Institution: Beth Israel Deaconess Medical Center

Mentor: Brian O'Gara, MD MPH

Project(s) Available: Perioperative virtual reality to reduce sedative and opioid administration

For decades, standard perioperative anesthesia care has included the liberal use of sedatives and opioids. While intended to maximize patient comfort, this approach can have adverse consequences. Injuries related to over-sedation consist of 21% of all claims related to anesthesia care, with over 50% deemed preventable, leading to excess patient morbidity and cost (Bhananker 2006). The liberal use of perioperative opioids has helped create a national epidemic of opioid abuse in the US (Koepke 2018). Thus, there exists an urgent and ongoing need for interventions to balance the critical goals of patient comfort and patient safety. Virtual reality immersion may represent a means of reducing the burden of oversedation and overprescription of harmful medications while maintaining a high degree of patient satisfaction. In a preliminary trial, we were able to demonstrate significant reductions in intraoperative sedation requirements (median 260 vs 0 mg Propofol) and recovery times (75 vs 53 min) while maintaining high degrees of satisfaction and relaxation for hand/arm surgery patients. Our VR platform enables patients to use different VR experiences designed to help to distract them from pain while undergoing surgery. Healthcare providers are able to control and monitor the patients' activity in VR in order to ensure comfort. Going forward, we aim to expand the use of VR to other patients at risk for over-sedation: after bariatric surgery and during knee replacements in two parallel clinical trials funded by a grant from the BIRD foundation.

Institution: Beth Israel Deaconess Medical Center

Mentor: Maria Serena Longhi, MD, PhD

Project(s) Available:

1) Hypoxia disrupts purinergic signaling in inflammatory bowel disease Inflammatory bowel disease (IBD) is associated with aberrant immune system activation. Conventional immunosuppression is often ineffective and disease results in substantial morbidity, high cancer risk and early death. In the acute setting, hypoxia promotes protective immune responses. In contrast, during protracted inflammation, hypoxia leads to suppression of Tregulatory-1 (Tr1)-cells and boosts effector Th17-cells. Our data indicate that Crohn's-derived Th17-cells display heightened HIF-1a levels and downregulate CD39 under hypoxic conditions.
Hypothesis: Hypoxia in experimental colitis and human IBD limits Tr1-cell-mediated immunoregulation and promotes Th17-cells.
Significance: These studies will provide novel insights on how protracted hypoxia impacts colitis by altering ABC transporters. We will identify potential therapeutic interventions to control disease activity by harnessing O2. The student will be involved, under supervision, in animal experiments (monitoring of colitis, harvesting, histological and cell phenotype determination), data collection and analysis.

2) Alterations of aryl hydrocarbon receptor signaling in autoimmune hepatitis
Autoimmune hepatitis (AIH) is a severe liver disease of unknown etiology that follows a relapsingremitting course and often becomes refractory to immunosuppression. In AIH dysfunctional Tregs co-exist with heightened Th17-cell immunity. CD39 is an ectonucleotidase hydrolyzing proinflammatory ATP into immunosuppressive adenosine. We have noted that AIH-derived Tregs and Th17-cells fail to upregulate CD39 in response to AhR activation and express heightened Era, KLF6, AhRR and HIF-1a.
Hypothesis: We hypothesize that Treg and Th17-cell purinergic dysfunction in AIH is linked to aberrant AhR signaling and/or regulation.
Significance: Our investigations will provide mechanistic insights into autoimmune tissue damage in AIH and, notably, will aid identifying novel therapeutic targets to control inflammation and halt disease progression in AIH and other chronic liver illnesses. The student will be involved, under supervision, in cell culture experiments, RNA extraction, qPCR, flow cytometry as well as in data collection and analysis.

Institution: Beth Israel Deaconess Medical Center

Mentor: Balachundhar Subramaniam, MD, MPH, FASA

Project(s) Available:

1) Delirium Prevention After Cardiac Surgery Using IV Acetaminophen to Prevent Postoperative Delirium in Older Cardiac Surgical Patients (PANDORA)

This NIH funded project will study the impact of scheduled administration of IV acetaminophen on the incidence, duration, and severity of postoperative delirium and other important hospital outcomes. Additionally, this trial will evaluate the effects of IV acetaminophen on longer-term postoperative cognitive dysfunction and functional status and develop a biorepository of perioperative samples as a future resource to probe the mechanisms of postoperative delirium. The investigators propose three specific aims by conducting a randomized, triple-blind clinical trial that enrolls 900 patients 60 years of age or older undergoing cardiac surgery. Through this trial, the investigators will determine the effect of IV acetaminophen on; the incidence, duration, and severity of postoperative delirium, the use of opioids and other rescue analgesics in the first 48 postoperative hours, daily pain scores at rest and exertion, and length of stay in the Intensive Care Unit and overall hospital length of stay longer-term cognitive, physical, and self-care functional recovery after surgery.

2) The PATHFINDER Study: A Feasibility Trial

The main purpose of this study is to determine whether a rational strategy of EEG guided multimodal general anesthesia using target specific sedative and analgesics could result in enhanced recovery after anesthesia and surgery, decrease in postoperative delirium, and decrease in long term postoperative cognitive dysfunction up to 6 months following cardiac surgery.

Specific Aim 1: The feasibility of implementing multimodal general anesthesia strategy in the Operating Rooms (OR)

Specific Aim 2: The feasibility of implementing EEG guided sedation until extubation in the Intensive Care Unit (ICU)

Specific Aim 3: The enhancement of recovery after surgery (shorter ventilation time, ICU stay, hospital length of stay)

Specific Aim 4: To estimate the effect size of decrease in postoperative day (POD) and postoperative cognitive dysfunction (POCD) to power future large randomized trials

Institution: Beth Israel Deaconess Medical Center

Mentor: Simon Robson, Ph.D., M.B.Ch.B.

Project(s) Available:

1) Testing of soluble CD39-CD73 recombinant proteins in models of inflammation and pulmonary stress.

We hypothesize that the detrimental host responses in COVID-19 and associated vascular thrombosis/ARDS are mediated, at least in part, through perturbation of purinergic signaling and unfettered platelet and immune cell activation in the pulmonary vasculature. To that end, we have generated stable and innovative bifunctional therapeutic fusion products of CD39 and CD73. These will be highly potent in ameliorating inflammation by targeting the catalytic conversion of extracellular ATP/ADP directly to adenosine. This proposed study will not only shed light on the understanding of purinergic signaling networks and thrombosis in the setting of ARDS for therapeutic intervention, but also potentially test recombinant biologicals readily available for development and clinical testing.

Specific Aim 1: Establish purinergic immune studies of COVID-19 and ARDS.

Determination of expression patterns of purinergic signaling circuits in immune cells (T cells, macrophages, monocytes, neutrophils) isolated from blood. -- Mass cytometry (CyTOF) analysis of cryopreserved collections of blood and BAL cells, will be done, as recently validated (16).

- Characterization of immune cell ATP signaling in COVID-19 patients with ARDS and cytokinemia.
- Explore biological impacts of CD39CD73 on immune cells isolated from patients with COVID-19 in vitro.

Specific Aim 2: Establish in vivo murine experimental model for ARDS

• We have adoptive iNKT cell transfer mouse models for hyperoxic lung injury and thrombosis (17,18) (unpublished data). We will study hyperoxic pulmonary injury and vascular injury following implantation of immune cells from patients with and without ARDS, into NSG mice (The Jackson Lab, Bar Harbor, ME).
• Explore biological impacts of CD39CD73 bifunctional fusion proteins in the murine ARDS models.
Project 2: Development of functional cellular assays to detect ACE2 antibodies in COVID19 and thrombotic disorders.

3) Studies of Fgl-2 function in coagulation and heterologous immunity in COVID-19.

Institution: Beth Israel Deaconess Medical Center

Mentor: Shahzad Shaefi, MD, MPH
Project(s) Available:
1) Carbon Monoxide in Cardiac Arrest
Carbon Monoxide (CO), long thought of as singularly harmful, shows promise as a wide-ranging therapeutic agent with anti-inflammatory, antimicrobial, and antiapoptotic properties. This bioactive gas, produced endogenously by the enzyme Heme Oxygenase-1, exerts cytoprotective effects in various disease states, and in settings of oxidative stress and inflammation. Cardiac Arrest is a disease state with poor long-term outcomes, due to the damaging effects of the subsequent neurological and cardiovascular dysfunction, and ischemia-reperfusion injury. Several studies have demonstrated the potential of CO to ameliorate ischemia reperfusion injury and resolve systemic inflammation, key factors in the poor outcomes following Cardiac Arrest, yet the role of CO in this arena has not formally been examined. We are interested in creating a preclinical murine model of Cardiac Arrest and assessing the effects of CO on the disease physiology and outcomes. The student in the proposed project will be exposed to small animal models as well as basic techniques of experimental design, execution and eventual publishing. We aim to carry the knowledge gained in these studies into larger animal models and eventually into human treatment. This project commitment could range from small summer focused project to a year plus commitment depending on student's interest and scope.

2) Oxygen Titration in Septic Shock: Sepsis and Septic Shock remains one of the leading causes of morbidity and mortality in the critically ill population, responsible for one out of every three hospital deaths, and exhibits a concerning upward trend in incidence. It remains difficult to treat and requires novel therapeutic approaches, one of which may come by a rethinking of the first line of treatment, oxygenation. We posit that targeted titrations of oxygen could reduce the burden of oxidative stress placed on the body by conventionally higher oxygen therapy, activate several key cytoprotective pathways, and improve patient outcomes. We aim to investigate the effect of varying oxygen titrations on Septic Shock patient outcomes. The student in this proposed trial would be closely involved with the development and execution of a large clinical trial, including gaining an understanding of human subjects research, patient screening, enrollment and consenting as well as grant writing, manuscript preparation and fundamentals of biostatistics and epidemiological research.

Institution: Brigham and Women's Hospital

Mentor: Richard Urman, M.D. , M.B.A.
Project(s) Available: Novel Computational Methods for Continuous Objective Multimodal Pain Assessment Sensing System (COMPASS)
Pain is a complex human experience and a symptom of numerous medical conditions with anatomic, physiologic, psychosocial, and cultural determinants. Clinicians rely on patients' self-reported information as well as assessments of multiple clinical cues, and few methods are available for objective assessment of pain. The most common measures available for pain assessment are VAS scales, numerical rating scales, and verbal rating scales. These self-reporting measures, which come from patients, are subject to high variability. Consequently, objective measurement of pain has long been clinicians' holy grail for effective pain management.

Virtual (remote) research option might include writing a systematic review or analyzing existing data
The goal of this National Science Foundation (NSF) funded study is to develop a Continuous Objective Multimodal Pain Assessment Sensing System (COMPASS), to objectively and accurately measure pain for clinical use, with multimodal data coming from facial-expressions and non-invasive physiological sensors. The study focuses on chronic Low Back Pain, although the science and methods being developed are broadly applicable to other types of pain. The long-term goal is to enable objective chronic pain assessment and management without undesirable and unintended consequences, and potentially extend its use to other patient states such as stress, depression, and emotion.

COMPASS is built on the premise that pain can be assessed accurately and reliably through integrations of non-invasive, multimodal sensor data to assess pain objectively. These non-invasive modalities will include Facial Expression, Electroencephalography (EEG), Eye movement, Galvanic Skin Response, Electrocardiogram (ECG), Electromyography (EMG), Skin Temperature, Respiratory Rate, and Blood Pressure. The study will investigate optimal sensor selection to assess pain objectively and accurately with fewer sensors. The methodology includes developing feature extraction methods, machine learning models, and data fusion algorithms to objectively assess pain. We will design experiments to collect a large set of clinical data from chronic low-back pain patients.

Institution: Brigham and Women's Hospital

Mentor: Vesela Kovacheva, MD, PhD
Project(s) Available: Postpartum hemorrhage (PPH) is the leading cause of maternal morbidity and mortality worldwide. Uterine atony is the most common etiology, contributing to 80% of PPH cases. In most cases, the diagnosis of PPH is made based on the observed/estimated blood loss or maternal decompensation. Multiple studies have demonstrated that the blood loss is commonly imprecisely estimated and, in postpartum patients, even using quantitative blood loss (QBL) methods may fail to identify up to 33% of the patients on time. Timely detection of PPH can prevent significant maternal morbidity and mortality.

We hypothesize that changes in maternal hemodynamics can be used to detect PPH. We are working on developing a machine learning algorithm which will monitor the patient's hemodynamics and alert the physician if a pattern consistent with PPH is detected. We anticipate that this research will significantly advance our understanding of the hemodynamic signs of PPH, and ultimately aid obstetric anesthesia care of pregnant patients by enabling early PPH detection.

We are looking for a motivated and self-directed team player who is interested in obstetrics, anesthesia and translational research. The project involves accessing medical records to collect clinical data, annotating records, basic data analysis and literature review. No prior experience necessary; if the candidate has programming skills in Python3 and PostgreSQL, we can provide opportunity to get experience with data processing. Most of the work can be done remotely, the clinical exposure will include BWH L&D suite.

Institution: **Cedars Sinai Medical Center**

Mentor: Michael Nurok, M.D.
Project(s) Available: TBD

Institution: **Cedars Sinai Medical Center**

Mentor: Roya Yumul, M.D., PhD.
Project(s) Available: TBD

Institution: **Cedars Sinai Medical Center**

Mentor: Ofelia Loani Elvir Lazo, M.D.
Project(s) Available: TBD

Institution: **Cleveland Clinic Foundation**

Mentor: Daniel Sessler, MD
Project(s) Available: POISE-3, a 10,00-patients multicenter factorial RCT.
Hypotension prediction index evaluation, a 300-patient single-center RCT.
Two RCTs of regional blocks for thoracic surgery.
Many others!
Students can and do participate in all aspects of trials.

Institution: **Cleveland Clinic Foundation**

Mentor: Alparslan Turan, MD
Project(s) Available: As above.

Institution: **Emory University School of Medicine**

Mentor: Roman Sniecinski, MD, MSc
Project(s) Available: Contact Activation in Ventricular Assist Devices
Heart failure patients have a unique coagulation profile that, when combined with poor circulation and stagnant blood, places them at great risk for thrombotic events. This is particularly relevant to those patients requiring circulatory support with ventricular assist device (VADs). The purpose of this project is to characterize the coagulation changes that occur when blood from heart failure patients is exposed to various extracorporeal circuits. Students will learn how to measure coagulation factors using both ELISA techniques as well as translational tools such as viscoelastic testing (i.e. TEG/ROTEM) and calibrated automated thrombography (CAT). They will also be involved in the consenting of subjects and collection of blood from surgical patients.
Airway Ultrasound in Cardiac Surgical Patients

Ultrasound of the airway is a promising technique that has been used in prior studies to determine the difficulty of intubation in surgical patients. Particular measurements can change during the course of cardiopulmonary bypass (CPB), although the significance of this change is not known. It is possible measurements can help determine the readiness for patient extubation following prolonged CPB runs. The purpose of this study is to correlate airway ultrasound measurements with time to extubation. It may also help determine when patients are too edematous to safely extubate. Students will learn how to perform airway ultrasound in cardiac surgical patients. They will also be involved with patient recruitment and follow-up of the subject's hospital course.

Institution: **Emory University School of Medicine**

Mentor: Vinita Singh, MD
Project(s) Available: There are race and ethnic disparities that exist in opioid utilization for pain. However, long term use of opioids is known to cause more harm, and it would be beneficial to identify if these disparities exist for other pain treatments. The Center for Disease Control guidelines for pain recommends using opioids as a last resort and promote the use of non-pharmacological treatment such as physical therapy. Interventional treatments such as joint or epidural steroid injections are often utilized to treat pain after the failure of conservative methods such as physical therapy and non-steroidal anti-inflammatory agents.

The primary goal of this research project would be to identify disparities in the utilization of non-pharmacological pain treatments such as physical therapy and interventional procedures and identify potential barriers.
Aim 1: Identify the disparities in the utilization of non-pharmacological pain treatments (physical therapy and interventional pain procedures). Healthcare utilization data and demographic data will be gathered from the center for medicare and medicaid services, and chart review for patients coming to Emory Pain Center. Pain treatment utilization will be correlated with socioeconomic status, educational level, geographical location, gender, race, and ethnicity.
Aim 2: Identify potential barriers in the utilization of non-pharmacological pain treatment. In the groups identified with a low utilization rate of non-pharmacological pain treatments, a survey will be conducted to identify barriers.

