance collaboration will provide expertise and guidance, along with training and education that will help protect and promote the occupational health, safety and well-being of workers, particularly by reducing and preventing exposure to hazards and addressing issues. In addition, the collaboration will provide knowledge and skills for workers to help in understanding their rights and the responsibilities of employers.



The Alliance agreement is signed by Chuck Easterly, Director, Safe and Healthy Workplace Center, SAIF; Michael Wood, Administrator, Oregon OSHA, Department of Consumer and Business Services; Steven Shea, PhD, Director, Oregon Institute of Occupational Health Sciences, OHSU.

Summer Internships

Summer Student Research Awards are three-month paid summer internships designed to introduce undergraduate students to biomedical and occupational health research. In 2017-2018, the Oregon Institute of Occupational Health Sciences provided intensive research opportunities across a range of basic and applied research areas to 30 undergraduates.

2017 Oregon Institute of Occupational Health Sciences Summer Interns



Teala Alvord
Portland State Univ.
Ryan Olson Lab



Natasha Andrews
Oregon State Univ.
Amanda McCullough Lab



Meera Bhide
Cornell Univ.
Steven Shea Lab



Payton Bushaw
University of Portland
Suzanne Mitchell Lab



Izzy Fawson
Lewis and Clark College
Doris Kretzschmar Lab



Ali Noel Gunesch
Brown University
Charles Allen Lab



Gregory Heinonen
Oregon State Univ.
David Hurtado Lab



Molly Herinckx
Oregon State Univ.
Mitch Turker Lab



Oskar Linde
Portland State Univ.
R. Stephen Lloyd Lab



Lydia Lutsyshyna
Reed College
Matt Butler Lab



Jessica Nguyen
Portland State Univ.
Leslie Hammer Lab



Sydney O'Neill
Portland State Univ.
Brad Wipfli Lab



Randall Olson
University of Portland
Miranda Lim Lab



Sharanya Pradeep
Portland State Univ.
OHWC Outreach Core



Jonathan Sisley
Oregon State Univ.
Ryan Olson Lab

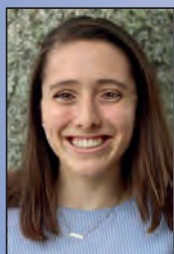


Austen Suits
University of Washington
Peter Spencer Lab

Oregon Institute of
Occupational Health Sciences

Whether studying molecules, cells, organ systems, non-human organisms, or out gathering data in the community, students gained valuable experience conducting a specific project in their host faculty member's research program.

2018 Oregon Institute of Occupational Health Sciences Summer Interns



Claire Boenisch
Oregon State University
Ryan Olson Lab



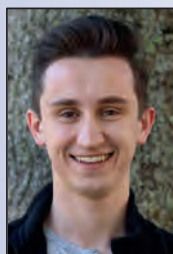
Lev El-Askari
Willamette University
Leslie Hammer Lab



Adeline Fecker
University of Oregon
Suzanne Mitchell Lab



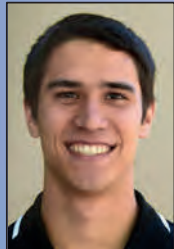
Abigail Gillingham
Whitworth University
Amanda McCullough Lab



Gregory Heinonen
Oregon State University
David Hurtado Lab



Isabel Katlaps
Portland State Univ.
Steven Shea Lab



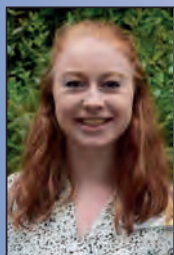
Peter Lahti
Lewis & Clark College
Ryan Olson Lab



Oskar Linde
University of Portland
R. Stephen Lloyd Lab



Claire Mersereau
Tulane University
Doris Kretzschmar Lab



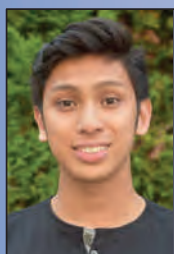
Sydney Reynolds
George Fox University
Brad Wipfli Lab



Mirena Scott
Pomona College
Andrew McHill Lab



Lori Sun,
Case Western Reserve
Matthew Butler Lab



JJ Terrobias
University of Portland
Mitch Turker Lab



Kendall Wynde
OHSU School of Nursing
Miranda Lim Lab

Oregon Institute of
Occupational Health Sciences

Faculty Publications

In 2017-2018, our research scientists published over eighty papers in high-quality journals. Publications are an important aspect of the research endeavor, because this is where the discoveries from our research meet the scrutiny of scientific peers from all over the world. Findings from Institute research contribute to overall knowledge within the various scientific disciplines, which furthers progress toward a better understanding of factors that affect worker health, safety and well-being.

