The Role of Blurred Lenses in Modulating Choroid Thickness and Preventing Myopia

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Mentor: Jay Neitz, Ophthalmology

Myopia, or nearsightedness, is the only cause among the top five causes of blindness in the world that remains completely untreatable and has reached epidemic proportions. Characterized by a thin choroid layer and increased axial eye length, myopia develops when the eye continues to grow so that images of objects seen in the distance become in focus in front of the retina rather than at the retina itself. This study aims to find a means to prevent the progression of myopia from its onset during early childhood, and help the eye return to a length closer to emmetropia, a process in which the eye stops growing when objects are in maximal focus at most distances. Specifically, we developed and tested a prototype blurry lens (eye glasses) to see if it could serve as a potential means to decrease the axial length of the eye, increase the thickness of the choroid layer, and ultimately help prevent the progression of myopia. Subjects were required to wear glasses in which the left eye was UV irradiated with a blurry pattern and the right eye served as a self-regulated control. The choroid layer was measured in pre and post-treatment sessions using OCT (optical coherence tomography) imaging of the retina and choroid via a Rowland RETImap OCT machine and standard regression analyses. Results show a significant increase in the choroidal thickness and decrease in the axial length of the left eye compared to the control and baseline measurements, along with a change in retinal morphology. Our study suggests that the eye experiences signals that modulate its axial length in response to myopic stress. Thus, the blurred lenses were an effective means to prevent the progression of myopia because they brought about similar changes in axial length and choroidal thickness changes as seen in emmetropic conditions.

Pulmonary Hypertension Research Study

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Mentor: Gail Van Norman
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Although patients diagnosed with pulmonary hypertension (PHTN) are at a higher risk for postoperative complications, studies to date have not distinguished whether this applies equally to all PHTN patients, nor have they determined the severity of postoperative complications should they occur. Pre-operative screenings take place in the form of echocardiograms (ECHO), which are accurate but rather expensive. This study, one of the largest pulmonary hypertension studies to date, is headed by Dr. Gail Van Norman, director of the Pre-Anesthesia Clinic at the University of Washington Medical Center (UWMC). We look to explore the correlation between the severity of pre-existing pulmonary hypertension and post-operative complications. This study additionally explores the correlation between metabolic equivalents (METS) and PHTN, which could yield a new, more cost-effective method of screening for the disease. As research interns on this project, we abstract data from the medical records of eligible patients at UWMC. We focus on patients who have undergone surgery with moderate to severe PHTN, and collect pre-op and post-op data using hospital affiliated databases. Patients with these specific conditions are believed to have <4 METS and are at an elevated risk for post-operative complications. Should these hypotheses be proven correct, the results of this study will benefit both patients and providers, reducing the cost of screening, as well as improving patient care by allowing doctors to better manage the disease in the peri- and postoperative settings, reducing both complication and mortality rates.
Determining the Relationship between Blood Pressure and Blood Loss at Site of Injury During Trauma

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Traumatic injuries can often lead to massive blood loss. When a patient’s mean blood pressure (MAP) drops due to bleeding, the standard protocol is to administer intravenous fluids with the goal of restoring normal blood pressure. However, increasing blood pressure may also increase the rate of bleeding, causing even more overall blood loss. There is no current evidence to show that MAP correlates directly to the velocity of blood exiting a wound. We hypothesize that a direct relationship exists between blood pressure and velocity of bleeding. We test this hypothesis using direct ultrasound imaging of a bleeding artery in a swine model of trauma. N=8 anesthetized pigs underwent bleeding from a femoral artery punch wound and were simultaneously given intravenous fluids to increase blood pressure and cardiac output. Ultrasound measurements of blood flow velocity from a femoral artery punch wound were taken at regular intervals. We found that MAP did not correlate with the bleeding velocity at the wound (R=0.27, p=0.068). However, cardiac output was significantly correlated with bleeding velocity (R=0.37, p=0.012). MAP and cardiac output were then stratified into normal or low categories based on their median values for the entire group. Average bleeding velocity was not different when MAP was low compared to when it was normal (normal=255.7 cm/s vs. 221.8 cm/s, p=0.18). However, bleeding velocity was significantly decreased when cardiac output was low vs. normal (normal=253.6 cm/s vs. 196.1 cm/s, p=0.01). This data does not support our hypothesis of a direct relationship between MAP and wound bleeding velocity. Alternatively, cardiac output as a measurement of blood flow, rather than pressure, may better reflect bleeding after injury and may be a more-useful guide for fluid resuscitation during active bleeding.