Institution: **Emory University School of Medicine**

Mentor: Daniel Harper, PhD
Project(s) Available: Perception of an experimental neuropathic-like pain in fibromyalgia and neuropathic pain
The thermal grill illusion, in which alternating warm and cool stimuli applied to the skin create an illusion of burning pain, has been said to resemble a common symptom of neuropathic pain called cold allodynia. However, sensitivity to this illusory pain has never been formally tested in patients with neuropathic pain or fibromyalgia. This project would entail recruiting 20-30 patients with neuropathic pain and/or fibromyalgia and testing their sensitivity to the thermal grill illusion. The sensitivity of chronic pain patients to this illusion will be compared to

the sensitivity of pain-free individuals. We hypothesize that neuropathic pain patients with cold allodynia will have heightened sensitivity to the illusion compared to pain patients without this symptom, and that pain patients will generally be more sensitive to the thermal grill and thermal pain than the pain-free controls. The student would be involved with recruitment, quantitative sensory testing (QST) of the thermal grill illusion and thermal pain, and data management and analysis. We hope that these results could be used to indicate that the thermal grill illusion is a solid measure of a neuropathic-like pain, which could be useful for the development of new therapies for neuropathic pain in the future

Institution: **Icahn School of Medicine at Mount Sinai**

Mentor: Garrett Burnett, M.D.
Project(s) Available: Project(s) available: Serious gaming for Local Anesthetic Systemic Toxicity (LAST) management
A serious game is any type of game that provides educational value beyond pure entertainment value. Serious games are rapidly emerging in the era of educational research and may provide improved knowledge retention and increased learner satisfaction when compared to traditional didactics. The aim of this study is to develop a screen-based interactive serious game to teach recognition and management of Local Anesthetic Systemic Toxicity (LAST). Following initial validation of the application, users of this game will then be evaluated for knowledge retention in the simulation laboratory environment using anesthesia trainees. Student opportunities will be in development of the serious game (content and/or coding), validation of the serious game, simulation-based evaluation of knowledge retention, data collection and analysis, and manuscript preparation. Clinical observations will include experiences in regional anesthesia, but may be tailored to the student's preferences.

Institution: **Icahn School of Medicine at Mount Sinai**

Mentor: Daniel Katz, M.D.
Project(s) Available: Title: Utilization of Factor Concentrates in Obstetric Hemorrhage: An In-Vitro Study
Obstetric hemorrhage is one of the leading causes of maternal mortality worldwide. A contributing factor to death in these cases is coagulopathy. Currently, blood products such as fresh frozen plasma and cryoprecipitate are used to restore coagulation, however, these products have a host of issues. They can cause TRALI, TACO, transfusion reactions and in the case of cryoprecipitate transmission of viral infections. Factor concentrates do not suffer from many of these drawbacks, however, there is a grave concern of these medications causing thrombosis.

Currently, it is not known how much of these medications should be used in obstetric hemorrhage and current consensus is that the dose quoted in the literature is too high. For this project, we will build a dilutional model of obstetric hemorrhage and reconstitute maternal blood with varying doses of these medications. We will build dose response curves that will better inform clinicians about how to use these medications. Coagulation will be analyzed using thromboelastometry, specifically ROTEM.

Institution: **Massachusetts General Hospital**

Mentor: Jianren Mao, M.D., Ph.D.
Project(s) Available: The MGH Center for Translational Pain Research is a combined preclinical and clinical research facility. We are testing a new pharmacological therapy that could improve opioid analgesic effect and reduce opioid side effects such as opioid-induced hyperalgesia.

The student will learn clinical study design, subject recruitment, and research data collection. The student will have the opportunity to be exposed to laboratory studies of pain and opioid-related disorders using the state-of-art neuroscience techniques.

Institution: **Massachusetts General Hospital**

Mentor: Joe Cotten, M.D., Ph.D.
Project(s) Available:
1) We are interested in the molecular mechanism(s) by which inhaled, halogenated anesthetic gases activate TASK potassium channels. Using random and targeted mutagenesis and guided by several recent potassium channel crystal structures, we will identify regions of the TASK potassium channel critical for activation by halogenated anesthetics. We will identify amino acid residues in TASK-3 important for anesthetic regulation using either a yeast-based or a mammalian cell line-based functional assay combined with next general DNA sequencing.

2) Opioid sensitivity in providing analgesia and in causing respiratory depression is modified by exposure to hypoxia as determined in patients with sleep apnea and in patient living at high altitude. In a rat model, we will study the effects of hypoxia, normoxia, and hyperoxia on opioid sensitivity and tolerance.
The student would focus on either molecular biology/ion channel or rodent studies. A unique and important role will be defined based on the student's interests. The student will work closely with the mentor and/or his research assistant to master multiple basic laboratory skills in molecular biology, ion channel electrophysiology, basic electronics, respiratory physiology, and rodent handling/experimentation.

Institution: **Massachusetts General Hospital**

Mentor: Lorenzo Berra, M.D.
Project(s) Available:
1) Lung rescue team: the goal of this interventional crossover study, in intubated and mechanically ventilated Acute Respiratory Distress Syndrome (ARDS) patients, is to compare two positive end-expiratory pressure (PEEP) titration techniques regarding: respiratory mechanics, gas exchange, changes in aeration and distribution of ventilation and its impact on cardiac function, specially the right heart (RH). The PEEP titration techniques are: incremental PEEP titration (PEEPinc) and Lung recruitment maneuver plus incremental (LRM plus PEEPdec).

2) Inhaled Nitric Oxide (NO) in COVID-19: the goal our efforts is to test high dose NO gas as an antiviral in patients with infection. We published recently a novel device we built in the lab for delivery of NO gas and additional two reports of its use: one, in pregnant patients with COVID-19 and the second in medicine-floor patients with severe form of COVID-19. We started two randomized trials of NO gas in COVID-19, for more information please visit www.clinicaltrials.gov

The student will join the research team led by Drs. Berra, Zapol and Kacmarek, with 3 MD research fellows and 2 PhDs in respiratory physiology. We actively perform on several study protocols in the field of management of ventilator and airway care of patient admitted to the ICU. Student's duties include but not limited to:
a) Participate in ongoing research project on lung/heart interaction and respiratory care or nitric oxide and cardiac surgery
b) Record data of procedures and results

c) Learn clinical trials and clinical research compliance
d) Report analyzed data to PI and participate in interpretation of results of studies, compared hypothesis research methodology
e) Participate actively in enrollment of patients, study procedures and samples analysis
f) Learn basics application of statistics for the analysis of clinically relevant data
g) Present at weekly research team meeting
h) Develop a poster presentation for the annual ASA meeting to summarize preliminary or definitive results of study s/he takes part in

Institution: **Massachusetts General Hospital**

Mentor: Fumito Ichinose, M.D., Ph.D.
Project(s) Available:
1) Role of plasma NO consumption in post-arrest patients: Sudden CA is a leading cause of death worldwide. Despite advances in cardiopulmonary resuscitation (CPR) methods only 10-20% of adult out-of-hospital CA (OHCA) victims survive to hospital discharge and up to 60% of survivors have moderate to severe cognitive deficits 3 months after resuscitation. Most of recent pharmacological interventional studies in CA have shown no benefit in improvement on mortality and other outcomes. Endothelial-derived nitric oxide (NO) maintains vascular homeostasis and prevents organ injury induced by ischemia and reperfusion (I/R). In the presence of hemolysis, Hb is released into the circulation in form of oxyhemoglobin (Oxy-Hb), which depletes vascular NO via dioxygenation reaction to form methemoglobin (Met-Hb). NO depletion by plasma free Hb produces vasoconstriction, impaired tissue perfusion and inflammation. We previously showed in preclinical studies breathing NO after CPR improves outcomes in mice, rats, and pigs subjected to experimental CA. We reported that hemolysis and plasma NO consumption are increased in post-arrest patients and mice subjected to experimental CA, and breathing NO decreases plasma NO consumption in post-CA mice. However, the extent of hemolysis after CA in humans and its correlation with plasma NO consumption over time hasn't been clearly elucidated. This study we aim to measure levels of hemolysis in patients resuscitated from OHCA, levels of plasma NO consumptions, and analyze correlation of these parameters with clinical outcomes in existing cohort of plasma samples obtain in Neuroprotect trial.

2) Role of sedation in post-arrest neurological recovery: While most post-arrest patients are managed with a combination of targeted temperature management (TTM) and sedation, precise effects of sedation in these critically ill patients are largely unknown. In a mouse model of cardiac arrest and CPR, we recently found that sedation protects brain above and beyond TTM. To determine the effects of sedation, we will examine effects of different sedative agent on EEG in mice after cardiac arrest. Effects of sedation on EEG will be analyzed in detail using programs based on MATLAB and correlation between EEG changes and neurological outcomes after cardiac arrest will be examined.

Student will assist researchers with measuring plasma free Hb and NO consumption and analysis of data, and recording EEG and analyze EEG changes in post-arrest mice.

Institution: **Massachusetts General Hospital**

Mentor: Zhongcong Xie, M.D., Ph.D.
Project(s) Available: Postoperative delirium (POD), a condition characterized by a state of confusion, is one of the most common postoperative complications among senior patients with substantially increased rates of morbidity and mortality, increased care cost, and risk of developing Alzheimer's disease and related dementias (ADRD). However, even with ongoing POD studies, pathogenesis of POD is still mostly unknown, which impedes further studies of POD, including the targeted interventions. There is no treatment for POD at present. Consistent with the notion that gut microbiota dysbiosis, neuroinflammation and mitochondrial dysfunction are part of ADRD neuropathogenesis and are also associated with cognitive impairments, our previous studies showed that anesthesia/surgery induced an age-dependent gut microbiota dysbiosis, neuroinflammation, mitochondrial

dysfunction and POD-like behavior in mice. We extend these studies to further define a potential multifactorial model of POD pathogenesis by testing the hypothesis: anesthesia/surgery-induced neuroinflammation is promoted by age-associated microbiota dysbiosis, leading to mitochondrial dysfunction and POD-like behavior in mice. We will employ an innovative label-free nano-biosensing system for biomolecular analysis in the proposed studies. These studies could help develop the targeted interventions of POD by targeting microbiota dysbiosis. These efforts would ultimately promote safer anesthesia and surgical care, leading to better postoperative outcomes for senior patients and consequently the development of strategies towards preventing ADRD. Supported by 4 NIH R01 and 1 NIH R21, our lab has focused on the research of anesthesia/surgery and brain health, one of the initiatives of ASA. The student will perform abdominal surgery under anesthesia, harvest blood and brain tissues of the mice, determine the effects of the anesthesia/surgery on monocytes, B cells, IL-6 and others in blood, and IL-6, microglia activation and neuronal dysfunction in brain of the mice. S/He will also perform behavioral test (e.g., Morris Water Maze and Barnes Maze), and learn technology including flowcytometry, ELISA, Western blot, and nanobeam. S/He will learn data analysis, literature search and drafting of manuscript. Traditionally, students with contributions to the research projects will be included in our publications based on the research projects. S/He will also be encouraged to develop own research projects for future career development.

Institution: **Massachusetts General Hospital**

Mentor: Shiqian Shen, M.D.
Project(s) Available: Accumulating evidence suggest a critical role for neuro-immune interactions in pain perception, and in the transition from acute to chronic pain. Our lab focuses on dissecting key immunological events that are implicated in the development of neuropathic pain.

Taking advantage of preclinical animal models of pain, particularly chemotherapy-induced peripheral neuropathy and sciatic nerve chronic-constriction injury, we will examine the underlying contribution from different subset of immune cells during the onset and maintenance of neuropathic pain.

Student is expected to participate in the experiments using animal models of pain, and is expected to learn how to perform nociceptive behavior testing, including von Frey Filaments, Hargreaves apparatus, and facial grooming. Perspective student will participate in scientific literature review, experimental design, data interpretation, and troubleshooting. For virtual component, student is expected to learn computing animal behavioral data into composite scores.

Institution: **Massachusetts General Hospital**

Mentor: Ken Solt, M.D.
Project(s) Available: Our laboratory aims to elucidate the neural circuits involved in anesthetic-induced unconsciousness and emergence from general anesthesia, with the long-term goal of developing novel methods to rapidly reverse the effects of general anesthesia to restore consciousness and cognition. This project will involve the use of various neural circuit manipulations in rodents to elicit changes in arousal state, including (but not limited to) chemogenetics and optogenetics. EEG and intracranial recordings will also be used to assess changes in neurophysiology. The student must be willing to work with rodents.

With appropriate supervision by senior lab members, the student will learn how to handle an anesthetize laboratory animals, and will participate in various activities including stereotaxic neurosurgery, behavioral experiments, neurophysiological recordings, histology, and data analysis. The student will attend weekly lab meetings to present brief progress reports and learn about other ongoing projects. At the end of the fellowship, the student will be expected to summarize and present their work at the final lab meeting.

Institution: **Massachusetts General Hospital**

Mentor: Yi Zhang, M.D.
Project(s) Available: Retrospective study on post-operative pain management in Opioid Use disorder patients receiving buprenorphine maintenance therapy.

Student will be involved in medical chart review, data collection, statistical analysis (with supervision and help from PI and statistician), literature review, and manuscript writing.

Institution: **Massachusetts General Hospital**

Mentor: J.A. Jeevendra Martyn, M.D., F.R.C.A., F.C.C.M.
Project(s) Available: The project will examine changes in motor neuron numbers with time using burn injury and sepsis as relevant models. The role of microglia in these changes and how the motor neuron changes affect muscle synapse and muscle mass will be studied. Therapeutic maneuvers to attenuate these motor neuron changes will also be tested.

The student will be taught simple basic experiments on PCR, western blots and in vivo rodents experiments on establishment of various pathologic states described above.

Institution: **Massachusetts General Hospital**

Mentor: Stuart Forman, M.D., Ph.D.
Project(s) Available: Wild-type zebrafish embryos (up to 7 days post-fertilization) will be used to screen libraries of compounds for suppression of motor responses to environmental stimuli, using a high-throughput programmable video analysis tool. Active compounds will be further characterized for potency and reversibility. Zebrafish colonies with knockout or knockin of specific genes associated with general anesthesia sensitivity will be created and used for further testing of general anesthetics.

Students will participate in lab meetings, present their findings, and work with labmates to summarize their work in the form of Powerpoint slides or a poster.

Institution: **Mayo Clinic College of Medicine and Science (Arizona) Program**

Mentor: Bradford Smith, M.D.
Project(s) Available: Dr. Smith's group is conducting research evaluating serious adverse events attributed to chlorhexidine, sulfadiazine, and latex containing central venous catheters placed in the perioperative period. Patients with or without documented allergic reactions to chlorhexidine, sulfa, or latex may be at risk of serious allergic reactions when central venous catheters containing these solutions are inserted. This large analysis will evaluate adverse events and outcomes in this cohort and develop an implementation project to ensure that every Mayo Clinic patient receives an appropriate central venous catheter to limit potentially avoidable patient morbidity.

To enhance the student's research experience, the student will spend time with our data extraction team, statisticians, and will observe clinical areas where their research will impact and enhance safe perioperative care. Furthermore, the student will be provided extensive clinical opportunities to optimize their clinical exposure in the field of anesthesiology in accordance with their career interests. The student will be invited to attend daily morning medical student and resident keyword lectures and the weekly resident lecture series. The student will meet with Dr. Smith at least twice weekly to reaffirm research goals, monitor research progress, and ensure that the student is having a well-rounded experience.

Institution: **Mayo Clinic College of Medicine and Science (Arizona) Program**

Mentor: Veerandra Koyyalamudi, M.B.B.S.
Project(s) Available: Dr. Koyyalamudi's group is conducting research evaluating the spread of dye following an ultrasound guided nerve and interfascial block. The student will have the opportunity to assist with block performance and aid in the dissection of cadavers in collaboration with an anatomist. Dye spread will be evaluated during dissection.

During the research rotation, the student will be able to observe clinical care provided in various subspecialties of anesthesia. Attendance at medical student and resident lectures will be encouraged. Dr. Koyyalamudi will serve as a mentor to the student and assist in achieving research goals of the rotation.

Institution: **Mayo Clinic College of Medicine and Science (Arizona) Program**

Mentor: Molly Kraus, M.D.
Project(s) Available: Dr. Kraus' research group is investigating potential genetic contributions to back pain. The Mayo Clinic's Center for Individualized Medicine (CIM) and Mayo Biobank have taken great strides in sequencing 10,078 patients on an 84 pharmacogenomic panel (RIGHT10K data). We manually curated 14 ICD9/10 codes that are related to chronic low back pain. By analyzing the Mayo Clinic Right 10k data, we have found dozens of SNPs that are associated with back pain. Many of these variants are in the protein coding regions but the majority of them are in the non-coding regions. Our next aim is to study sex differences on genetic variants that are associated with chronic low back pain. Our hypothesis is that germline genetic variants may play important roles in the sex difference in the disease. In this project, the objectives are: a) to identify genetic variants that are associated with chronic low back pain in a gender disparity context; b) to predict the function of the coding variants with a deep learning model by integrating protein sequential and structure information; c) to predict the function of noncoding variants by integrative analysis with gene expression data. A medical student will assist in this project by annotating significant SNPs that are identified, if the SNP is not located in a gene, noting those genes that are in close proximity, if the SNP is coding or noncoding, and evaluating the literature to identify any previous information published related to that gene and back pain.