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Vartanian, V., Minko, I. G., Chawanthayatham, S., Egner, P. A., Lin, Y. C., Earley, L. F., ... Lloyd, R. S. (2017). *NEIL1 protects against aflatoxin-induced hepatocellular carcinoma in mice*. Proceedings of the National Academy of Sciences of the United States of America, 114(16), 4207-4212. <https://doi.org/10.1073/pnas.1620932114>

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Wipfli, B., Hanson, G., Anger, K., Elliot, D., Bodner, T., Stevens, V., & Olson, R. (2018). *Process Evaluation of a Mobile Weight Loss Intervention for Truck Drivers. Safety and Health at Work*. <https://doi.org/10.1016/j.shaw.2018.08.002>

Yaldiz, L. M., Truxillo, D. M., Bodner, T., & Hammer, L. (2018). *Do resources matter for employee stress? It depends on how old you are*. Journal of Vocational Behavior, 107, 182-194. <https://doi.org/10.1016/j.jvb.2018.04.005>

Grants 2017 - 2018

We receive base operations funding from the Oregon Workers' Compensation System to achieve our mission, and we leverage these funds to obtain federal and other research dollars. For every dollar invested in our mission by the State's Workers' Benefit Fund in 2017, our scientists were awarded an additional \$1.28 of grant funding. For 2018, this number increased to \$2.28 for every dollar invested.

Allen, Charles N.	
Cellular Electrophysiology of the Suprachiasmatic Nuclei	National Institute of Health, National Institute of Neurological Disorders and Stroke
Astrocyte regulation of GABA neurotransmission in the circadian timing system	National Institute of Health, National Institute of Neurological Disorders and Stroke
Mechanisms of GABAergic Signaling in the Suprachiasmatic Nucleus Network	National Institute of Health, National Institute of Neurological Disorders and Stroke
Anger, W. Kent	
Oregon Healthy Workforce Center: Supervisor training to promote health/safety in construction	National Institute of Occupational Safety and Health
Pacific Northwest Agricultural Safety and Health Center: Impact of Workplace Stress on Health in Farmworker Families	National Institute of Occupational Safety and Health
Oregon Healthy Workforce Center: Planning and Evaluation Core	National Institute of Occupational Safety and Health
Berman, Fred	
The National Pesticide Information Center at Oregon State University	United States Environmental Protection Agency via Oregon State University
Bowles, Nicole	
Cannabinoids and vascular function	OHSU Foundation
Comparison of cannabinoid ingestion method and impact on endogenous circadian rhythms and vascular function	Ford Foundation Fellowship
Effect of tetrahydrocannabinol (THC) on sleep in humans	American Sleep Medicine Foundation
Butler, Matthew P.	
Apnea patterns predict heart disease and mortality	National Institute of Health, National Heart, Lung, and Blood Institute
Androgen receptors and sex differences in the biological clock	National Institute of Health, National Institute of Neurological Disorders and Stroke
Lights, food, and mis-timed clocks	Medical Research Foundation of Oregon
Photosensitivity and Pain in Complex Traumatic Brain Injury	U.S. Army Medical Research Acquisition Activity
Sex differences in sleep apnea and novel sleep measures to predict cardiovascular risk	American Sleep Medicine Foundation
Cassar, Marlene	
Investigate loss-of and gain-of functions of human Tau modifications in Drosophila	OHSU-Layton Center for Aging and Alzheimer Research
Hammer, Leslie	
Oregon Healthy Workforce Center	National Institute of Occupational Safety and Health
Development and Evaluation of Veteran Supportive Supervisor Training (VSST): Improving Reintegration of the Oregon National Guard and Reserves in the Workplace	U.S. Army Medical Research Acquisition Activity
Evaluation of a Work-Family and Sleep Leadership Intervention in the Oregon National Guard: A Behavioral Health Leadership Approach	U.S. Army Medical Research Acquisition Activity

