

## Characterization and optimization of water sensors to increase technology readiness level (\$30,000)



**Woo-Jin Chang**, Ph.D., Associate Professor, Biomedical Engineering, Faculty, Mechanical Engineering

Dr. Chang's research focuses on environmental and biomedical monitoring, biosensors, bionanotechnology, and bioseparations. He has worked closely with companies involved in the UWM Water Equipment and Policy center to create new heavy metal, phosphate, and pH sensors. In this proposal, he proposes to further optimize these sensors to minimize interference of competing molecules and materials in polluted water or drinking water. The goal of this technology is to be sensitive to low levels of contaminants, easy to use, and less expensive

compared to current options on the market.

**The Need for Contaminant Sensors.** Contamination of soil, groundwater, and air with heavy metals such as lead, mercury, cadmium, copper, zinc, and arsenic is a major environmental problem. Even in trace concentrations, heavy metals present in air, food, and drinking water can bio-accumulate and pose a major threat to human health.

Phosphate is a well-known contaminant of water that can lead to an excess of nutrients and plant over growth. This overgrowth can lead to the death of fish and disruption of the surrounding ecosystem. Many companies are also under EPA regulations to keep their waste and waterways below certain

mandated levels of contamination. The World Health Organization has established a guideline limiting lead concentration in drinking water to 10ppb. Studies have shown that 10—20% of adults and 40-60% of infants are exposed to lead via drinking water.

***This proof of concept testing will allow Dr. Chang to demonstrate that the sensors he has developed for detecting heavy metals in water will be useful in real-world environments where other contaminants could perturb the sensors readings; this work will help lead to low-cost disposable water sensors to address important unmet needs in water quality.***

**Problems with Current Sensors on the Market.** Current analytical devices for heavy metals are expensive, bulky, require professional operators, and have high operation cost. There are few options for portable equipment that also has a sensitive detection limit. Dr. Chang's sensors can be disposable for one time use or deployed for long-term monitoring. The UWMRF continues to receive many requests from companies to evaluate and test Dr. Chang's sensors in a variety of industries. A common need is for on site testing with sensors that can last for several months.

**Market for Heavy Metal and Phosphate Sensors.** The global market for water analysis instrumentation is projected to reach \$3.6B by 2020, and is driven by water testing for residential, commercial, and industrial uses. Many states have bans of the use or sale of phosphorus. The major causes of phosphates from humans are sewage, runoff from agricultural sites, and application of lawn fertilizers. Rapid growth in population and industrialization has led to significant contamination of water resources.

**Project Objective – Optimization and Characterization.** Dr. Chang's sensors are patent pending in multiple countries and have been non-exclusively licensed to several members of our water equipment and policy center at UWM. Further funding is necessary to progress these lab models to the next step and test real world water samples. It is important to show the sensitivity of the sensors for the target contaminant versus other competitive molecules present in the sample. Another important aspect to companies is the longevity of a sensor in the field when continuously immersed in a water sample. Dr. Chang is interested in forming a start-up company that will manufacture the sensors to be used by companies in a variety of devices from hand-held to larger multi-sensor units.

## Assessing the antidepressant, anxiolytic, and thermoregulatory effects of a novel estrogen receptor beta agonist in a mouse model of menopause (\$56,000)

**Karyn Frick**, Ph.D., Professor, Department of Psychology

The primary focus of the Frick laboratory is to understand how sex-steroid hormones, aging, and environmental factors affect brain function and memory. Her work is motivated by the rapidly expanding elderly population and the increase in age-related cognitive decline and dementia. She has joined forces locally with researchers from Marquette University and Concordia University to develop new drugs that lessen the side effects seen with the loss of estrogen during menopause. Such effects include memory loss, depression, anxiety, and hot flashes. These side effects are also connected to higher rates of dementia in women later in life.



**Problems with Current Estrogen Therapies.** While there are several estrogen replacement therapies on the market, many have been linked to harmful side effects such as cancer and heart disease. There are two estrogen receptors in the body, ER $\alpha$  and ER $\beta$ , but only ER $\alpha$  is linked to such diseases. The team has focused on creating new molecules that selectively bind to ER $\beta$  to avoid the detrimental side effects. 80% of women will experience physical or psychological symptoms of menopause, but 55% do nothing to treat these due to perceived or family risks of cancer or stroke, and lack of physician training in managing menopause.