Institution: Mayo Clinic College of Medicine and Science (Rochester) Program

Mentor: Carlos Mantilla, M.D. Ph.D.
Project(s) Available:
1) Opioid-induced respiratory depression
2) Clinical assessment of diaphragm muscle function

Student Role:
The student will work closely with Dr. Mantilla and his research fellows using techniques such as whole-body plethysmography, lung mechanics and wireless telemetry of respiratory function. The studies will assess the impact of physiological changes in motor neurons, muscle fibers and neuromuscular junctions across diseases and conditions that limit the ability to sustain breathing and perform expulsive maneuvers such as coughing and sneezing that are necessary to maintain clear airways. Students will participate in data collection, analyses and interpretation with the goal of generating an abstract for presentation at a major meeting and inclusion as a co-author on a subsequent manuscript.

Institution: Mayo Clinic College of Medicine and Science (Rochester) Program

Mentor: Christina Pabelick, M.D.
Project(s) Available:
1) "Pediatric Airways smooth muscle cells as a model for pediatric airway disease"
Overview: My lab is interested in airway diseases such as asthma. In human adult and fetal airway smooth muscle, we have identified differences in mechanisms for asthma and sex differences in asthma in the adult population. We have also established mouse models of asthma for different ages. This project will use airway smooth muscle from pediatric patients to a) identify any differences in contractility, calcium handling, and protein expression in comparison to human adult and fetal cells, and b) investigate mechanisms of asthma in this population.

2) "Role of hydrogen sulfide (H2S) in neonatal/pediatric airway disease"
Overview: My lab is interested in airway diseases such as asthma. Previously, we have identified the detrimental effects of oxygen on the neonatal and pediatric lung (even in doses of 60% or less). We are currently looking at the effects of H2S as a potential therapeutic target. Interestingly, H2S is a naturally occurring gaseous transmitter in the human body, like e.g. NO. In previous work, we demonstrated that H2S alleviates the detrimental effect of oxygen on the lung in these age groups. We are currently exploring the mechanisms by which H2S alleviates the negative oxygen effects on the lung.

Student's role: The student will be mentored by me and a fellow throughout their internship. The student will help with literature searches, learn basic lab techniques and a variety of methods (e.g. western blot, calcium imaging, immunohistochemistry) to be able to address the above mentioned questions. The student will learn data analysis, interpretation of their results and will present his or her findings at lab meetings. Towards the end, the student will write an abstract to be submitted for the ASA meeting as well as the American Thoracic Society meeting. Throughout their time with me, the student will have an opportunity to shadow me and my colleagues in the operating room (depending on current guidelines related to Covid) and attend resident lectures as well as medical student lectures provided by Mayo's IMSP program.

Institution: Memorial Sloan Kettering Cancer Center

Mentor: Rebecca Twersky, MD, MPH, FASA

Project(s) Available:

1) Cluster-Randomized, Prospective Assessment of Postoperative Pain Management in Patients Undergoing Bilateral Mastectomy with Immediate Reconstruction (BMw/IR) Using Preoperative Paravertebral (PVB), Serratus+PECS-1, or PVB+PECS-1 Nerve Blocks: is a novel clinically integrated trial (CIRT) in an ambulatory surgery cancer center. It uses a cluster randomized design with 3 regional block arms where eligible patients are randomized to receive one of the three blocks on a monthly basis. The outcomes include opioid-consumption and postop pain related outcomes. The student will observe the regional blocks, the intra- and postop stages of patients' recovery and work under appropriate supervision on: eligibility screening, data collection & analysis, recruitment tracking, communication with study team, ensuring protocol compliance.

2) Evaluation of perioperative clinical outcomes and patient reported outcomes following ambulatory surgery using Enhanced Recovery After Surgery (ERAS) programs. Goals: a. test for an association between important periop outcomes & post-discharge recovery, b. evaluate the impact of opioid minimization on postop & post-discharge pain, c. test for an association between periop outcomes & post-discharge recovery 10 days after surgery, d. test for an association between high-risk conditions & recovery after discharge, e. determine frequency of frailty & postoperative cognitive impairment in ambulatory oncology geriatric patients, f. determine if ERAS implementation is associated with improved post-discharge recovery. The student will work with clinicians and biostatisticians on retrospective chart review and analysis.

3) Double Blind, Randomized, Placebo Controlled Trial of Locally Instilled Bupivacaine in the Surgical Bed After Unilateral Mastectomy Without Reconstruction: a prospective randomized controlled trial focused on improving pain control following mastectomy without immediate reconstruction and no intraoperative regional nerve blocks. The rationale for the study comes from literature showing a reduction in pain, opioid use, and nausea with continuous infusion of a long-acting anesthetic via an indwelling pump after breast procedures (bupivacaine, a long acting local anesthetic, into the mastectomy cavity after skin closure, and leaves it to dwell for 2 hours). Metrics: pain - BPI scale, Impact Score for PONV. The student will observe the surgical intervention and assist in post anesthesia assessments.

Institution: Memorial Sloan Kettering Cancer Center

Mentor: Hanae Tokita, MD

Project(s) Available:

1) Cluster-Randomized, Prospective Assessment of Postoperative Pain Management in Patients Undergoing Bilateral Mastectomy with Immediate Reconstruction (BMw/IR) Using Preoperative Paravertebral (PVB), Serratus+PECS-1, or PVB+PECS-1 Nerve Blocks: A novel clinically integrated trial (CIRT) to prospectively obtain high-quality data using standard EMR data in a large ambulatory surgery cancer center in women undergoing mastectomy with immediate reconstruction. The study design involves 3 arms, using a cluster scheme with randomization at the treatment level on a monthly basis. With this design, eligible patients will be randomized to receive: either a paravertebral (PVB) block alone, a serratus and PECS-1 block combination, or a PVB and PECS-1 combination. The project outcome variables include opioid-consumption and postop pain related outcomes. The student will observe the regional blocks, the intra- and postop stages of patients' recovery and work under appropriate supervision on: eligibility screening, data collection & analysis, recruitment tracking, communication with study team, ensuring protocol compliance. The student will also attend all meetings related to this study.

2) Evaluation of perioperative clinical outcomes and patient reported outcomes following ambulatory surgery at Josie Robertson Surgery Center (JRSC) using Enhanced Recovery After Surgery (ERAS) programs and electronic self-reporting symptom tracker MSK Engage system. Goals: a. test for an association between important periop outcomes & post-discharge symptoms/recovery, b. evaluate the impact of opioid minimization on postop &

postdischarge pain, c. test for an association between periop outcomes & post-discharge recovery 10 days after surgery, d. test for an association between high-risk conditions & recovery after discharge, e. determine frequency of frailty & postoperative cognitive impairment in ambulatory oncology geriatric patients, f. determine if ERAS implementation is associated with improved post-discharge recovery patterns. The student will work with clinicians and biostatisticians on retrospective chart review and analysis. The student will have the opportunity to collect and review these data and learn the techniques of data management and analysis under appropriate supervision from the study investigators and biostatisticians.

Institution: **Montefiore Medical Center/Albert Einstein College of Medicine**

Mentor: Jonathan Leff, M.D.
Project(s) Available: Surgical prehabilitation is a new paradigm shift in perioperative medicine, and this entitles taking care of modifiable factors that are associated with surgical outcomes. Prehabilitation in cardiac surgery has been associated with improved outcomes. We are planning to conduct a retrospective chart review of patients undergone CABG alone and CABG value surgeries with a latency of 3 weeks or more between the preoperative anesthesia clinic visit and surgery. The purpose of the study is to evaluate whether modifiable pre-surgical factors were addressed in the pre-operative clinic. The student will be reviewing the medical charts, collecting information from pre-operative clinic notes, will use an existing database for other study-related outcomes.

Institution: **Montefiore Medical Center/Albert Einstein College of Medicine**

Mentor: David Adams, M.D.
Project(s) Available:
1) Published studies have established the role of prehabilitation in improving surgical outcomes. However, in our systematic review, we have identified that most of the published studies are in cancer-related specialties and have only used one modality of prehabilitation. We are conducting randomized controlled research evaluating the role of multimodality of prehabilitation in spine surgery patients. The student will be responsible for screening the patients, helping with the consenting process, and collecting the data in the intra and post-operative period and maintain the database.

2)The traditional method for preoperative evaluation of diabetic management is through the surveillance of HbA1C values. However, the association between HbA1C values and surgical outcomes is controversial. Fructosamine is an alternative reliable test; due to relatively short half-life compared with HbA1c, fructosamine is a better measure of glycemic control in the preceding 2- to 3-week period. In this observational cohort study, preoperative fructosamine values will be correlated to surgical outcomes. The study will be conducted in patients undergoing spinal fusion procedures. The student will be responsible for screening the patients, helping with the consenting process, and collecting the data in the intra and post-operative period and maintain the database.

Institution: **Montefiore Medical Center/Albert Einstein College of Medicine**

Mentor: Jerry Chao, M.D. M.S
Project(s) Available: Enhanced recovery after surgery (ERAS) protocol is well established in many surgical disciplines and leads to a decrease in the length of hospital stay and morbidity.This is a prospective, randomized controlled trial assessing the effect of an ERAS Protocol for patients undergoing bariatric surgery and rates of 30-day complications. The components of the protocol will include (i) preoperative interventions, (ii) intraoperative interventions, and (iii) postoperative interventions designed for patients scheduled for bariatric surgery. Subjects randomized to the intervention will receive all three perioperative components of the ERAS Protocol. Controls will be randomized to receive standard of care (no ERAS) at our institution. The endpoints of the study will be 30-day complications, including ED visits for clinically significant events and 30-day re-admissions. The student will be responsible for screening the patients, helping with the consenting process, and collecting the data in the intra and post-operative period and maintaining the database.

Institution: **Montefiore Medical Center/Albert Einstein College of Medicine**

Mentor: Iyabo Muse, M.D.
Project(s) Available: The Food and Drug Administration (FDA) just approved 1% Chloroprocaine HCL for use in spinal anesthesia. In this double-blinded, randomized controlled study preservative-free, 1% chloroprocaine HCL will be compared to hyperbaric bupivacaine in ambulatory hemorrhoidectomies. The Primary outcomes will be recovery time (return of motor and sensory function) and fit to discharge time from the PACU. Secondary outcomes will be evidence of hypotension during the case, and evidence of TNS (transient neurologic symptoms)

24hr after the procedure. The student will be responsible for screening the patients, helping with the consenting process, and collecting the data in the intra and post-operative period and maintaining the database.

Institution: **Montefiore Medical Center/Albert Einstein College of Medicine**

Mentor: Naum Shaparin, M.D. M.B.A.

Project(s) Available:

1) Approximately 8% of the US adult population has high impact chronic pain and has been linked to restrictions in mobility and daily activities, dependence on opioids, anxiety and depression, and poor perceived health or reduced quality of life. In this retrospective study, we compare different treatment modalities of chronic pain among high and low utilizers of the pain clinic. We are comparing sociodemographic, clinical, and treatments offered to two patient populations. We will query our internal database for identifying patients with the diagnosis of chronic pain and plan to collect all the factors associated with chronic pain and compare between the groups. We are conducting a database-driven study, and no medical records will be queried. Student responsibility will be gathering the data, cleaning up the database, actively participating in the study discussions, meeting with the statistician, and preparing the manuscript.

2) COVID virus has profoundly impacted several patients' daily lives, especially in hospitalized patients with COVID diagnosis. Patient-reported outcomes (PRO) are a vital component of patient-centered care and decision making. Patient-reported outcomes in chronic pain patients hospitalized with the diagnosis of COVID are scarce in the literature. In this longitudinal study, we are collecting PRO on chronic pain patients who were hospitalized with the diagnosis of coronavirus infection. The student will help coordinate the visit, collect the PRO responses, and collect necessary information from the medical records.

Institution: NYPH (Columbia Campus) Program

Mentor: Charles Emala, M.S., M.D.
Project(s) Available:
1) Airway GABAA receptors and reactive airway disease
Dr. Emala's main area of research interest is in the understanding of interactions between signal transduction pathways in airway nerves and smooth muscle and how these interactions contribute to diseases such as asthma. A broader understanding of the non-neuronal expression and function of GABAA receptors in smooth muscle is a central focus.

Student Role: Assist with measuring ex vivo airway smooth muscle contraction and relaxation of human and mouse airways in a perfused organ bath system. Assist with cell based assays measuring intracellular calcium, plasma membrane potential and intracellular second messengers. ELISA and western blotting of phosphoproteins will be performed. The student will participate and present at weekly lab meetings and participate in laboratory journal clubs. The student will have the opportunity to attend research seminars in the department of anesthesiology and neighboring basic science departments. The student may have the opportunity to contribute to the writing of meeting abstracts and primary manuscripts associated with this research.

2) Natural phytochemicals relax airway smooth muscle and reduce lung inflammation
Description: Dr. Emala's main area of research interest is in the understanding of interactions between signal transduction pathways in airway nerves and smooth muscle and how these interactions contribute to diseases such as asthma. The laboratory has demonstrated that phytochemicals of the flavonoid and ginger family have dual beneficial effects in asthma; smooth muscle relaxation and anti-inflammation.

Student Role: Assist with measuring ex vivo airway smooth muscle contraction and relaxation of human and mouse airways in a perfused organ bath system. Evaluate histologic changes in fixed lung samples from asthmatic mice chronically treated with phytochemicals. The student will participate and present at weekly lab meetings and participate in laboratory journal clubs. The student will have the opportunity to attend research seminars in the department of anesthesiology and neighboring basic science departments. The student may have the opportunity to contribute to the writing of meeting abstracts and primary manuscripts associated with this research.

Institution: NYPH (Columbia Campus) Program

Mentor: Jeanine D'Armiento, MD, PhD
Project(s) Available:
1) Lung Smoke Exposure and Injury
Studies in the laboratory have identified that the use of an inhaled MMP inhibitor protects mice from the development of injury in a model of ARDs. This protection is consistent with blockade of neutrophil influx into the lung. Present studies are exploring the use of these compounds long term and the lasting improvement in lung function in this model system.
Student Role: Summer students will perform Western Blot analysis and PCR analysis to explore the mechanism by inhaled MMP inhibitors block tissue destruction and protect lung function.

2) Lung Injury Proteases
Matrix Metalloproteinases (MMPs) are critically important in the degradation of the lung in the pathogenesis of COPD. However, the impact of these proteases on the altered lung maintenance program is less understood. The work on this project delineates the role of MMP-13 in cell senescence and proliferation under conditions of smoke induced lung injury.
Student Role: Summer students will perform Western Blot analysis and PCR analysis to explore the mechanism by which proteases during smoke exposure alter cell senescence and proliferation lung function.

Institution: **NYPH (Columbia Campus) Program**

Mentor: Paul Garcia, MD, PhD
Project(s) Available:
1) Thalamocortical oscillations and their influence on emergence and recovery from anesthesia
The neuronal circuits responsible for re-establishment of consciousness and arousal behaviors can be influenced by many factors such as: sleep, pain, baseline neurocognitive health, and pharmacokinetics. Our previous work demonstrates that certain frontal EEG patterns can predict normal vs abnormal cognitive recovery from general anesthesia. We are currently investigating the influence of noxious stimulation on these EEG patterns by focusing on manipulations of thalamocortical oscillations during anesthesia and the effects on post-operative pain.
Student Role: The MSARF student will learn general clinical research techniques and receive advanced training in spectral analysis of EEG data, pre/intra/post-operative behavioral assessments, and statistics.

2) Pre-clinical investigations on the integration of cortical information in emergence and recovery from anesthesia
The clinical concern for long-term adverse cognitive consequences in vulnerable patients after surgery remains high. We have developed specific measurements of abnormal recovery in rodents that mimic cognitive problems in the immediate post-anesthesia time-period (hours to days). By investigating activity levels and latency to appearance of normal waking behaviors, we can rigorously determine the influence certain disease states have on emergence and recovery. Our aim is to identify neuroprotective strategies through an examination of the pharmacologic and neurophysiologic determinants of post-anesthesia behavior.
Student Role: The MSARF student will learn in vivo anesthetic and surgical techniques with rodents, behavioral testing, statistical techniques and scientific communication skills. Ample opportunities for shadowing in the operating room are also available to see the pharmacology in action.

Institution: **NYPH (Columbia Campus) Program**

Mentor: George Hasko, MD, PhD
Project(s) Available:
1) Extracellular ATP metabolism in sepsis
Dr. Hasko's main area of research interest is in the understanding of ATP signaling and metabolic pathways in sepsis.
Student Role: Assist with sepsis animal models especially the cecal ligation and puncture model. Assist with cell-based assays identifying the cellular mechanisms of the regulation of ATP metabolic enzymes. RT-PCR, RNA-Seq, Western blotting, and chromatin immunoprecipitation, as well as confocal microscopy will be performed.