Kretzschmar, Doris	
Circadian Clocks and Aging	National Institute of Health, National Institute on Aging
Creating new Drosophila models to study Tau loss and gain-off functions	National Institute of Health, National Institute of Neurological Disorders and Stroke
Connecting Alzheimer's Disease, APP, Circadian Regulation	National Institute of Health, National Institute on Aging
FoxP1 as a therapeutic target for Huntington's Disease	National Institute of Health, National Institute on Aging
SWS/NTE function in neurodegeneration and axonopathy	National Institute of Health, National Institute of Neurological Disorders and Stroke
Investigate the connection between circadian clock, chronic neuroinflammation, and neuronal damage in the Drosophila	Medical Research Foundation of Oregon
Lloyd, R. Stephen	
Novel Targets in Cancer Chemotherapy: Chemical Biology of Guanine Alkylation	National Institute of Health, National Cancer Institute via Vanderbilt University
DNA Adduct-Induced Mutagenesis	National Institute of Health, National Institute of Environmental Health Sciences via Vanderbilt University
Targeting DNA Base Excision Repair in Acute Myeloid Leukemias	National Institute of Health, National Cancer Institute
Discovery of a New DNA Repair Pathway for Protection from Liver Cancer	Medical Research Foundation of Oregon
The roles of BER and TLS in limiting aflatoxin-induced carcinogenesis	National Institute of Environmental Health Sciences, National Institute of Health
Development of agonists of the DNA glycosylase OGG1 for the prevention of obesity and obesity-associated diseases	
Cellular responses to DNA-protein crosslinks	National Institutes of Health, National Cancer Institute
Enhancement of DNA Repair Capacity Following UW Irradiation	Restoration Genetics
McCullough, Amanda	
Cellular responses to DNA-protein crosslinks	National Institute of Health, National Cancer Institute
Cellular responses to DNA-protein crosslink- diversity supplement	National Institute of Health, National Cancer Institute
DNA Base Excision Repair as a New Target for the Treatment of Acute Myeloid Leukemia	OHSU Knight Cancer Institute
Enhancement of DNA Repair Capacity Following UW Irradiation	Restoration Genetics
McHill, Andrew	
Oregon Clinical and Translational Research Institute (KL2)- Influence of Circadian Misalignment on Energy Expenditure & Glucose Regulation in Obstructive Sleep Apnea	Department of Health and Human Services, National Institutes of Health, National Center for Advancing Translational Science
Montgomery, Dede	
Oregon Healthy Workforce Center	National Institute of Occupational Safety and Health
Olson, Ryan	
Social Support During a Randomized Trial of a Trucker Weight Loss Intervention	National Institute of Health, National Heart, Lung, and Blood Institute
Oregon Healthy Workforce Center	National Institute of Occupational Safety and Health
FACE: Improving Occupational Health in Oregon: Turning Data to Action	National Institute for Occupational Safety and Health
SHIFT Onboard: Protecting New Transit Operators Against Safety and Health Hazards	National Institute of Health, National Heart, Lung, and Blood Institute
The effects of an anti-vibration truck cab mattress on team truck drivers' sleep, health, and performance	State of Washington Department of Labor and Industries via University of Washington