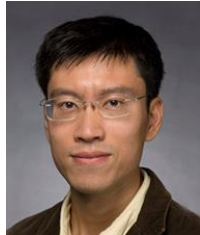
**I-Corps and Customer Discovery.** In July 2018 the three partners formed Estrigenix Therapeutics, Inc. to develop and commercialize ER $\beta$  compounds to reduce memory dysfunction and dementia risk in women. After conducting 31 interviews through the Milwaukee I-Corps program, the team found that dementia is not a druggable indication for the FDA and it is not a primary concern for doctor and patients. The top concerns were hot flashes, depression, and anxiety. The global hormone therapy market is expected to reach \$28.4 B by 2022, and estrogen therapy is expected to dominate the product segment with 50% market share. Estrigenix Therapeutics will utilize Bradley Catalyst funding to set up a hot flash testing model in mice to collect proof of concept data for an SBIR Phase I grant application. Dr. Frick has already collected data showing that their patented lead compounds lead to better memory consolidation in mouse assays. The team plans to apply for the national I-Corps program this summer to collect further interviews regarding their market plan.

***Dr. Frick's customer discovery as part of the NSF I-Crops program showed that treatment for the symptoms of menopause needed to focus on more near-term side effects, including hot flashes; this work will help her develop a new model to test that treatments that have demonstrated effectiveness for memory loss are also useful in relieving hot flashes.***

**Catalyst Grant Goals.** The Frick laboratory will utilize Bradley Catalyst funding to set up standard assays in mice for hot flashes (core body temperature, tail skin temperature), depression (forced swim test, tail suspension test), and anxiety (elevated plus maze, open field), to determine if their lead compounds are effective. In order to mimic menopause and the lack of estrogen and sex hormones, female mice are used which have had their ovaries surgically removed. Equipment for thermal imaging will be necessary to accurately follow changes in the mouse physiology. Future studies will expand into aging mice and an Alzheimer's mouse model. In parallel with applying for an SBIR grant, Estrigenix will work to negotiate a license for their related intellectual property owned by the Universities.

## A Microscopic Agent-based Simulator and Data Analytics Tool for Smart Off-street Parking Facilities, (\$55,000)

**Yue (Troy) Liu**, Ph.D., Professor, Department of Civil and Environmental Engineering



Dr. Liu's laboratory research focuses on several aspects of the Smart Cities theme. His areas of expertise include traffic control and operations, emergency evacuation planning, driver behavior analysis and intersection safety, traffic flow models and simulation, and computer-aided transportation system design. In this proposal Dr. Liu is focusing on tools for smart off-street parking.

**Lack of Sufficient Smart Parking Tools.** The current market lacks an intelligent tool to assess the layout design, operational performance, and management of parking systems to increase revenue. Existing products do not consider park space sharing, serving specific types of vehicles such as plug-in electrical vehicles, reserved parking spaces for hybrid vehicles, ancillary services such car washing, mixed use parking for cars, motorcycles and bikes, multi-design park-and-ride facility, or automated parking facilities.

**Market for Smart Parking Software.** 11% of public parking spaces globally (on-street and off-street) are now smart, and the figure is expected to increase to 16% by 2023. The market spending on smart parking products and services is predicted to reach at least \$3.8 billion by 2023.

It is believed that the real value of smart parking solutions lies in the parking data generated, that when combined with other stakeholders' data, processes and systems yield real innovation in smart city settings. An average car spends 95% of a day or 23 hours per day parked, therefore parking facilities occupy huge amount of land use and could possibly cause congestions, emissions, noise, and accidents in the urban area. The

parking industry produces an enormous amount of data every day, and if properly utilized, will change the way the industry operates. The collected data points form patterns that, in most cases, would allow parking operators and property owners to better understand how to maximize revenue and decrease operating expenses and support the decisions such as how to set specific parking policies (e.g. as electrical charging only parking space) to achieve the sustainable and eco-friendly parking. The research team has already attracted smart parking technology companies and property management companies in Wisconsin, California, and Illinois for possible licensing of the system.