Institution: **NYPH (Columbia Campus) Program**

Mentor: Caleb Ing, MD, MS
Project(s) Available:
1) Epidemiology of perioperative complications and adverse outcomes in pediatric patients.
The project consists of evaluating short and long-term complications and adverse outcomes in children undergoing surgical procedures. This includes evaluation of causes, risk factors, and methods for prevention of a variety of adverse outcomes. The specific complications and datasets to be used will be determined after discussion with the candidate. Given the potential for restrictions due to COVID-19, a project that could be completed remotely is a possibility.
Student Role: The student's responsibilities will involve literature review which involves identifying and reading relevant articles and aiding in the writing of a manuscript. Interpreting data and generating tables and figures, as well as potentially some minor data analysis depending on the experience of the student.

Institution: **NYPH (Columbia Campus) Program**

Mentor: H.T. Lee, MD, PhD
Project(s) Available: Acute kidney injury and multiple organ dysfunction
Dr. Lee's research focuses on the pathomechanisms of perioperative acute kidney injury, AKI induced remote organ dysfunction and translational approaches to attenuate this injury. One focus of the laboratory is the role of Purinergic and Toll like receptors on acute kidney injury in vivo as well as in vitro.

Student Role: Assist with in vitro cell signaling experiments. The medical student will learn in vitro cell death assays, immunoblotting and RTPCR under the supervision of PI and postdoctoral fellows. The student will work with cultured cell lines and tissues obtained from animal models to investigate the expression of mRNA and proteins involved in cellular injury and protection following ischemia reperfusion injury. The student will be encouraged to analyze and present their data in written and oral form and participate in weekly laboratory meetings.

Institution: **NYPH (Columbia Campus) Program**

Mentor: Richard Levy, MD
Project(s) Available: Age-specific Propofol Toxicity
Propofol infusion syndrome (PRIS) is a potentially life-threatening side-effect of treatment with the sedative/hypnotic, propofol. Young children appear to be at higher risk than older patients. However, the underlying cause of PRIS is unknown. Recently, we identified a novel mechanism of propofol toxicity in cardiac mitochondria of immature mice. In this project, we aim to determine the exact cause of propofol toxicity and will attempt to develop mitigating strategies.
Student Role: Assist in rodent exposures and data analysis. Assist in measuring various aspects of mitochondrial function in the mouse heart through a variety of basic science techniques.

2) Assessing the Permeability Transition Pore (PTP) in Developing Mitochondria
The PTP is a voltage-gated, non-specific, non-selective mega-channel present on the inner mitochondrial membrane. Although the presence of the pore and its functional importance have been well established, its exact proteinaceous molecular identity remains elusive. Mounting evidence suggests that opening of the pore within mitochondria plays a pathological role in a variety of cardiac disease processes while physiological regulation of the PTP may be important for normal cellular development and differentiation. In this project, we aim to identify novel proteins that may regulate the PTP or serve as pore components. Furthermore, we aim to determine the role of the PTP in cardiomyocyte mitochondrial maturation.
Student Role: Assist in isolation of cardiomyocyte mitochondria from newborn and juvenile rodents. Assist in measuring various aspects of mitochondrial function in the mouse heart through a variety of basic science techniques.

Institution: **NYPH (Columbia Campus) Program**

Mentor: Gebhard Wagener, MD
Project(s) Available: COVID-19 and acute kidney injury
The COVID-19 crisis in New York City has resulted in a large number of patients who required mechanical ventilation and critical care services. Many of these patients developed acute kidney injury and the exact mechanism of AKI in these patients is poorly understood. The aim of this project is to determine risk factors for AKI in patients with severe COVID-19 and describe the clinical response and recovery rate in a large population. For this purpose, we will analyze a database of over 2500 COVID-19 patients.
Student Role: The student's responsibilities will to help organize the COVID-19 database of the Department of Anesthesiology and help create statistical models that predict AKI in these patients. Additionally students will describe the specific treatment response to COVID-19 induced AKI and possible mechanisms. The student will further be able to shadow the PI during his clinical work in the operating rooms and the ICUs.

Institution: Ohio State University Wexner Medical Center

Mentor: Tristan E Weaver, M.D.
Project(s) Available: "Opioid consumption after Hospital Discharge in Radical Cystectomy".
Surgical patients at The Ohio State University, and across the country, who are admitted for at least 2 days in the hospital, are overprescribed a significant amount of opioid medications when discharged to home. Our hypothesis is that the opioid medication (oral morphine equivalent) prescribed to treat pain after cystectomy exceeds by a large margin (30-50%) the actual patients' requirement and results as a leftover medication.

Study population: Adult patients ≥ 18 years old, scheduled to undergo a cystectomy, who give written informed consent to participate in the study and who meet all inclusion and no exclusion criteria.

Data collection: Data will be collected by weekly follow-up phone survey. Considering this an observational study aimed to explore and describe opioid consumption post-discharge, no formal inferential statistical analyses will be performed.. Continuous variables will be expressed using means, medians, standard deviations and other appropriate measures of spread and categorical variables using frequencies and percentages. Estimated means and confidence intervals will be provided for the outcome variables of interest. Continuous variables will be expressed using means, medians, standard deviations

Medical Student activities:
a) The medical student will be trained to screen possible candidates for the study.
b) The student will assist the postdocs or research fellows to perform the informed consent, patient enrollment, collect demographics, medical history and medications.
c) The student will have the opportunity to interact and assist the anesthesiologist on the case with any study procedures, which will provide him/her a more accurate knowledge of the clinical work of the anesthesiologist.
d) The student will be instructed on how to perform the necessary intraoperative assessments and how to record the data on the case report forms.
e) In this particular study, the MS will perform follow-up telephone interviews to discharged patients.
f) Finally, the student will transfer the data to a database for analysis, and will interact with one of the lab's statisticians to learn how to register the data and to interpret the results of the data analysis.
g) The student will be expected prepare an abstract and/or poster to present at the local OSUMC Research Day and at at the ASA Annual Meeting

Institution: Ohio State University Wexner Medical Center

Mentor: Barbara Rogers, Associate Professor-Clinical
Project(s) Available: "Clinical Characteristics of Recovered COVID-19 Inpatients after Hospital Discharge: An Observational Descriptive Study"
In this observational descriptive study prospective/retrospective, we intend to collect relevant information from recovered COVID-19 patients that have been admitted at The Ohio State University Wexner Medical Center (OSUWMC) since the beginning of the current pandemic in order to determine the evolution of their clinical outcomes after 60 days of hospital discharge. This study aims to provide updated clinical references and evidence-based literature of this critically ill patient population.
Patient population: Adult patients (>18 years old), at 60 days discharged from hospital.
Primary objective: To assess the progression of clinical deterioration during hospitalization and clinical improvement after hospital discharge in recovered patients treated for COVID-19 at OSUWMC.

Medical student activities:
a) The medical student will be trained to screen possible candidates for the study.
b) The student will assist the postdocs or research fellows to perform the informed consent, patient enrollment, collect demographics, medical history and medications.

c) The student will have the opportunity to interact and shadow his/her Mentor which will provide him/her a more accurate knowledge of the clinical work of the anesthesiologist.
d) The student will be instructed on how to extract the data from EMR and collect it in a data collection sheet design by him/her.
e) In this particular study, the MS will perform follow-up telephone interviews to discharged patients.
f) Finally, the student will transfer the data to a database for analysis, and will interact with one of the lab's statisticians to learn how to register the data and to interpret the results of the data analysis.
g) The student will be expected prepare an abstract and/or poster to present at the local OSUMC Research Day and at at the 2021 ASA Annual Meeting.

Institution: **Ohio State University Wexner Medical Center**

Mentor: Hamdy Elsayed-Awad, Associate Professor-Clinical
Project(s) Available: "Ischemic Spinal Cord Injury in the Setting of Aortic Aneurysm Surgery"
Dr. Elysaed-Awad's lab focuses on studying ischemic injury in patients who receive aortic aneurysm surgery. Previous mouse model studies conducted in the lab have shown that inflammation is a key mechanism that causes ischemic spinal cord (SC) injury after aortic surgery. In addition, oligodendrocytes (OLs) are important in both the sensing of hypoxia and maintaining the myelin sheath. The current project is focused on how to prevent SC injury in an in-vitro OL culture. The primary outcome of this project will be to elucidate the mechanistic origin of ischemic damage to the spinal cord. Secondary outcomes will include translating our findings into larger animal models.

Medical student activities:
a) The medical student will be trained to screen possible candidates for the study.
b) The student will assist the research fellows to perform the informed consent, patient enrollment, collect demographics, medical history and medications from EMR.
c) The student will have the opportunity to interact and shadow his/her Mentor which will provide him/her a more accurate knowledge of the clinical work of the anesthesiologist.
d) The student will be instructed on how to extract the data from EMR and collect it in a data collection sheet design by him/her.
e) In this particular study, the MS will perform follow-up telephone interviews to discharged patients.
f) Finally, the student will transfer the data to a database for analysis, and will interact with one of the lab's statisticians to learn how to register the data and to interpret the results of the data analysis.
g) The student will be expected prepare an abstract and/or poster to present at the local OSUMC Research Day and at at the 2021 ASA Annual Meeting.

Institution: **Oregon Health & Science University**

Mentor: Kirk Lalwani, M.D.
Project(s) Available: In women who are pregnant and delivering via cesarean delivery, are there any racial or ethnic disparities that exist regarding the method of anesthesia used for the procedure?

This will be a retrospective database study using datasets from OHSU compared to other MPOG database institutions analyzing the electronic health record. Women at least 18 years old or older who deliver by elective Cesarean delivery between 2010 and 2020 will be considered for the study. The choice of anesthesia, race/ethnic group, and primary language will be documented. The data analysis will determine the proportion of women total who received general anesthesia or regional anesthesia. This study will also examine Black women, Hispanic women, Pacific Islander/Hawaiian women, Native American women and non-native English speakers to White women, and native English speakers. The aim of this study is to understand if there are racial disparities in the mode of anesthesia administered to women of different minority groups. The medical student for this project will work on data retrieval and analysis and manuscript development.

Institution: **Oregon Health & Science University**

Mentor: Katie Schenning, M.D., M.P.H., M.C.R.
Project(s) Available: Preoperative Frailty and Cognitive Screening in Geriatric Surgical Patients: A New Paradigm
A before and after study design will be used to compare cognitive and frailty screening tools administered in a preoperative clinic. The medical student will be involved in all components of a retrospective before & after study. The student will be involved in study design, data abstraction, database creation, statistical analyses, and abstract, poster, and manuscript preparation.

Institution: **Oregon Health & Science University**

Mentor: Austin Peters, M.D., M.C.R.
Project(s) Available: Retrospective Review of Patient Outcomes and Biomarker Response to Ketamine Administration after Traumatic Brain Injury.

Because this is a retrospective study, it can work well with remote help. I am conducting a retrospective analysis on the data collected from the Tranexamic Acid for TBI study conducted at OHSU. I am exploring whether patients that received ketamine experienced any difference in survival or disability, and also exploring what effects ketamine had on serum levels of TBI-related biomarkers. This will result in a manuscript publication.

Institution: **Oregon Health & Science University**

Mentor: Michael Hutchens, M.D., M.A.
Project(s) Available:
1) Role of heart-derived cardiac LIM protein in acute cardiorenal syndrome
Acute cardiorenal syndrome is a common and deadly perioperative complication which may lead to chronic kidney disease. The Hutchens lab focuses on myocyte-kidney signaling in critical illness with the goal of intervening to prevent AKI-CKD transition. This long-term project includes extensive evaluation of a specific heart-kidney signal, the transcriptional modifier cardiac LIM protein, in cardiorenal syndrome induced by cardiac arrest and cardiopulmonary resuscitation in the mouse. Numerous projects for students are available, ranging from detailed investigation of mouse physiology around cardiac arrest and resuscitation to the molecular biology of a filtered protein signal in the tubular epithelium.
Student Role: The student will collect and analyze data, prepare figures, present data, and help with manuscript writing.

2) Role of megalin-mediated endocytosis in rhabdomyolysis-induced acute kidney injury

Trauma-induced crush syndrome causes acute kidney injury (AKI) because muscle-released myoglobin is directly toxic to tubular epithelial cells. Myoglobin is taken up into tubular epithelial cells via the endocytic receptor megalin, and interference with megalin-mediated myoglobin uptake is protective. This US DOD-funded project investigates novel therapies for rhabdomyolysis-induced AKI which work through megalin interference/inhibition. Several projects for students are available, including in vitro investigation and assessment of megalin function and megalin interference, and in vivo investigation of specific therapeutic modalities in this easily-learned surgical animal model.
Student Role: The student will collect and analyze data, prepare figures, present data, and help with manuscript writing.

Institution: **Oregon Health & Science University**

Mentor: Nabil Alkayed, M.D., Ph.D.
Project(s) Available: Role of GPR39 in neurovascular injury
The project will investigate the role of GPR39 in stroke and vascular cognitive impairment. Students will assist in various aspects of the project, including brain image acquisition and analysis, mouse behavior testing, drug administration, measurement of blood levels of glucose and other constituents, tissue analysis using Western blot and real-time PCR, genotyping, histology, immunohistochemistry and data analysis.

Institution: **Oregon Health & Science University**

Mentor: Eric Schnell, M.D., Ph.D.
Project(s) Available: Project overview: Despite years of clinical use, the mechanisms underlying gabapentin function remain elusive. This goal of this project is to elucidate the mechanisms through which the gabapentin receptors, CACNA2D1 and CACNA2D2, contribute to synapse formation and function in the central nervous system. These proteins are both critical to neuronal calcium channel signaling and also serve as the primary receptors for glial-secreted thrombospondin proteins, and we will be investigating how these proteins function during central nervous system development.

Student role: The student will use primarily use viral-vector mediated neuronal cell labeling together with confocal imaging of fixed brain tissue samples to quantify how loss of function of these proteins affects neuronal structure. Prior experience with these techniques not required, but basic laboratory skills preferred. Please see https://doi.org/10.1523/JNEUROSCI.1514-19.2020 for more background.

Institution: **Oregon Health & Science University**

Mentor: Selva Baltan, M.D., Ph.D.
Project(s) Available: This is to apply to have a medical student for summer 2021 to work on the dual role of microglia in white matter ischemic injury. Using a confocal microscope and transgenic mice which express GFP in microglia cells, live imaging of green fluorescent microglia during ischemia in in vitro optic nerve preparation will identify the mechanisms of oxidative injury mediated by NOS isoforms from young and aging animals. The project is part of the epigenetic regulation of the white matter repair process following stroke. The student will be an author of a manuscript in preparation for this study.

Institution: **Rutgers/ New Jersey Medical School**

Mentor: Yuan-Xiang Tao, Professor, PhD, MD.
Project(s) Available: N6-methyladenosine demethylase FTO contributes to neuropathic pain by stabilizing G9a expression in primary sensory neurons
Nerve injury-induced change in gene expression in primary sensory neurons of dorsal root ganglion (DRG) is critical for neuropathic pain genesis. N6-methyladenosine (m6A) modification of RNA represents an additional layer of regulation of gene expression. We recently demonstrated that peripheral nerve injury increased the expression of the m6A demethylase FTO in the injured DRG via the activation of Runx1, a transcription factor that binds to the Fto gene promoter. We will define whether mimicking this increase erases m6A in Ehmt2 mRNA (encoding the histone methyltransferase G9a) and elevates the level of G9a in DRG and leads to neuropathic pain symptoms. We will also examine whether blocking this increase reverses a loss of m6A sites in Ehmt2 mRNA and destabilizes the nerve injury-induced G9a upregulation in the injured DRG and alleviates nerve injury-associated pain hypersensitivities. Our proposed study will not only advance our understanding of posttranscriptional mechanisms of neuropathic pain, but will also open a door to develop a new strategy for the prevention and treatment of this disorder.

Student Role: The student will be involved in partial phases of the project, including preclinical neuropathic pain model preparation, behavioral tests, tissue harvest, RT-PCR, data collection and analysis, and abstract/manuscript preparation.