Hydrothermal Synthesis of PZT Nanoparticles for 3D Printer Ink

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Mentor: Weiwei Xu, Mechanical Engineering
Mentor: Steve Shen, Mechanical Engineering

Lead zirconate titanate (PZT) is a piezoelectric material commonly used in sensors and actuators. The goal of this project is to formulate a process of producing PZT nanoparticles to be imbedded in a polymer ink that could be used in a 3D printer. The particles must be small enough to make a homogenous colloidal ink that will not obstruct the printer nozzle. My project analyzes the synthesis procedure in detail and how it can affect the piezoelectric properties and morphology of the product. Hydrothermal synthesis was performed at 200 degrees Celsius to control particle size, agglomeration, and chemistry of the PZT particles. It was found that the previous method of synthesis produced particles on the order of 1 to 3 microns in size. In order to reduce particle size below 1 micron, I have proposed to reduce time spent growing the particles at elevated temperatures.

Ferromagnetic Materials for Improving RF Isolation in Wirelessly Powered Medical Devices

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Mentor: Joshua Smith, Computer Science & Engineering, Electrical Engineering
Mentor: Benjamin Waters, Electrical Engineering

The research I have conducted focused on evaluating the effect and performance of various types of ferromagnetic material on Radio Frequency isolation. RF isolation is crucial for the optimal delivery and operation of wireless energy transfer to electronic devices ranging from consumer electronics to implanted medical devices. The material was tested in a typical configuration of implanted parts for the Free-Range Resonant Electrical Energy Delivery project. The configuration was then tested for weight, cost, size, Coil Q factor and efficiency over distance. The various ferromagnetic materials were then compared with each other and to various control setups. The results show that in comparison to the control setups, all of the ferromagnetic materials performed better with respects to efficiency over distance. Further evaluation of efficiency and size determined that ferromagnetic materials IRLG5 and IBF10 had the best efficiencies and coil Q factor. Depending on whether an application requires a lower cost/ higher production or smaller size/weight, either ferromagnetic material IRLG5 or IBF10 will be chosen for use. The research has profound implications on the development of more efficient and stable wirelessly powered electronics such as tablets, smart watches, cell phones, etc. For example, ferromagnetic material can be used to isolate radio frequency signals emanating from a wireless receive coil from the metal housing of a cell phone/tablet or in ensuring that the implanted circuitry controlling a neuro-prosthetic is not disrupted by RF noise.

Participant Perspectives on Mall Walking Programs

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Mentor: Basia Belza, Biobehavioral Nursing & Health Informatics

Mall walking provides a safe environment for older adults to engage in physical activity and participate in a social community. Walking has many health benefits, a few of the benefits include reducing the risk of falls, reducing falls, increasing quality of life, increasing cardiac function, a low cost activity, and increasing mobility. However, there is limited data
on mall walking as an activity and the benefits it provides for older adults. The purpose of this study is to understand the benefits of mall walking from the perspective of mall walking leaders and mall walking participants. The results of this study will be used to create an Evidence-informed Mall Walking Program Resource Guide which will be used to help start potential programs and to benefit programs already in place. I will utilize a structured interview guide created by the research team and conduct phone or in-person interviews with three mall or non-mall walking leaders and three mall or non-mall walking participants in the Seattle area. The interview guide includes items about how participants learned about the mall walking program, what they like and dislike about mall walking, transportation to and from the mall, how long they have been a part of this walking community, what makes this community successful, and the age and ethnic diversity of the mall walkers. To date, I have completed three interviews of mall walking participants and one interview of a mall program leader. From these interviews I learned mall walking is a great health promoting activity enjoyed by older adults. Participants and leaders alike have found a social community and are able to engage physically, mentally, and psychosocially while walking. By the time of the poster presentation I will have additional data to present on two other mall walking participants and three mall walking leaders.