Parker, Kelsey	
NCOHS Professional Training Opportunities Program	University of Washington
Rao, Xiaoquan	
Role of Lipid Oxidation in Air Pollution-Induced Atherosclerosis	National Institutes of Health, National Institute of Environmental Health Sciences
Concentrated Ambient Particulates (CAP'S) Exposure System 4	Oregon Health and Science University
Rohlman, Diane	
Oregon Healthy Workforce Center	National Institute of Occupational Safety and Health
Sampath, Harini	
Role of Oxidative DNA Damage in the Onset and Progression of Metabolic Syndrome	National Institute of Health, National Institute of Diabetes and Digestive and Kidney Diseases
Shea, Steven	
Circadian Rhythms and Cardiovascular Risk	National Institute of Health, National Heart, Lung, and Blood Institute
Circadian mechanisms of cardiovascular risk in obesity	National Institute of Health, National Heart, Lung, and Blood Institute
Sleep and Circadian Mechanisms Contributing to Disparity in Prevalence of Hypertension Between Black and White Americans	National Institute of Health, National Heart, Lung, and Blood Institute
Oregon Healthy Workforce Center	National Institute for Occupational Safety and Health
Chronobiology of Cardiovascular and Pulmonary Disease	National Institute of Health, National Heart, Lung, and Blood Institute
Thosar, Saurabh	
Circadian disruption, physical inactivity and cardiovascular risk	National Heart, Lung, and Blood Institute, National Institute of Health
Circadian Rhythms of vascular function in cardiovascular disease	Sleep Research Society Foundation
Sleep, Physical Inactivity, Circadian Rhythms and Cardiovascular Vulnerability	National Aeronautics and Space Administration via Baylor College
Turker, Mitchell	
The Relation Between Cognitive Injury, Network Stability and Epigenetic Change Following Exposure to Space Radiation	National Aeronautics and Space Administration (NASA)
Identification of neuroprotective pathways of E2 against early and late onset hAPP/Ab-induced hippocampal injury	National Institute on Aging, National Institute of Health
Ground-Based Studies in Space Radiobiology	National Aeronautics and Space Administration (NASA)
GCR Simulator Validation Studies with Human and Mouse Models	United States Department of Energy
NeuroPredict; A Screening Assay for Chemicals that Affect the Differentiation of Human Neural Cells	National Institute of Health, National Institute of Environmental Health Sciences via Nzumbe Inc.

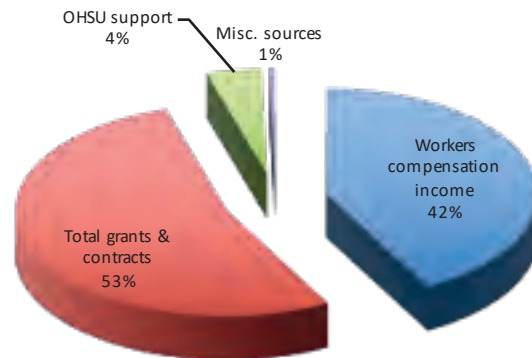
Financial Statement

July 1, 2016 - June 30, 2017

Income

Workers compensation income	4,066,698
Total grants & contracts	5,154,900
OHSU support	405,146
Misc. sources	41,885
	9,668,629

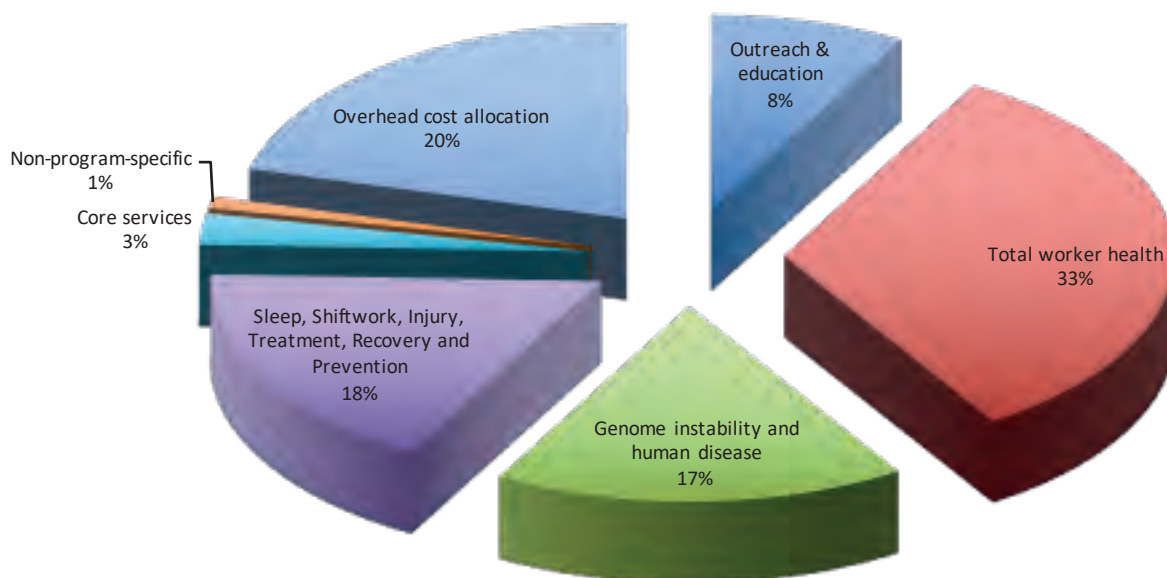
Income by Source



Expenses

All salaries & fringe benefits	5,285,687
Services & supplies	1,737,566
Bond principal & interest	353,481
OHSU overhead cost allocation	434,808
	7,811,542