Institution: **Rutgers/ New Jersey Medical School**

Mentor: Jiang-Hong Ye, Professor, MD, MSc
Project(s) Available: Endocannabinoid Metabolism in the Impact of Alcohol on Alzheimer's Disease
Heavy alcohol drinking increases the risk of Alzheimer's disease (AD), a neurodegenerative disorder characterized by neuroinflammation that chronic heavy alcohol drinking may increase the risk of. Therefore, resolving neuroinflammation may reduce the risk of AD promoted by alcohol use. The endocannabinoid system (eCBs) displays anti-inflammatory and neuroprotective properties. 2-arachidonoyl-glycerol (2-AG), the most abundant eCB ligand, is hydrolyzed by monoacylglycerol lipase (MAGL) to glycerol and arachidonic acid, a precursor of prostaglandins that are a key player in the inflammatory responses. Several lines of evidence show that augmentation of 2-AG signaling by inhibiting its metabolism has profound anti-inflammatory properties. There is abundant evidence that alcohol alters brain eCBs. Previous studies showed that JZL184, a selective and potent MAGL inhibitor robustly suppresses production and accumulation of total Aβ and Aβ42, significantly the number of degenerated neurons, and prevents cognitive decline in an AD mouse model. Thus, MAGL is likely a new AD therapeutic target. However, we do not know whether MAGL inhibition will yield beneficial effects in alcohol-promoted pathogenesis and AD's neuropathology. In this project, we will test the central hypothesis that heavy alcohol exposure induces AD-like neuropathology by disrupting eCBs. Thus, the primary objective of the proposed studies will demonstrate that alcohol induces AD-like neuropathology, and cognitive deficits in normal mice and exacerbates these aspects in APP transgenic mice. That alcohol promotes neuroinflammation and impairs cognitive functions by disrupting eCBs. The results from this project will provide evidence that alcohol drinking increases the risk of AD likely resulted from disrupting 2-AG metabolism, and thus, may ultimately lead to the development of a novel intervention for AD-like neurodegenerative and neuroinflammatory disorders in alcohol drinkers.

Student Role: Participate in alcohol treatment, testing behaviors of animals, data collection and analysis, and abstract/manuscript preparation.

Institution: **Rutgers/ New Jersey Medical School**

Mentor: Huijuan Hu, Associate Professor, PhD

Project(s) Available: Role of store-operated calcium channels (SOCs) in pain

Research in my lab aims to identify key molecule targets that are involved in pain plasticity. Currently we are interested in store-operated calcium channels (SOCs), which are composed of two calcium sensors STIM1 and STIM2 (mainly located on the surface of the ER membrane) and three pore-forming subunits Orai1/2/3. We have demonstrated that SOCs are functional and contribute to neuronal excitability in DRG and spinal cord neurons. Inhibition of STIMs or Orais markedly decreases nociception and inflammatory pain. Our recent data show that the protein expression of Orai3 and STIM2 is significantly increased in the DRG and spinal cord under chronic pain conditions. We have also identified that STIM1, STIM2, Orai1 and Orai3 mediate SOC entry (SOCE) in DRG neurons. Despite we have reported the importance of Orai1 in central sensitization, whether it contributes to peripheral sensitization remains unknown. More importantly, whether STIM1, STIM2 and Orai3 contributes to pain hypersensitivity has never been explored. Using transgenic (global and conditional knockout) mice and pharmacological tools, we will investigate: 1. whether STIM1, STIM2 and Orai3 expression and function are altered under chronic pain conditions; 2. whether SOCs contribute to peripheral sensitization; 3. whether STIM1 and STIM2 contribute to central sensitization; 4. whether SOCE modulates pain targets including sodium channels, potassium channels and TRP channels TRPV1 and TRPA1; 5. whether SOCs contribute to synaptic transmission in spinal cord slices. We will use a combination of behaviora tests, biochemistry, electrophysiology, live-cell imaging techniques to elucidate the role of SOCs in peripheral and central sensitization associated with chronic pain conditions.

Student role: The student will be involved in one of these studies. He/she will be trained to perform experiments related to this project including cell culture, calcium imaging, Western blot analysis, RT-PCR, behavior test. He/she will be trained to analyze experimental data and write abstract/manuscript.

Institution: **Rutgers/ New Jersey Medical School**

Mentor: Sabine Hilfiker, PhD

Project(s) Available: LRRK2-mediated centrosomal alterations as peripheral biomarker for familial and sporadic Parkinson´s disease

Current therapeutic approaches for Parkinson´s disease (PD) are largely limited to symptomatic approaches, which leave the underlying disease progression unchecked. However, the identification of genetic factors which influence PD risk in human populations has provided several novel targets for disease-modifying therapies. One example of such genetic cause of PD lies in LRRK2. Point mutations in LRRK2 cause autosomal-dominant familial PD, and variants increase PD risk. The LRRK2 gene encodes a large protein kinase, and pathogenic mutations have been shown to cause increased kinase activity. Based on these observations, inhibition of kinase activity may be therapeutically useful to prevent the onset or possibly progression of PD, and distinct LRRK2 kinase inhibitors are in various stages of clinical development. We have recently demonstrated LRRK2-mediated centrosomal alterations in lymphoblastoid cell lines from patients with PD due to the G2019S LRRK2 mutation as compared to healthy controls. The same alterations were also observed in samples from a subset of sporadic PD patients. The present project aims to analyze for centrosomal deficits in another sampling of healthy control and PD patients, and correlate the observed changes with alterations in the phosphorylation status of distinct LRRK2 kinase substrates. In addition, the effects of various disease-relevant manipulations (lysosomal stress, mitochondrial stress) on the cellular readouts and on LRRK2 kinase activity will be determined. Studies of this type will advance our understanding of the molecular mechanism(s) underlying familial and sporadic PD, and aid in development of patient stratification approaches for clinical trials around LRRK2 kinase inhibitors.

Student Role: The student will be involved in partial phases of the project, including culture and immunocytochemistry of patient-derived cells, extracts and quantitative Western blotting techniques, data collection and analysis, and abstract/manuscript preparation.

Institution: **Rutgers/ New Jersey Medical School**

Mentor: Ying-xian Pan, MD, PhD

Project(s) Available: Characterization of novel opioid drugs that are potent against various pain models devoid of the side-effects associated with traditional opiates

Most clinically used opioid drugs including morphine, fentanyl and oxycodone, as well as drugs of abuse such as heroin, act through mu opioid receptors. Over the past two decades, my laboratory's research has been focusing on mu opioid receptors towards our main goals to understand molecular and cellular mechanisms of mu opioid actions and to translate our basic research into development of novel opioid analgesics that have potent analgesic actions devoid of side effects. One of our major findings in the past years is that the single-copy gene encoding mu opioid receptors, OPRM1, undergoes extensive alternative pre-mRNA splicing, generating multiple receptor isoforms or variants. One type of OPRM1 splice variants, the truncated six transmembrane (TM) variants, is particularly interesting because they mediate the actions of a novel class of opioid, such as 3-iodobenzoyl-6beta-naltrexamide (IBNtxA). IBNtxA is potent against thermal, inflammatory, and neuropathic pain in animal models and does not produce respiratory depression, physical dependence, or reward behavior.

The project will involve characterization of IBNtxA derivatives in animal models using different behavioral tests such as radiant-heat tail-flick, respiratory depression and rewarding assays, as well as in vitro pharmacological tests including opioid receptor binding and [35S]GTPγS binding assays. The purpose of this study is to obtain a better IBNtxA derivative for further drug development.

Student role: The student will be involved in partial phases of the project, including behavioral tests, such as radiant-heat tail-flick, respiratory depression and rewarding assays, in vitro pharmacological tests including opioid receptor binding and [35S]GTPγS binding assays, data collection and analysis, and abstract/manuscript preparation.

Institution: **Stanford University School of Medicine**

Mentor: Eric Sun, M.D., Ph.D.
Project(s) Available: The student will work on a project utilizing administrative claims data and a unique regression discontinuity approach to (a) assess whether the perioperative utilization of opioids among pediatric patients undergoing surgery increases with age and (b) to assess whether perioperative utilization of opioids is associated with worse long-term outcomes.

Institution: **Stanford University School of Medicine**

Mentor: Eric Gross, M.D., Ph.D.
Project(s) Available: Approximately 560 million people in the world have a genetic variant limiting the ability to break down reactive aldehydes and having a flushing response after alcohol consumption. However, produced during cellular injury, particularly for surgeries which result in organ ischemia-reperfusion (such as cardiac bypass and solid organ transplants) and are known to cause both pain We are studying how this genetic variant that limits reactive aldehyde metabolism may affect outcomes to surgery and influence responses to pain and injury (see Gross ER, Science Translational Internal Medicine, and Annual Reviews of Pharmacology and Toxicology). We have ongoing basic science and clinical projects where our overall aim is to develop a precision anesthesia genetic variant in order to allow for optimal recovery from surgery. This will help us to also understand how to improve surgical recovery for all patients.

Student Role: Several portions of the project are reasonable to accomplish within an 8-week time period and is suitable in challenge and scope for a medical student. Each mini-project listed here will consist the student will meet with the mentor at least weekly to discuss progress. Further, the student will have six hours per week of clinical exposure and be the only student assigned to the project.

Basic Science Mini-Project: The student will measure reactive aldehyde metabolism to test whether volatile anesthetics can increase reactive aldehyde metabolism in liver homogenates variant versus rodents which do not have the genetic variant. The student will be able to determine how volatile anesthetics modify reactive aldehyde metabolism for these rodents and provide drug can be further moved towards testing in the clinic.

Clinical science Mini-Project: Using next generation mass spectrometry technology, we are establishing techniques to measure levels of reactive aldehydes in patients undergoing surgery. during surgery and quantify the level of reactive aldehydes that are produced during surgical surgery. The student will work on enrolling patients, collecting and processing samples, analyzing the data to determine how the levels of aldehydes change during surgery in people and to gain a better understanding of mass spectrometry.

Institution: **Stanford University School of Medicine**

Mentor: Boris Heifets, M.D., Ph.D.
Project(s) Available:
1) Separating MDMA ('ecstasy')'s therapeutic pro-social effects from its abuse potential.
MDMA is an abused drug that also has therapeutic potential for several conditions including Post-Traumatic Stress Disorder. We model behaviors in mice related to sociability and drug reward, strongly influenced by the drug MDMA, which has effects on both behaviors in humans. Using a combination of genetic, pharmacological, optogenetic and chemogenetic manipulations, we to these various drug effects in search of a therapy capable of enhancing sociability yet with low abuse potential.

2) Investigating the neural circuitry of ketamine's antidepressant effect in humans and mice
Ketamine is an anesthetic drug with a long history of safe use in the operating room environment, and recently it has also been found to have profound antidepressant effects when given rom. Although animal studies suggest that ketamine’s antidepressant mechanism relies on NMDA receptor antagonism and activation of specific

intracellular signaling pathways, mechanistic support this idea. We are using findings obtained from human studies of ketamine's antidepressant mechanism to inform refined animal models of ketamine's antidepressant effect. We are neuronal ensemble detection methods to identify neural circuits that are necessary and sufficient to account for ketamine's antidepressant mechanism.

3) How does ketamine engage the endogenous opioid system?
We have recently found that an opioid receptor antagonist, naltrexone, can completely block the antidepressant effect of ketamine in patients with treatment resistant depression. This can modulate the endogenous opioid system for therapeutic benefit. Using transgenic mouse lines that allow for selective controls of various populations of endogenous opioid-releasing neurons, role that ketamine has in modulating behaviors related to these neural circuits.

4) Hallucinogens and creativity: establishing animal models with relevance to humans.
Classical hallucinogenic drugs like psilocybin have garnered significant recent media attention for their possible role in treating a host of psychiatric disorders, and for their potential to studying behavioral processes relating to perception, learning, and creativity in both human studies and in mouse models.

Institution: **Stanford University School of Medicine**

Mentor: Sam Rodriquez, M.D.
Project(s) Available:
1) Immersive technologies in a laboratory induced pain model – several studies focusing on various parameters (hardware/software) in healthy volunteers undergoing a cold pressor challenge. responsible for consenting patients and running various protocols on healthy volunteers. They will have the opportunity to design their own pilot study if interested as well as participating in trials.

2) Virtual Reality and Augmented Reality for Rehabilitation in Pediatric Pain – Investigating clinical protocols and efficacy of using immersive technologies for pediatric patients with acute/chronic outpatient settings. Students will be expected to consent patients and guide them through VR/AR protocols in the inpatient and outpatient setting. Students will be able to participate in designing for this and future projects if interested.

Institution: **Stanford University School of Medicine**

Mentor: Vivianne Tawfik, M.D., Ph.D.
Project(s) Available: The contribution of central nervous system glia to the transition from acute to chronic pain
The study of chronic pain in mouse models is complex but crucial to advancing our understanding of the underlying mechanisms and best approaches to treatment. Central nervous system microglia and astrocytes provide support to neurons but also key functions as neuroimmune mediators by releasing cytokines and chemokine when activated. Using mouse models of surgical trauma and complex regional pain syndrome, the lab focuses on the role of these cells in the progression from acute to chronic pain. Approaches include pharmacological and genetic manipulations in mice, complex behavioral evaluations, immunohistochemistry and flow cytometry.

Student role: Motivated medical students can participate in all aspects of an ongoing study looking at the role of spinal cord astrocytes in chronic pain, from learning mouse surgeries to performing behavioral and molecular analyses. Wonderful opportunity to experience what it is like to see patients with the same disease you study in the lab. Clinical time in pain management clinic with Dr. Tawfik on Mondays and the rest of the time engaging in clinically-informed basic science with exciting projects and passionate people.

Institution: **Stanford University School of Medicine**

Mentor: Pervez Sultan, M.D.
Project(s) Available:

1) Development of new 6-week postpartum quality of recovery scoring tool
Childbirth is one of the most common reasons why adults seek in-patient medical management. Despite the large numbers of women delivering globally, recovery following childbirth is a largely unexplored entity. In this study we aim to develop a new quality of recovery scoring measure using methodology endorsed by the PROMIS (patient reported outcome measurement instrument) group.
Aim: To pilot test a new quality of recovery patient reported outcome measure (PROM), which will subsequently be field tested in a larger sample size.
Methods: The student, under direct supervision, will perform ask women to complete the PROM as women recover from childbirth at 6 weeks postpartum during clinic visits. Women will be recruited prior to the student starts their attachment.

2) Prediction of recovery following childbirth – Part 1
There are currently no biomarkers that can predict worse postpartum recovery following childbirth. A significant number of women still have not recovered to their baseline by 6 weeks postpartum.
Aim: to determine whether pre-operative biomarkers can be used to predict worse in-patient recovery in women undergoing elective cesarean delivery. Mass cytometry and plasma biomarkers (olink.com) will be assayed and correlated with in-patient recovery scores in a subset of women undergoing elective cesarean delivery.
Methods: The student, under close supervision, will recruit 10 women into this small single center study and women will also be asked to complete a survey (Obstetric Quality of Recovery-11) 24 hours following delivery.

3) Prediction of recovery following childbirth – Part 2
The ObsQoR-11 patient reported outcome measure (PROM) is a validated measure of quality of recovery following childbirth. No Spanish version currently exists.
Aim: to translate the ObsQoR-11 PROM and validate its use in this population.
Methods: The student will, under direct supervision, help with translation (with an interpreter / medical physician fluent in Spanish). They will then validate this in a subset of 50 women undergoing all delivery types at Stanford University School of Medicine by asking Spanish speaking women to complete the survey 24 hours after delivery.

Institution: Stanford University School of Medicine

Mentor: Ban Chi-Ho Tsui, M.D.
Project(s) Available:
1) Enhanced Recovery after Cardiac Surgery with Erector Spinae Plane (ESP) Catheters
ESP may reduce perioperative anesthetic exposure and perioperative opioid use that can lead to a less detrimental effect on brain development. The project's aims are to determine whether improve neurologic outcomes utilizing electroencephalogram (EEG) and to examine whether blood metabolic changes can predict the neurologic outcome using nuclear magnetic resonance The student will learn and work with pediatric cardiac surgeons, anesthesiologists, cardiologists, intensivists, and neurologists.

2) Electrical Epidural Stimulation Test for Confirmation of Epidural Catheter Placement in Laboring Women
Combined spinal-epidural is an established technique for providing labor analgesia to obstetric patients. Historically though, after rapid onset analgesia, the epidural catheter remains untestable effectiveness. It was previously determined that the motor threshold current of an epidural stimulation test was unaffected by local anesthetic and placement confirmation. The student will recruit patients, and to coordinate closely with regional anesthesiologists and OB-GYN physicians to investigate the ability of the EST to confirm the placement of the epidural catheter.

3) Umbilical Vessel Catheterization under ECG Monitoring and Guidance
Umbilical Venous Catheters (UVC) are typically placed with poor guidance and some radiological confirmation, however, misplacement of the catheter in other unintended anatomical areas placement could prove detrimental

in critically ill infants. A previous study suggests the use of electrocardiograms to guide the placement of the UVC and provide a tool for around-the-clock engage with neonates and families in the NICU, work closely with neonatologists in the development of biotechnological solutions in neonatal UVC placement.

4) Pediatric Scoliosis Surgery: Enhanced Recovery with ESPB
We propose the use of the ESPB to reduce perioperative opioid use and morbidity after surgery, and radically improve pain management. Students will work closely with orthopedic surgeons anesthesiologists while assisting in the implementation of ESPB within pediatric scoliosis surgeries.