Guided Fluorescence Diagnosis of Childhood Caries: Preliminary Measures Correlate with Depth of Carious Decay
Mari-Alina Timoshchuk, Recent Graduate, English Literature, University of Washington
Mentor: Eric Seibel, Mechanical Engineering

Childhood caries, also known as tooth decay, is on the rise worldwide and has increased the demand for portable technologies that can quickly and accurately detect and diagnose early stage carious lesions. These lesions, if identified at an early stage, can be reversed with remineralization treatments, education, and improvements in home care. A multi-modal optical prototype was previously developed at the University of Washington’s Human Photonics Laboratory for the detection and diagnosis of early occlusal caries demineralization in vivo. The device uses a 405-nm laser as an illumination source to obtain high-resolution images that can better guide the operator to identify a suspicious enamel region. When the suspicious region is located, the device can be switched to perform dual laser fluorescence spectroscopy using 405-nm and 532-nm laser excitations generating an auto-fluorescence (AF) ratio with the main goal of diagnosing the start of early caries. Recent research had the device test in vivo on 7 children’s teeth with clinically diagnosed carious, non-cavitated lesions. Using the 405-nm scanned light source, lesion depth was visually estimated by the clinician. Within a month, the clinician assessed the maximum drill depth after the tooth had been drilled and the spectroscopic data acquired. The researcher and clinicians were masked from previous measurements in a blinded study protocol. Using the drill depth as the gold standard, the researcher assessed the preliminary results of the 7 patients to see if the severity or depth of the lesion could be compared quantitatively by using the device. Preliminary results indicate that the quantitative AF spectrum of a tooth correlates with the severity of demineralization as assessed by the clinician after drilling.

Incidence and Outcomes of Bloodstream Infections with Common Over-the-Counter Probiotic Organisms among Bone Marrow Transplant Recipients
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Mentor: Steven Pergam, Medicine, Fred Hutchinson Cancer Research Center

Supplementation with “good bacteria” (probiotics) has been promoted for various health conditions. Marketing and over-the-counter (OTC) access has also led to increased availability of these agents. Safety of probiotic supplementation for individuals with weakened immune systems, such as bone marrow transplant (BMT) recipients, is unknown. Since these patients are at increased risk for developing bloodstream infections (bacteremia), we sought to evaluate the incidence and outcome of bacteremia due to organisms common to OTC probiotic supplements in a cohort of BMT recipients. We reviewed all blood culture results from BMT recipients transplanted at the Fred Hutchinson Cancer Research Center in Seattle, WA between 2002-2011. Patients with at least one positive blood culture for common probiotic organisms (Lactobacillus species, Bifidobacterium species, or Streptococcus thermophilus) within one-year post-BMT were considered cases for this study. Patients with evidence of pre-transplant bacteremia from these agents were excluded. Data were collected from center databases, which contain archived laboratory data, patient demographics, and clinical summaries. We found that a total of 18/3799 (0.47%) BMT recipients developed bacteremia with Lactobacillus species within one-year post-HCT; no events with Bifidobacterium or S. thermophilus were identified. Positive blood cultures for Lactobacillus species occurred at a median of 84 days post-transplant (IQR: 34, 127), but the majority (n=12 [67%]) occurred within the first 100-days. The overall incidence rate of Lactobacillus bacteremia was 1.54 cases per 100,000 patient-days, but the highest incidence occurred during the first 100-days post-transplant (3.31 cases per 100,000 patient-days). Incidence did not deviate significantly by year of transplant. Most patients had a singular positive blood culture (n=17 [94%]); one patient developed prolonged bacteremia (30 days). No Lactobacillus-attributed mortality was observed during follow-up. We concluded that organisms frequently incorporated in available OTC probiotic supplements
are infrequent causes of bacteremia after BMT. Studies evaluating the use of probiotics among these high-risk patients are needed.