Expenses by Program



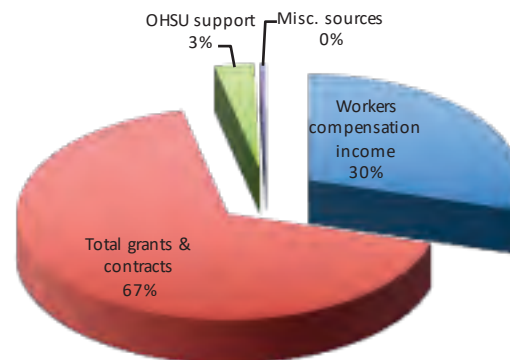
Financial Statement

July 1, 2017 - June 30, 2018

Income

Workers compensation income	3,414,482
Total grants & contracts	7,772,661
OHSU support	350,257
Misc. sources	52,431
	11,589,831

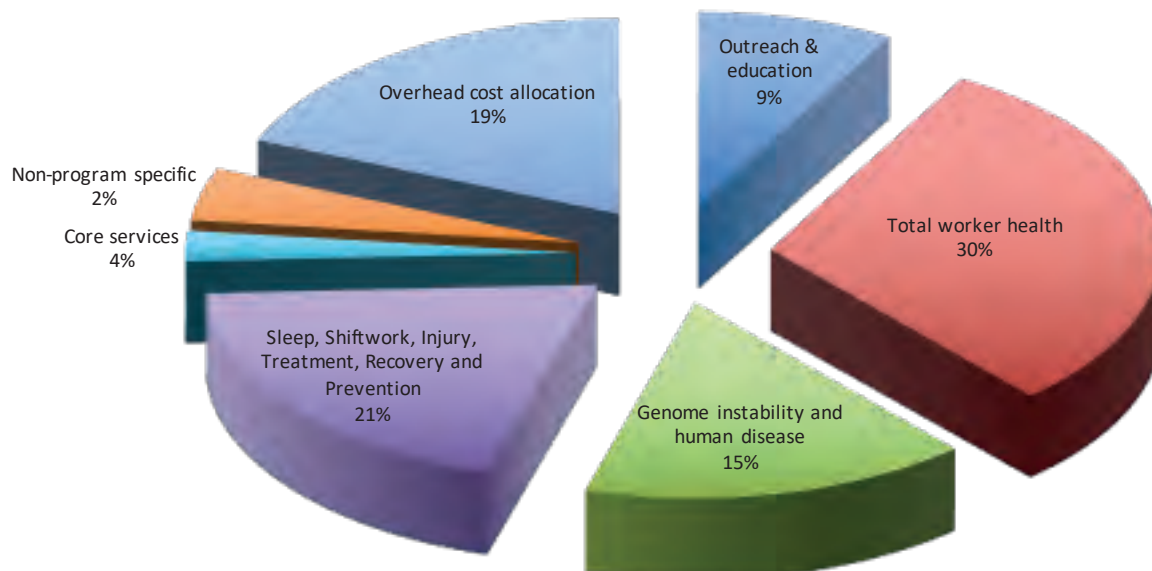
Income by Source



Expenses

All salaries & fringe benefits	6,042,885
Services & supplies	2,387,825
Bond principal & interest	353,481
OHSU overhead cost allocation	411,543
	9,195,734

Expenses by Program



Institute Personnel (with years of service)