Institution: SUNY Downstate Medical Center

Mentor: Ketan Shevde, M.D.

Project(s) Available:

1) Echocardiogram Evaluation of Pre-eclamptic patients-
Comparison of echocardiogram evaluation in pre-eclamptic patients in the peripartum period: Pre-eclamptic vs Healthy
In this project, we will monitor the changes in cardiac function, in pre-eclamptic patients in comparison to healthy patients. We will evaluate echocardiograms performed following pre-eclampsia diagnosis to determine whether there is a significant difference between pre-eclamptic and healthy patients. We hypothesize that patients with pre-eclampsia will have more cardiac pathology due to hypertension, and the heart's inability to relax during contractions, and will demonstrate a poorer prognosis compared to healthy patients. The student will assist with protocol implementation, patient recruitment, and management, data collection and analysis.

2) Retrospective Chart Review of Pre-eclampsia and Cardiac Disease
We hypothesize that patients with pre-eclampsia will have more cardiac pathology due to hypertension, and the heart's inability to relax during contractions, and will demonstrate a poorer prognosis compared to healthy patients. Students will assist with chart review, data management and data analysis.

Institution: SUNY Downstate Medical Center

Mentor: Ming Zhang, M.D., Ph.D.

Project(s) Available:

1) Complement Expression Profiles in Human Cord Blood
Studies show certain components of the complement system are present in fetal serum at approximately eighteen weeks gestation. As the fetus matures, such complement levels increase proportionally to fetal maturity. Deficiency of complement factors in neonates correlated with gestational age and may predispose the infants to severe invasive bacterial infection. However, new factors of complement system, particularly those of MBL pathway are not well studied in the fetal circulation. This study quantifies the profile of the initial molecules in three complement pathways in cord blood. Blood samples from the mothers and cord blood from the fetal placenta at the delivery of the baby will be collected. The student will assist in protocol implementation, patient recruitment, sample collection data collection and analysis.

2) Temporal Alterations in complement expression Profiles are Associated with Increased Mortality in Septic Shock.
We will analyze the level of endogenous complement via ELISA assays while the induced expression of complement related inflammatory factors will be measured by RT-qPCR and western blot. In addition, we collect 5-10 ml of blood samples from patients after diagnosis of septic shock to compare the levels of complement related factors in the blood versus those levels in healthy patients . This study will provide important insights into the cytotoxic effects of complement in Septic shock patients. Students will assist in protocol implementation, patient recruitment, sample collection data collection and analysis.

3) Retrospective Chart Review of Pre-eclampsia and Preterm Birth.
Students will assist with chart review, data management and data analysis.

4) Temporal Alterations in Complement Expression Profiles Associated with Increased Mortality in COVID-19 Patients Including Those with Septic Shock
We will analyze the level of endogenous complement via ELISA assays while the induced expression of complement related inflammatory factors will be measured by RT-qPCR and western blot. Blood samples from patients after diagnosis of COVID-19 will be compared to the levels of complement related factors in the blood versus those levels in healthy patients . This will provide important insights into the cytotoxic effects of

complement in COVID-19 positive patients.Students will perform chart reviews, assist in sample and data collection and data analysis.

Institution: **SUNY Downstate Medical Center**

Mentor: Gina Subtirelu, M.D.
Project(s) Available: We will prospectively compare changes in optic verve sheath diameter (ONSD) during anesthesia maintenance with sevoflurane-only anesthesia versus anesthesia maintenance with propofol in patients undergoing urologic and gynecologic surgery in the steep Trendelenburg position. We hypothesize that ONSD will be significantly smaller (% change) during anesthesia maintenance with propofol versus anesthesia maintenance with sevoflurane. We will measure the percentage of change in ONSD during anesthesia maintenance with sevoflurane versus propofol. Group A will begin anesthesia maintenance with sevoflurane. Then will be switched after 30 minutes to anesthesia maintenance with propofol then will be switched to sevoflurane. The student will assist with protocol implementation, patient recruitment optic nerve measurement, data collection and analysis.

Institution: **SUNY Downstate Medical Center**

Mentor: Ira Kass, Ph.D.
Project(s) Available:
1) The effect of volatile anesthetics on behavior, electrophysiology, molecular signaling pathways and neuropathology in neonatal and adult mice.
The developing brain is extremely sensitive to drug exposure and can undergo long-lasting changes that impact its function during adulthood. By using molecular/cellular/epigenetics, electrophysical and behavioral tools, our lab investigates the impact of drugs, such as anesthetics , on the developing brain. We aim to understand the long-term effects of different anesthetics on their target receptors in the neonatal brain and the resulting changes in neuronal functional output in adulthood. With this approach, we are working are working toward developing neurodevelopmental abnormalities and disease vulnerabilities associated with specific anesthetic exposure during early brain development. We hope to gain a comprehensive understanding on the mechanisms of different anesthetics on the developing brain to assist optimum treatment approaches in pediatric anesthesiology.
The student will assist in anesthetizing neonatal mice, surgical dissection of mice and carryout molecular/cellular/epigenetics, electrophysical and/or behavioral experiments.

2) Early life exposure to anesthetics and seizure development later in life.
Our long-term goal is to gain a comprehensive understanding of neurological change/disease vulnerability associated with each type of anesthetic in order to develop a safe treatment approach. The overall objective for this study, which is one of the series of steps toward attainment of our long-term goal, is to identify an association between exposure to GABAA receptor targeted anesthetics in young children and an increased risk of seizure disorder later on in life. The student will assist in carrying out molecular/cellular/epigenetics, electrophysical and/or behavioral experiments.

3) Analyzing patient EKG and correlating it with EEG from BIS monitor to assess anesthetic state and other pathophysiologic brain conditions from EKG analysis alone.
The student will assist with EKGs, protocol implementation, data collection and analysis.

Institution: **SUNY Downstate Medical Center**

Mentor: Panayiotis Tsokas, Ph.D.
Project(s) Available: Development of novel amnesic agents using a strategy of blocking PKM-zeta activity
Development of novel amnesic agents using a strategy of blocking Protein Kinase M-zeta (PKM-zeta is a brain-specific, constitutively active isoform which plays a key role in the maintenance of long-term memory. We have devised an antisense oligodeoxynucleotide (ODN) sequence which specifically blocks new PKM-zeta synthesis from the PKM- zeta mRNA. In vivo intrahippocampal injection of the antisense ODN blocks long- term synaptic

potentiation (LTP) and long-term memory formation. We are planning on modifying the ODN so that it can cross the blood brain barrier and block the formation of new memories during anesthesia. The student will perform the intrahippocampal injections of different drugs. This will involve cranial surgery and the implantation of cannulae into the brain. Students with prior laboratory experience may become involved with other aspects of the project. Knowledge of basic techniques in protein biochemistry (western blotting)and tissue staining (immunohistochemistry) would therefore be useful, but not necessary.

Institution: **SUNY Downstate Medical Center**

Mentor: Ivan Velickovic, M.D.
Project(s) Available:
1) Is Obesity a relative contraindication for Quadratus Lumborum Block in post-caesarian obstetrical patients? A retrospective chart review.
We will retrospectively compare the rate of QL block failure as defined by post operative pain requiring supplemental analgesia in cesarean delivery patients with BMI greater than or equal to 30 and less than 30. we hypothesize that the rate of QL block failure will be higher in patients with a day-of-surgery BMI greater than or equal to 30. Students will assist with chart review, data management and data analysis.

2) Intravenous Magnesium Sulfate as an Adjuvant of Epidural Bupivacaine on Postoperative Analgesia in 50 Patients ages 18-40 Undergoing Elective Cesarean Section: a Prospective, Double-Blind, Randomized Controlled Trial.
Magnesium sulfate has been used to prevent seizures in pre-eclamptic patients. It has also been used in the treatment of asthma and as an anesthetic adjunct in patients undergoing surgery. This study will investigate the analgesic effects of Magnesium Sulfate undergoing cesarean section. It is a double-blind, randomized, controlled study with a hypothesis that IV Magnesium Sulfate will act as an adjuvant of epidural bupivicaine, thus improving postoperative analgesia. The student will recruit patients, collect data in the operating room as well as perform data management, entry, and analysis.

3) Regional Anesthesia versus General Anesthesia in African Americans
Neuraxial anesthesia (NA) is used in over 94% of cesarean deliveries (CD) in the US. NA is preferred over general anesthesia (GA) in CD due to several perinatal advantages including reduced maternal morbidity, decreased maternal blood loss, and avoidance of airway instrumentation along with subsequent associated complications of intubation. While there are indications for GA in CD, data have shown a discrepancy between the relative rates of GA used in various racial demographics for CD cases. The disproportionate rate of GA used in African American CD patients is particularly glaring when compared to that in their Caucasian and Hispanic counterparts. Studies suggest that GA was used in 11.3% of African American CD patients. This percentage is greater than double that which was reported for Caucasian CD patients (5.2%). In this study, we will compare the use of NA versus GA at Downstate Medical Center, compared to state rates. Students will assist with chart review, data management and data analysis.

Institution: **SUNY Downstate Medical Center**

Mentor: James Cottrell, M.D.
Project(s) Available:
1) The project examines the relationship between Alzheimer's Disease and the susceptibility to or exacerbation of postoperative cognitive dysfunction (POCD). Using biochemistry, immunocytochemistry, brain slice electrophysiology and behavioral methods, we study the effects of sevoflurane on wild-type mice and a mouse model of AD. We focus on the effects of sevoflurane anesthesia on the synthesis, the anatomical and sub-cellular distribution, and the neuroprotective function of PKMzeta. PKMzeta is a brain specific, constitutively active isoform of PKC which plays a role in the maintenance of long-term memory. Abnormal function or localization of PKMzeta may have profound effects on the formation and persistence of memory.

Students will deliver sevoflurane anesthesia to mice and to brain slices from wild-type mice and a mouse model of AD and perform tissue staining (Immunohistochemistry) and western blotting to samples from untreated and anesthetized animals. Students with prior laboratory experience may become involved with other aspects of the project. Knowledge of basic techniques in protein biochemistry (western blotting) and tissue staining (immunohistochemistry) would therefore be useful, but not necessary.

2) Mechanism by which anesthetics alter behavior, learning and memory.
The student will perform the intrahippocampal injections of different drugs. This will involve cranial surgery and the implantation of cannulae into the brain. Students with prior laboratory experience may become involved with other aspects of the project. Knowledge of basic techniques in protein biochemistry (western blotting)and tissue staining (immunohistochemistry) would therefore be useful, but not necessary.

Institution: SUNY Downstate Medical Center

Mentor: David Wlody, M.D.
Project(s) Available:
1) Quadratus lumborum nerve block versus intrathecal spinal morphine on postoperative opioid consumption and pain control after Cesarean delivery: A prospective randomized controlled trial
The quadratus lumborum block (QLB) was introduced in 2015, and it has been associated with a significant reduction in morphine consumption and visual analogue scale pain score 48 hours post cesarean delivery compared to placebo. The aim of our study is to compare the effectiveness of pain control with bilateral lateral QLB compared to intrathecal morphine following cesarean delivery. We will investigate the analgesic effect by means of quality and quantity pain metrics, including morphine consumption using morphine milligram equivalent (MME) as a primary outcome measure. We will also investigate the side effects of morphine. The student will recruit patients, collect data in the operating room as well as perform data management, entry, and analysis.

2) The Effect of COVID-19 on the Opioid Epidemic: A retrospective review investigating the changes in opioid consumption in chronic pain patients unable to undergo their elective steroid injection procedure during the COVID-19 pandemic.
The objective of our study is to measure the change in opioid consumption in chronic pain patients unable to undergo their elective steroid injection procedure from March 1, 2020 to May 30, 2020 during the COVID-19 pandemic. Students will review each patient's pain medication regimen the visit(s) prior to his/her cancelled procedure and the pain medication regimen seen in subsequent visit(s) after the patient has been notified of his/her canceled procedure. The number of opioid(s), frequency, dose, and duration of each opioid during each visit will be obtained. This will help us measure the change in opioid consumption for each patient by calculating the change in milligram morphine equivalents (MME), which will help us determine whether the change in opioid consumption for this patient population as a whole is statically significant. Students will also perform calculations, assist with data management, entry and analysis.

Institution: University of Alabama at Birmingham

Mentor: Brant Wagener, M.D., Ph.D.

Project(s) Available: Essential role of RAGE in amyloid beta (Aß)-mediated alveolar epithelial injury
Pseudomonas aeruginosa type III secretion toxins are virulence determinants that initiate the generation of alveolar epithelial and endothelial cell amyloid proteins. Emerging published evidence and our preliminary work suggest that these Aß species affect epithelial paracellular permeability and transepithelial ion transport. Furthermore, vitamin E modulates the release of Aß by lung epithelial and endothelial cells, possibly via the inhibition of RAGE signaling. In this project, we are testing the hypothesis that P. aeruginosa-induced release of epithelial amyloid proteins causes an increase in alveolar epithelial paracellular permeability via a RAGE-dependent mechanism that is inhibited by pretreatment with Vitamin E.
Students will be able to experiment with alveolar epithelial and endothelial cells to determine their permeability response to cytotoxic Aß species. They will determine roles for RAGE and Vitamin E in pulmonary barrier dysfunction. Students will be able to observe animal experiments and work with tissue derived from these experiments. Endpoints of these experiments will be measures of cell permeability by ECIS and Western blotting among other laboratory techniques.

The Role of Sex Dimorphism in Post-TBI Bacterial Pneumonia
Traumatic brain injury (TBI) is the leading cause of injury-related death under the age of 45 caused in part by the high incidence of post-traumatic bacterial pneumonia. TBI induces a systemic immunosuppressed state via a vagal response that acts via the a7 nicotinic acetylcholine receptor (a7nAChR) expressed on macrophages. Furthermore, our data suggests that gender differences may account for increased survival after post-traumatic bacterial pneumonia. If true, this could lead to novel therapies shortly after TBI that may lead to decreased morbidity and mortality for patients.

Students will be able to experiment with male and female alveolar macrophages to determine their immune response to Pseudomonas aeruginosa. They will be able to test the effect of a7nAChR and estrogen receptor activators and inhibitors on this immune response. Students will be able to observe animal experiments and work with tissue derived from these experiments. Endpoints of these experiments will be measures of immune response by ELISA and Western blotting among other laboratory techniques.

Institution: University of Alabama at Birmingham

Mentor: Dylan Addis, M.D.

Project(s) Available: Novel insight into preeclampsia and fetal growth restriction: role of extracellular heme
Our published studies show that brief exposure of pregnant mice to halogens (chlorine and bromine) results in a preeclampsia-type disease and fetal growth restriction. The mechanisms responsible for damaging the placenta have not been elucidated. We propose that reactive intermediates generated by the interaction of halogens and lung epithelial cells result in the generation of long lived reactive intermediates which damage red blood cells causing release of hemoglobin in the plasma. Hemoglobin is readily oxidized to heme, a pro-oxidant known to cause severe damage to proteins, lipids and DNA. To test our hypothesis, we will exposed pregnant mice at E13 (gestation day 13) to chlorine for 400 ppm for 30 min and return them to room air. We will use ultrasound to perform serial measurements of fetal length and damage to the maternal hearts at E15, E17 and E19, as we have done in the past (PMID: 28607126). In addition pregnant mice will be sacrificed at E15, E17 and E19 and blood, placentas and lungs will be collected and a variety of biochemical, immunological and physiological measurements will be performed. In the second set of experiments, we will administer hemopexin (a human protein with high affinity to heme) and these studies will be repeated. The student will be involved in all aspects of this project. He/she will learn how to expose mice to halogens, perform ultrasound measurements as well as a variety of biochemical, physiological and immunological measurements. In addition, the students will be introduced to the clinical aspect of this project, which involves collecting plasma samples and placenta samples from pre-eclamptic women.

Institution: **University of Alabama at Birmingham**

Mentor: Aftab Ahmad, Ph.D.
Project(s) Available: Effect of anesthetics on survival and inflammatory pathways.
Anesthetics are routinely used for surgery. Increasing evidence suggest that anesthetics can influence the outcome of such surgeries. Studies have shown that anesthetics can also alter cancer metastasis. Anesthetics are also known to alter the extracellular milieu, which include extracellular vesicles and extracellular nucleic acids. These extracellular molecules are increasingly being recognized in disease and development. They can alter cell growth and inflammation through activation of signaling pathways. The purpose of these studies is (a) to characterize nucleic acid types released in response to specific anesthetics, and (b) to determine whether anesthetics can influence cell growth and inflammatory pathways. These studies could lead to better understand the role of anesthetics in outcomes following surgery.

These studies will be carried out using in vivo followed by in vitro cell culture-based assays. Animals will be exposed to at least two anesthetics and blood will be collected. Initially extracellular vesicles will be isolated from the plasma of these animals. Total nucleic acids will also be isolated and quantified for the amount of RNA, DNA and microRNA species using standards. A NFkB-reporter cell line will be used to screen for anesthetic effects on inflammation by exposing these cell lines to anesthetics. Additionally, extracellular vesicles isolated from anesthetized animals will be added to cells following which cell growth and inflammatory markers will be assessed.