**Project Objectives** - A rule-based parking simulation model will be formulated to effectively capture the behaviors of drivers and pedestrians as well as space and time-based interactions of traffic dynamics in the parking system. The proposed simulator will be implemented in a Software as a Service (SaaS) graphic user platform for online visualization, analysis, and decision making. If successfully deployed, this product offers immediate benefits. It will assist parking operators and property owners to maximize revenue, decrease operating expenses, evaluate smart parking investment, and flexible parking policies. The application would provide a critical piece of the long-term push toward enabling next-gen data driven parking planning and management and result in a nationwide impact in the parking industry. After first developing the simulation models, the team will collect real field data at one of UWM's parking lots for a case study and invite customers to test the system. The findings and feedback will be used to fine tune the system.

*Dr. Liu is developing a range of tools that utilize big data and artificial intelligence to enable smart cities; this work will develop advanced tools and learning models for management of parking that optimize use of resources as part of a larger intelligent transportation network.*

## Maternity Metrix Solution for integrated Maternal Child Outcome Improvements, (\$50,000)

**AkkeNeel Talsma**, Ph.D., Professor, Schroeder Chair in Nursing Research and Associate Professor



Dr. Talsma's laboratory focuses on research related to quality/safety related outcomes, clinical informatics, electronic health records, point of care measures, implementation science, quality and safety measures during surgery, and maternal/child outcomes. She is the founder and CEO of Melius Outcomes, a company creating software solutions for hospitals and surgical centers to capture data from electronic health records for identification of poor patient outcomes. Their services help customers to cut expenses, improve hospital reputation, maximize reimbursements, and increase patient and staff satisfaction. This Bradley Catalyst grant proposal describes a new aim focused on the mother/infant patient outcomes.

**Current Challenges in US Hospitals.** American women are more likely to die during and from childbirth than women in any other high developed country (CDC, 2017). Increasing preexisting health issues and pregnancy-associated disease in pregnant women contribute to a greater risk for poor pregnancy, birth, and infant outcomes. Healthcare providers are challenged by a fragmented and ad hoc quality monitoring system, which limits the oversight of risk for complications before delivery, during hospitalization, and after discharge. There is a clear absence of an integrated overview of performance that is linked with recommended practices and guidance, leading to substandard care and outcomes.

**Commercial Market for Patient Outcome Tracking.** Global quality management in the healthcare market is expected to reach \$3.7B by 2023. Quality management in the healthcare market is characterized by constant technological advancements to keep pace with the changing industry needs. The growth of this market is fueled by the government initiatives to improve patient outcomes and safety, rising unstructured data in healthcare, rising geriatric population, burden of chronic diseases, improving health IT infrastructure, and shift towards value-based reimbursements. The Maternity Matrix Solution, proposed by Dr. Talsma, offers multiple commercialization opportunities, which can be made available as an integrated and/or separate product. The components include: 1) Clinical Data. With the receipt of clinical maternal/child related data, performance measures are prepared that will be made available through a secure online platform. Analyses include trends, benchmarks, and eventually machine learning technology to develop risk profiles. 2) Best & Evidence Based Practices. Based on performance of the measures, it links with best practices, research, and evidence to support clinical practice are made available. 3) Integration. Reporting, best practices, benchmarking, policies, and protocols are appropriately linked, providing implementation guidance for change management.

*Dr. Talsma has applied healthcare outcomes measurement to improve outcomes in surgery; in this project, she'll extend that work using big data and machine learning to improve outcomes in maternity care where better prediction can lead to early intervention and better outcomes for infants.*

**I-Corps and Commercial Opportunities.** In 2017 Dr. Talsma participated in the Milwaukee I-Corps program and conducted 21 interviews confirming that midlevel and senior leadership are concerned about the hospital performance and the lack of useable insights. In 2018 she conducted three focus groups with nurse managers and directors and determined that a hospital may spend \$375K on labor costs alone to obtain useful data to report. Insurance representatives and Medicaid population managers also expressed frustration regarding the lack of insight into current data, lack of improvement activities, and little monitoring of results. Her team concluded that the buyer of the product includes senior medical and nursing officers and population health leadership. The immediate user may be a clinician, (regional) director, or population health/quality improvement lead. The commercialization of the Maternity Metrix Solution initially focuses on developing pilot projects with regional entities, including the Department of Health Services, which oversees the Medicaid recipients through BadgerCare™ in the State of Wisconsin.