Executive Director

Shea, Steven A Ph.D. 2012 - present

Associate Director of Applied Research

Anger, W. Kent Ph.D. 1989 - present

Associate Director of Basic Research

Lloyd, Stephen Ph.D. 2003 - present

Associate Director for Administration

Prissel, Jen M.A. 2017 - present

Faculty

Allen, Charles Ph.D. 1990 - present
Anger, W. Kent Ph.D. 1989 - present
Butler, Matt Ph.D. 2013 - present
Hammer, Leslie Ph.D. 2015 - present
Hurtado, David Sc.D. 2015 - present
Kretzschmar, Doris Ph.D. 2002 - present
Lloyd, Stephen Ph.D. 2003 - present
McCullough, Amanda Ph.D. 2003 - present
Olson, Ryan Ph.D. 2005 - present
Rao, Xiaoquan Ph.D. 2018 - present
Shea, Steven A. Ph.D. 2012 - present
Thosar, Saurabh Ph.D. 2018 - present
Turker, Mitchell Ph.D. , J.D. 1996 - present
Weinhouse, Caren Ph.D. 2018 - present

Affiliated/Secondary Faculty

Deyo, Richard M.D., M.P.H. 2009 - 2018
Emens, Jonathan M.D., M.P.H. 2016 - present
Lim, Miranda M.D., M.P.H. 2014 - present
Mitchell, Suzanne Ph.D. 2012 - present
Spencer, Peter Ph.D., F.A.N.A., FRCPath 1987 - present
Wipfli, Brad Ph.D. 2008 - present



Scientific Staff

Allen, Shalene B.S. 2015 - present
Austin, Dan M.S. 1989 - present
Berman, Alec B.S. 2015 - 2018
Berman Fred D.V.M., Ph.D. 2001 - 2018
Brockwood, Krista Ph.D. 2015 - present
Camman, Sydney B.S. 2017 - present
Cassar, Marlene Ph.D. 2013 - present
Chib, Shubeena Ph.D. 2017 - present
Clemons, Noal B.A. 2013 - present
Cravetchi, Olga M.S. 2011 - present
Dumet-Poma, Lisset M.B.A. 2016 - present
Epstein, Barb M.P.H. 2016 - present
Gilbert-Jones, Illa M.S. 2014 - present
Greenspan, Sam M.P.H. 2016 - present
Grygoryev, Dmytro Ph.D. 2009 - present
Guilfooy, Nichole B.S. 2018 - present
Guros, Frankie Ph.D. 2016 - 2018
Hablitz, Lauren Ph.D. 2015 - 2018
Herzig, Maya B.A. 2016 - present
Klett, Nathan Ph.D. 2018 - present
Kukino, Ayaka B.S. 2015 - present
Kyler-Yano, Jason M.S. 2015 - 2018
Lasarev, Michael M.S. 1996 - 2018
Law, Alexander B.S. 2016 - present
Malach-Fuller, Jason B.S. 2015 - present
Mansfield, Layla Ph.D. 2015 - present
Minko, Irina Ph.D. 2003 - present
Moldavan, Michael Ph.D. 2001 - present
Montgomery, Dede M.S., C.I.H. 2004 - present
Morioto, Miki M.D. 2014 - present
Owen, Nichole Ph.D. 2015 - 2018

Parish, Megan Ph.D. 2013 - 2017
Parker, Kelsey Ph.D. 2015 - 2018
Perry, MacKenna Ph.D. 2016 - present
Rainbird, Phoenix B.S. 2015 - present
Rameshbabu, Anjali Ph.D. 2015 - present
Rimby, Jarred B.A. 2018 - present
Running, Sydney B.S. 2018 - present
Sianoja, Marjaana Ph.D. 2017 - present
Schuckers, Helen M.P.H. 2017 - present
Vartanian, Vladimir Ph.D. 2003 - present
Vaughn, Katie B.A. 2015 - 2018
Wan, Wylie Ph.D. 2015 - 2017
Wild, Sara M.P.H. 2017 - present

How to Contact Us

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Oregon Institute of Occupational Health Sciences

The Oregon Institute of Occupational Health Sciences works to promote health, and prevent disease and disability among working Oregonians and their families. We do so through basic and applied research, outreach and education. The Institute includes scientists and research staff exploring a range of questions relating to prevention of injury and disease, and promotion of health, in the workforce of Oregon and beyond.

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Oregon Health & Science University includes the Schools of Dentistry, Medicine, Nursing and Public Health; OHSU Hospital; numerous primary care and specialty clinics; multiple research institutes and several outreach and public service units. OHSU is an equal opportunity, affirmative action institution.