The student will be involved in all aspects of the project and will be trained to carry out the work. The student will have hands-on experience in culturing cells and performing cellular assays. The student will isolate, characterize and quantify extracellular vesicles and extracellular nucleic acids using a fluorimeter and nanosight particle analyzer. The student will conduct reporter assays using a luminometer. The student will be included in authorship arising from the work and present at meetings.

Institution: **University of Alabama at Birmingham**

Mentor: Kevin Harrod, Ph.D.
Project(s) Available:
1. COVID-19, SARS-CoV-2, and lung pathogenesis
2. Influenza and secondary pneumococcal infections
3. Influenza mediated regulation of airway ion channel biology

Dr. Kevin Harrod's current research portfolio is not limited to, but includes the above topics. His research goals are grounded in the use of emerging or high throughput technologies to elucidate system-wide knowledge of host-pathogen interactions in respiratory infection. He has a primary focus in the molecular mechanisms underlying pathogenesis, immunity and host defense to respiratory viruses such as coronaviruses, influenza, and a long-standing interest in community-acquired bacterial infections of the lung including sepsis. He has a broad background in lung, cell, and molecular biology, infectious disease of the respiratory tract using both bacterial and viral pathogens. A particular focus on translational approaches is a priority for this laboratory.

The student role will focus on in vivo and/or in vitro projects related to the topics listed above. Projects will employ a variety of molecular biology and virology techniques. Computaional biology and bioinformatics projects are available as well.

Institution: **University of Alabama at Birmingham**

Mentor: Jennifer DeBerry, Ph.D.
Project(s) Available: Opsin-based neuromodulation to recover lower urinary tract function after paralysis

Loss of volitional control over urine storage and voiding after spinal cord injury (SCI) has a profound negative impact on an individual's independence, general health, and quality of life. Normal lower urinary tract function requires opposing, but coordinated, activity between the detrusor (i.e., smooth muscle of the urinary bladder) and the striated muscle of the external urethral sphincter (EUS). Following SCI rostral to bladder innervation, there is an acute period of spinal shock when the bladder is flaccid. This is followed by a gradual re-emergence of detrusor contractility that is mediated by a spinal reflex loop, which is typically only functional during postnatal development before volitional control develops. In contrast, the EUS quickly recovers tonic contractile activity. Thus, when detrusor contractility re-emerges, its coordination with EUS relaxation is lost. The result is detrusor-sphincter dyssynergia and urinary retention, which can trigger autonomic dysreflexia. The current standard of practice for bladder emptying after SCI introduces susceptibility to urogenital infection and long-term damage. Optogenetics is an innovative technology that allows for optical control of excitable cells via light-gated ion channels and pumps.

The aim of this project is to use a combination of excitatory and inhibitory light-gated proteins expressed in sensorimotor pathways (bladder and EUS) to recover lower urinary tract function after paralysis. The model we use is a mouse model of mid-thoracic spinal contusion injury. Participants will have the opportunity to perform hands-on work including advanced neurosurgical procedures, in vivo urodynamic testing, and in vitro analysis of post-mortem tissues.

Institution: **University of Alabama at Birmingham**

Mentor: Songwei Wu, M.D.
Project(s) Available: Endothelial derangement in pulmonary arterial hypertension
Wu lab

Lung vascular endothelial cells (ECs) are main participants in initiation and progression of pulmonary arterial hypertension (PAH). Dysregulated EC proliferation leads to disordered angiogenesis with intralumenal growth causing arteriolar occlusion and obliteration. Endothelial-to-mesenchymal transition (EndMT) can result in pulmonary artery muscularization, which contributes to the distinct pathologic characteristics of PAH. We recently observed that pulmonary microvascular ECs produce and release vascular endothelial growth factor (VEGF) under conditions known to produce PAH. This microvascular EC-derived VEGF exerts a strong chemotactic effect on macrovascular ECs and smooth muscle cells (SMCs) in a neuropilin-2 (NRP2)-dependent manner. We revealed that PAH also caused activation of the Hippo pathway transducers YAP and TAZ, and a VEGF-dependent rise in HMGA1 protein, which has recently been identified to promote EndMT in PAH. Our evidence also indicates the distal migration of the larger vessel ECs into alveolar capillaries in lungs from rats with experimental PAH as well as in arteriolar plexiform lesions from patients with severe PAH. Hence, this project will test the CENTRAL HYPOTHESIS that microvascular EC-derived VEGF signaling promotes migration and deranged proliferation of macrovascular ECs and SMCs into distal microvascular beds to initiate vascular remodeling leading to a rise in pulmonary vascular resistance and progression of PAH. Specific Aims will test: [1] VEGF derived from microvascular ECs acts through NRP2 to trigger distally-directed macrovascular EC/SMC migration; [2] VEGF-NRP2 signaling effects the migrated macrovascular ECs/SMCs to stimulate proliferation and EndMT; [3] VEGF-NRP2 signaling promotes hemodynamic decline in PAH.

The students will learn a number of cell and molecular biology techniques including: cell culture, RNA extraction, qPCR, immunoblotting, and immunofluorescence to assess YAP/TAZ activation and EndMT in pulmonary macrovascular ECs, have the opportunity to present their work at research conferences and potentially be listed as coauthors of related publications.

Institution: University of Alabama at Birmingham

Mentor: Jianguo Gu, M.B., Ph.D.
Project(s) Available:
1) This project is to study the roles of ion channels including voltage-gated potassium channels in mediating pathological pain induced by cold temperatures. The long-term goal of this research project is to develop therapeutic compounds targeting these channels for clinical treatment of cold pain in patients.

2) This project focuses on cellular and molecular mechanisms underlying the transduction and encoding of mechanical stimulation such as gentle touch. The long term goal of this project is to identify therapeutic targets for treating sensory disorders such as mechanical allodynia (i.e., pain induced by gentle touch) seen in patients with neuropathic and inflammatory diseases.

3) Nodes of Ranvier are highly specialized axonal regions on myelinated nerve fibers of sensory, motor and central nervous systems where action potentials are propagated by saltatory conduction. Saltatory conduction through nodes of Ranvier ensures timely sensory and motor responses and precise signal processing in the CNS. A number of neurological diseases affect nodes of Ranvier to impair saltatory conduction leading to motor disorders, such as paralysis and sensory dysfunctions, such as pain, numbness, and other abnormal sensations. Knowledge of ion channels and their functions at mammalian nodes of Ranvier is a key to fully understanding saltatory conduction under both physiological and pathological conditions, and for potential treatments of those sensory and motor disorders. The overall goal of this project is to study ion channel mechanisms for securing saltatory conduction of action potentials at mammalian nodes of Ranvier.

STUDENT ROLE
As a trainee working in Dr. Gu's lab, you will learn to assess pain in animals after tissue inflammation and nerve injury to help in understanding the mechanisms underlying these pain conditions and to identify effective treatments for alleviating these pain conditions. Specifically, you will perform behavioral tests to asses neuropathic and inflammatory pain using methods such as von Frey Test for mechanical sensitivity, and the orofacial operant test for thermal sensitivity and mechanical sensitivity in orofacial regions. You will also give animals testing compounds to see if pain in the animals is relieved by the testing drugs.

Institution: University of Alabama at Birmingham

Mentor: Saurabh Aggarwal, M.D., Ph.D.
Project(s) Available: Role of Cigarette Smoking in HIV-associated Pulmonary Arterial Hypertension
HIV-associated vascular dysfunction such as pulmonary arterial hypertension (HIV-PAH) is a well-recognized cardiovascular complication of HIV infection with an adverse prognosis. However, the exact pathogenic mechanism that links HIV to PAH is not known. The overall objective of the project is to determine whether cigarette smoking (CS) disproportionately increases the risk of developing vascular endothelial and smooth muscle cell dysfunction in individuals living with HIV.

The FAER students will participate in the project and test the following aim:
Establish a direct link between CS and endothelial dysfunction in HIV positive patients. Smokers and non-smokers with and without HIV-1 infection will be recruited at the UAB HIV 1917 clinic. To evaluate vascular function, the following non-invasive measurements will be performed:
a) Assessment of Biochemical Plasma Markers of Endothelial Function. To determine the role of CS in endothelial dysfunction in HIV, endothelium-derived mediators of vascular tone, such as nitrite/nitrate levels, cyclic GMP (a readout of nitric oxide function), endothelin-1, thromboxane, and prostacyclin will be measured by ELISA in patient plasma. Decrease in nitritie/nitrate, cGMP, and prostacyclin levels, while an increase in endothelin 1 will be considered as impairment of endothelial dependent vasodilation.

b) Assessment of Endothelial dependent vasodilation. Blood pressure will be recorded by Pulse Wave analysis (indicator of vascular stiffness). Endothelial function in patients will be assessed by flow mediated dilatation, as it is non-invasive and measures by ultrasound the response of the brachial artery to increased shear stress. Shear stress increases vasodilation, which is dependent upon the release of nitric oxide by endothelial cells.
c) Vascular smooth muscle function will be assessed by measuring with ultrasound, the dilation of brachial artery, before and after administration of a sublingual nitroglycerin (0.4 mg). Administration of nitroglycerin causes vasodilation which is dependent upon vascular smooth muscle cells and independent of endothelial cells.

Institution: **University of Alabama at Birmingham**

Mentor: Qiang Ding, Ph.D.
Project(s) Available: Determine the mechanism of TGF-β1 activation in response to Pseudomonas (P.) aeruginosa
One of the projects in my laboratory is to understand the mechanism of transforming growth factor beta-1 (TGF-β1) activation in response to P. aeruginosa. TGF-β1 plays an important role in lung injury and repair processes. This sub-project will determine whether Neuronal Wiskott–Aldrich syndrome protein (NWASP) is required for TGF-β1 activation in alveolar epithelial cells in response to P. aeruginosa. We will genetically knockdown NWASP expression first. Once the genetic knockdown is confirmed and validated at protein levels by Western blot analysis, as well as at messenger RNA levels by quantitative real-time RT-PCR techniques, TGF-β1 activation in response to Pseudomonas (P.) aeruginosa in lung epithelial cells will be examined.

Students will receive training and usage of multiple research skills and techniques, including cell culture, harvesting cells for analysis, protein concentration analysis, Western blot analysis for protein expression and signaling pathway, and assistance with more complicated techniques including quantitative real-time RT-PCR techniques, genetic knockdown or overexpression of target proteins, and processing tissues or cells from harvested animal lungs.

Institution: **University of Alabama at Birmingham**

Mentor: Shama Ahmad, Ph.D.
Project(s) Available: Circulating catecholamines in bromine-induced cardiac dysfunction
Halogens are widely used highly toxic chemicals that pose potential threat to humans due to their abundance. Halogens such bromine (Br2) cause severe pulmonary and systemic injuries however, the mechanisms of their toxicity are largely unknown. Our studies have demonstrated that Br2 inhalation and subsequent formation of reactive brominated species caused acute cardiac injury and myocardial damage that can lead to heart failure. In an attempt to attribute hyper-adrenergic drive to acute cardiac damage we measured circulating and LV tissue catecholamines. We found that increase in LV shortening correlated with decrease in circulating and cardiac tissue catecholamines. We therefore, hypothesized that brominated lipids formed on the moist pulmonary bed may react and either destroy or modify the antigenic sites of these catecholamines. The purpose of these studies is (a) to determine if plasma catecholamines are modified by brominated lipids and (b) to determine if brominated lipids modify intracellular production of catecholamines. These studies could lead us to better understand of the role circulating catecholamines in halogen-induced cardiac injury.

The studies will initially be carried out using plasma and cardiac tissues already collected from control or Br2-exposed rats. In vitro cell culture based assays will also be utilized. Plasma and cardiac samples will be assayed for catecholamines using a rapid sandwich ELISA kit for the quantitative measurement of catecholamines in rat plasma, and tissue samples. Some samples will then be treated with brominated lipids and reassessed for catecholamine content. Immunoprecipitation and subsequent western blots will be performed to measure the catecholamine-antibody interaction after treatment. cardiac cells will be grown and assessed for catecholamine production before and after treatment with brominated lipids.

Institution: **University of California (Davis) Health System Program**

Mentor: Neal Fleming, MD, PhD
Project(s) Available:
1) Sugammadex: Renal Failure - An evaluation of the utility of sugammadex for reversal of neuromuscular blockade in patients undergoing renal transplantation.

2) Dexmedetomidine for sedation of pediatric patients - A Phase 4 trial of the utility of dexmedetomide for sedation of children undergoing MRI scans

3) Calibration and Validation of Patient Monitoring Device for Pressure Injury Prevention and Fall Detection - The initial clinical evaluation of a wireless device that has been developed as an aid in preventing bedsores and detecting patient falls.

4) Prospective Observational Study Characterizing Noninvasive Hemoglobin (SpHb) Measured with Pulse CO-Oximetry Technology in a Variety of Surgical Cases - A prospective, non-blinded, non-randomized, non-interventional study designed to collect additional data to evaluate, calibrate and improve the performance and understanding of the non-invasive SpHb technology.

5) Validation of PVI as a Parameter to Predict Fluid Responsiveness - This is an observational,retrospective, data analysis study to compare the new rPVI parameter to the older PVI and PPV standards.

6) Evaluation of Non-Invasive Pulmonary Health Parameters for Acute Care Medicine – Initial clinical trials of a novel non-invasive comprehensive monitor of ventilation/perfusion matching

Institution: **University of California (Davis) Health System Program**

Mentor: Richard Applegate, MD
Project(s) Available:
1) EEG Data Collection in Critically Ill Patients - A prospective, non-randomized, sequential data collection study of adult patients in the ICU designed to evaluate the utility of the SedLine monitor as a guide for sedation. Comparison of Depth of Sedation Performance between SedLine and Comparator Device during General Anesthesia - Directly compare the performance of the SedLine and BIS processed EEG monitors.

2) SedLine in pediatrics - An evaluation of the utility of the SedLine monitor as a guide to anesthetic depth in pediatric patients.

3) Patient Centered Outcome Research Institute: A Randomized Controlled Trial of Regional Versus General Anesthesia for Promoting Independence After Hip Fracture Surgery - A multi-center trial of the effects of operative anesthetic on post-operative outcomes.

4) Patient self-reported duration of analgesia after shoulder surgery and interscalene block with and without perineural adjuncts. - A prospective study of the impact of local anesthetic adjuncts on post-operative pain.

5) Transversis Abdominis plane (TAP) blocks with Ropivacaine Continuous Infusion Catheters vs Single Dose Liposomal Bupivacaine. - A prospective randomized controlled trial for pain control after renal transplant surgery

Institution: **University of California, Los Angeles**

Mentor: Ira Hofer, MD
Project(s) Available:
1) Development of machine learning models to predict postoperative outcomes
2) Retrospective analysis of the introduction of Sugammadex into clinical practice
3) Featurization techniques for EHR data for use in machine learning

For all of the projects, the students would be involved in data extraction, data validation and statistical analysis. Some knowledge of coding specifically SQL and/or Python would be beneficial.

Institution: **University of California, Los Angeles**

Mentor: Soban Umar, MD, PhD
Project(s) Available: Multi-Organ Transcriptomic Analysis in Experimental Pulmonary Hypertension
The applicant will have the opportunity to work with research fellows and the PI on projects investigating transcriptomic signature of various organs in experimental pulmonary hypertension. The applicants will have the opportunity to learn basic in vivo and in vitro animal physiology, molecular biology, immunohistochemistry and biochemical lab techniques. In case of virtual fellowship due to COVID-19, the applicant will have the opportunity to participate in online lab meetings and mentorship sessions and learn data analysis, scientific writing, and data presentation.

Institution: **University of California, Los Angeles**

Mentor: Andrew Hudson, MD, PhD
Project(s) Available:
1) Anesthetic perturbation of synaptic transmission in vivo assessed via calcium imaging.
How do anesthetics interrupt the propagation of information through the cortical network? This project will utilize the genetically-encoded calcium indicator GCaMP6 to report neuronal activity in vivo in superficial frontal cortex of the mouse. Activity in the imaged area will be driven through electrical and optogenetic stimulation of the cortical and thalamic afferents to that area, to allow a thorough characterization of the change in the input-output relationship between neurons as a function of volatile anesthetic dose. This project will have the opportunity for the student to participate in experimental data collection utilizing in vivo 2 photon resonance scanning microscopy, signal processing, and statistical analysis. Students will have the opportunity to observe animal surgery and injection of viral vectors.

2) Characterization of anesthetic dose responses in basal ganglia of mouse.
The basal ganglia play a huge role in action selection and motivation that directly impact the arousal signals propagated throughout the brain by the central thalamus, yet their contributions to anesthetic-induced unconsciousness remain relatively unexplored. This project utilizes high density depth-electrode recordings of action potentials and field potentials to characterize shifts in the relationship between the cortex, striatum, globus pallidus, and central thalamus as a function of anesthetic dose. This project will have the opportunity for the student to participate in experimental data recording utilizing a high density electrode-array system, signal processing, and statistical analysis of electrophysiology data. Students will have the opportunity to observe animal surgeries.

Institution: **University of California, San Francisco**

Mentor: Helen Kim, MD, PhD

Project(s) Available: Predictors of hemorrhage and outcome in patients with cerebrovascular malformations

Project Overview

We have several NIH-funded research projects focused on predictors and modifiers of clinical course in patients with cerebrovascular malformations, which are a major cause of hemorrhagic strokes in younger people. First, the UCSF Brain Arteriovenous Malformation Study Project tracks treatment results and patient outcomes for all sporadic bAVM patients seen at UCSF. Second, we are the coordinating center for the Brain Vascular Malformation Consortium, a multicenter effort studying the clinical behavior and genetics of familial cerebral cavernous malformations (CCM), Sturge-Weber Syndrome (SWS), and Hereditary Hemorrhagic Telangiectasia (HHT). Although the mechanisms underlying these vascular diseases differ, patients often present with similar clinical symptoms, and there is no primary medical treatment available. We collect detailed clinical and imaging data at baseline and outcomes at follow-up, as well as blood/saliva and tissue specimens for functional studies.

The student will have the opportunity to participate in current projects, and will gain hands on experience in designing clinical research studies, patient recruitment, data collection, and/or data analysis. Examples of possible projects include but are not limited to: (1) clinical outcomes and quality of life in cerebrovascular malformation patients; (2) treatment complications or outcomes in cerebrovascular malformation patients; (3) bioinformatics analysis of exome sequencing data; (4) candidate gene studies using genome-wide association data; (5) functional and/or biomarker studies in tissue or stored plasma or serum samples; and (6) racial/ethnic differences in outcomes.

Institution: **University of California, San Francisco**

Mentor: Arthur Wallace, MD, PhD

Project(s) Available:

1) Audio Visual Detection Monitor (AVD-M): Development and testing of a new class of monitors based on machine vision. This project is developing a remote, non-contact monitor of heart rate, respiratory rate, pulse oximetry, perfusion, blood pressure, and other parameters using machine vision. The student will work on development and testing of algorithms. Students in the past have developed machine vision algorithms for remotely measuring respiratory rate, heart rate, pulse oximetry, and perfusion. They have also done clinical testing of the system. Experience with electrical or biomedical engineering or computer science is helpful. Students are taught LabView and the basic signal processing necessary to work on algorithm development. Clinical testing includes working in the pulse oximetry lab doing desaturation testing on volunteers as well as testing in the recovery room.

2) Near Infrared Spectrophotometer (NIRSIT): Development and testing of a near infrared spectrophotometer for the measurement of severity of depression. This project is testing a device which provides an assessment of frontal lobe function using near infrared spectrophotometry. The device uses 200 lasers and measures frontal lobe oxygenation 30 times a second. We are testing the device as a measure of severity of depression. Students will work on a clinical trial of patients undergoing ECT or Ketamine therapy for treatment refractory depression. Patient's frontal lobe function is assessed prior to, during, and two weeks after either ECT or ketamine treatment. Near Infrared Spectrophotometry is able to assess the presence of depression. This experiment will demonstrate whether frontal lobe dysfunction in depression is a state variable which will improve with treatment or a trait variable which does not. The NIRSIT device is being tested as a measure of severity of depression and as a tool to guide clinical therapy.

Institution: **University of California, San Francisco**

Mentor: Judith Hellman, MD

Project(s) Available: Innate immune modulation by the endocannabinoid system

My laboratory is focused understanding the mechanisms of injury and organ failure in sepsis and other acute inflammatory disorders. We have active project defining the role of innate immunity, and endothelial and leukocyte signaling pathways in sepsis and injury, and the immunomodulatory effects of the endocannabinoid and endovanilloid systems in sepsis and acute inflammation. The student will have the opportunity to participate in studies focused on understanding the effects of cannabinoids on inflammatory activation of endothelial cells and leukocytes, and the roles of cannabinoid receptor 1 (CB1R) and the transient receptor potential vanilloid 1 (TRPV1) in mediating the immune effects of cannabinoids. They will gain experience in measuring parameters of inflammation and injury in vitro and in vivo in models of sepsis and inflammation. They will also have on average 6 hours per week clinical exposure in the ICU and/or OR. The student will, with my guidance, develop and create an abstract and poster based on their summer project, which they will present at the ASA Annual meeting.

Institution: **University of California, San Francisco**

Mentor: Zhonghui Guan, MD

Project(s) Available: Identification of perioperative risk factors for persistent post-surgical opioid use

Persistent post-surgical opioid use is a significant medical concern. In opioid-naïve surgical patients, each additional opioid refill is associated with an increase in the rate of post-surgical opioid misuse of 70.7%, and each additional week of post-surgical opioid use increases the rate of misuse by 34.2%. However, the perioperative risk factors for persistent post-surgical opioid use is largely unknown. We have collected the medical information from electronic medical records (EMR) of 5,857 opioid-naïve adult patients undergoing inpatient surgeries in 2019 at UCSF, which contain many perioperative medical factors. We found that 13.16%, 3.94%, and 3.21% of these opioid-naïve patients had opioid refill prescriptions within 30 days, 31-60 days, and 61-90 days after surgery, respectively. However, our EMR only contains opioid refill prescriptions prescribed by the physicians in our system, and any opioid prescribed by outside physicians was not included in our dataset. To more accurately monitor the post-surgical opioid use, we will check Prescription Drug Monitor Program (PDPM) for all the patients who had post-surgical opioid refill prescriptions after surgery, and we will document the time and the dosage of all the opioids the patients have received up to 12 months after surgery. Because PDPM officially records every filled opioid prescription, tracking PDPM's record is the best way to monitor how much opioid a patient had actually received during any given period of time. With the combination of our EMR records of perioperative medical information and the PDMP's records of patients' true opioid consumption after surgery, we will have a unique opportunity to investigate the perioperative risk factors of persistent post-surgical opioid use. Student will collect and analyze data from PDPM.

Institution: **University of California, San Francisco**

Mentor: Hua Su, MD

Project(s) Available: Developing innovative therapies for the treatment of brain arteriovenous malformation.

Brain arteriovenous malformation (bAVM) is an important cause of intracranial hemorrhage. Available therapies are all invasive and have potentially high morbidity. Excessive VEGF expression is a fundamental part of the bAVM pathology. Compelling evidence show interruption of VEGF signaling could be a therapeutic strategy. Soluble FLT1 (sFLT1) binds to VEGF in the tissue, thus reducing its downstream signaling through membrane-bound VEGFRs. We showed that systemic delivery of AAV9-sFLT1 reduced brain AVM severity in 2 mouse models. However, liver inflammation and growth arrest have been noticed. To reduce systemic side effect, we are testing a strategy to deliver sLIT1 to brain endothelial cell specifically. The goal of the project is to test if intravenous delivery of AAV-sFLT1 will prevent progression of or reverse the AVM phenotype with minimum side effect. Students will participate in ongoing projects. They will perform tissue section, histological and immunohistological staining, quantify vessel density and the number of abnormal vessels on tissue sections, and analyze gene expression

through qPCR and western blot. The goal for the students is to learn basic lab techniques, principles for design research projects, data analyses and interpretations. They are expecting to be co- authors on publications resulting from their activities during the fellowship period.

Institution: **University of Chicago**

Mentor: Zheng (Jimmy) Xie, MD, PhD
Project(s) Available: Our recent studies showed drugs, increasing [cAMP]i or/and inhibiting adenosine receptors, can reverse light anesthesia or facilitate anesthesia emergence in rats and in humans. Current investigation in our laboratory focuses on the mechanisms of common anesthetics with emphasis on three main aims: 1. Pharmacological agents that are able to accelerate emergence from anesthesia in rats and in humans; 2. Drugs can reduce the anesthetic induced neurotoxicity, particularly in the very young and very old populations in rats and in humans; and 3. Search for drugs or combinations of drugs which produce positive anesthetic effects with minimal side effects. The projects will involve blinded behavioral studies performed with both wild type and genetically engineered mice and rats in which these animals are anesthetized with commonly used inhaled or intravenous agents and their emergence from anesthesia assessed in the presence or absence of these reversal agents. Concurrently, translational studies assessing the effects of these agents on emergence and recovery from anesthesia in healthy human volunteers will be ongoing. In addition, our lab also conducted studies in intraoperative awareness with explicit recall in patients who received multiple anesthesia. This study can be done virtually. Overall, our lab conduct research from molecules, animals to humans.

The student will be trained to work with rats and directly perform experiments on these animals such as those described above. These investigations will occupy the bulk of the student's daily research activity. The student will be able to accompany the PI's to observe the conduct of human trials if the timing is appropriate. The student will meet PI and his colleagues in the lab and in the OR frequently. PI will work with the student to prepare his/her presentation at ASA meeting, and the student can potentially contribute to publication in a peer-reviewed journal.

Institution: **University of Chicago**

Mentor: Richa Dhawan, MD
Project(s) Available: Current investigation in the section of cardiac anesthesia focuses on perioperative outcomes in patients undergoing cardiac surgery. Specifically we have several clinical trials addressing pain, prediction of postoperative outcomes based on intraoperative transesophageal echocardiography, and the association of intraoperative medications with postoperative delirium.

Our clinical prospective study is assessing the utility of intraoperative transesophageal echocardiography measurements of renal resistive index and portal vein pulsatility for predicting postoperative acute kidney injury after cardiac surgery. Cardiac surgery associated AKI (CSA-AKI) has a complex, multifactorial pathophysiology with several major injury pathways. Intra-renal vasoconstriction (arterial) and venous congestion have been identified as important mechanisms of injury. This intra-abdominal blood flow irregularity, which can be assessed with point-of-care ultrasound, is associated with an increased risk of postoperative AKI.
This study will establish intraoperative measurements of renal resistive index and portal vein pulsatility as a promising rapid, early marker of renal injury that can be routinely utilized in the operating room during cardiac surgery to identify patients at risk of developing CSA-AKI. This study will compare intraoperative measurements on TEE to the Cleveland Clinic Acute Renal Failure Score and Mehta Score.

The student will learn the utility of echocardiography in cardiac anesthesia. The student will accompany the PI into the operating room and observe quantitative transesophageal echocardiography measurements in patients having cardiac surgery. The student will learn about postoperative complications associated with cardiac surgery, specifically the methods of evaluating and diagnosing acute kidney injury. The student will have the opportunity to observe anesthesia management of patients undergoing cardiac surgery. Students can perform data analysis in a virtual manner if appropriate. The investigators will work closely with the student to prepare an abstract for presentation at a national meeting.

Institution: **University of Chicago**

Mentor: Alina Lazar, MD
Project(s) Available: Our study compares the recovery profile of children after receiving either a pudendal or caudal block for ambulatory penile surgery. Pudendal block has seen a recent resurgence in interest due to concerns about a reported increased risk of uretro-cutaneous fistula in children who received a caudal block. Recent studies have also reported longer and better analgesia after pudendal block compared to caudal block. In addition, its superior safety profile and the fact that it can be used in patients in whom caudal analgesia may be contraindicated (neuraxial abnormalities) or impractical (older children) make pudendal block not only a viable alternative to caudal analgesia, but also a potentially superior one. However, there are only a few studies comparing these two techniques, most of them from abroad, and some with methodological problems. We are planning a randomized controlled study comparing the effectiveness of these 2 techniques.

The role of the student will be to participate in the selection of patients, obtaining consent for the study, administration of anesthesia (as an observer), education of parent on the utilization of pain evaluation tools at home and use of the study pain journal, and contacting the parent on postoperative day 1 or 2 to retrieve data on pain management at home. The student will be involved in analyzing the data and presenting it as an abstract at the ASA and SPA meetings. If the student is not able to be on site due to COVID restrictions, his/her role will resume to the collection of postoperative data (phone call to caregiver), analysis of data, and writing and presenting the abstract. Otherwise the student will participate in the clinical portion of the study one or 2 days per week (when the urology cases are typically scheduled).

Institution: **University of Chicago**

Mentor: Anna Clebone, MD
Project(s) Available: We are currently administering dexmedetomidine to healthy subjects as part of an existing protocol looking at the role of alpha-2 agonists on replicating normal sleep and the effect on perceptual memory. During the 8 week period, the student's main project would be to analyze the hemodynamic changes associated with dexmedetomidine administration in healthy subjects and compare this to existing data on the hemodynamic changes associated with a normal nap. The student would also be involved in data collection and learn about the existing memory consolidation protocol as well as the effects of anesthesia on EEG. Some weekend and evening assistance with subject collection will be a part of this project for the student. If needed, students can have zoom meetings with us, call subjects on the phone, and analyze data remotely.

Sleep produces learning consolidation in humans, restoring memories that were forgotten during a waking day and protecting memories against future forgetting. Theories of consolidation have linked sleep spindles as seen on electroencephalography to consolidation due to their putative role in hippocampal transfer to the neocortex. Sleep aids in the consolidation of generalized perceptual learning of speech. The alpha 2 adrenergic receptor agonist, dexmedetomidine, acts on subcortical areas of the brain, primarily the locus coeruleus, but does not bind to GABA receptors. Dexmedetomidine is “biomimetic” of non-REM, stage 2 sleep, preserving natural sleep spindle morphology (e.g., frequency and amplitude. We hypothesize that inducing sleep spindles by administration of dexmedetomidine in healthy human subjects will produce consolidation of perceptual learning. We expect that this memory consolidation will be similar to that seen in natural sleep, suggesting that biomimetic spindles are sufficient for producing memory consolidation. This research has the potential to impact clinical outcomes in people who struggle with generalized learning and/or who do not have normal sleep architecture, including people with Parkinson’s and Alzheimer’s diseases.

Institution: **University of Chicago**

Mentor: Atul Gupta, MD
Project(s) Available: We conduct health services research on various National databases to evaluate outcomes relevant to our specialty. We use national databases that are part of the Healthcare Cost and Utilization Project

(HCUP), a project sponsored by agency for health care research and quality (AHRQ). Our main project is a retrospective study that will examine patient demographic factors, comorbidities and procedures associated with death in hospital based ambulatory surgery centers. We will use National ambulatory surgery database (NASS) for this study. NASS is the largest all-payer calendar-year, encounter-level de-identified database of hospital owned ambulatory surgery centers in the US from 33-34 geographically dispersed states.

Other projects include a) evaluating outcomes and Readmissions after in-hospital cardiac arrest using National readmissions database and b) National trends in maternal mortality during deliveries using multi-year National inpatient sample.

Student will take a data use agreement course on HCUP website. Student will learn fundamentals of health services research. Specifically, she/he will learn about organization of relevant databases, ICD-9, ICD-10 and CPT code architecture. Student will review literature, learn about validated diagnosis and procedure codes to identify various diagnoses and procedures on the dataset and basics of dealing with missing and inconsistent elements. The datasets are in SAS language format. Depending upon the interest and prior knowledge, student may help with writing SAS code, debugging and data analysis. Student will be involved in creating data tables, helping out with discussion and end note to collate bibliography. Some of the work can be done virtually. The student will meet PI and his colleagues frequently both in and out of OR. PI will work with the student to prepare his/her presentation at ASA meeting, and the student can potentially contribute to publication in a peer-reviewed journal.

Institution: **University of Colorado Denver**

Mentor: Slobodan Todorovic, M.D., Ph.D.
Project(s) Available: Neuronal T-type voltage-gated calcium channels (T-channels) exist in three isoforms: Cav3.1, Cav3.2 and Cav3.3. Our recent studies documented supportive role of Cav3.2 isoform in painful diabetic neuropathy. However, the roles of Cav3.1 and Cav3.3 isoforms in painful diabetic neuropathy are not well studied. Hence, we plan to use our streptazocin-induced model of type 1 diabetes in mice to investigate the roles of Cav3.1 and Cav3.3 isoforms in painful diabetic neuropathy. We will inject streptazocin into a cohort of wild-type mice and age-matched cohorts of Cav3.1 and Cav3.3 null mice. We will then determine daily blood glucose levels, daily body weights as well as sensitivity of mice to mechanical and thermal painful stimuli for up to 6 weeks after injections of streptazocin. We expect that results of our study will further our knowledge of painful diabetic neuropathy which is a medical condition very resistant to current pain therapies.

We use rats and mice to probe the role of T-type calcium channel inhibitors in alleviating pain post-surgery. We make a small incision on the paw of the animals under anesthesia and test for mechanical and thermal hyperalgesia for the 7 days post-operatively. Drugs are injected directly into the paw, in the spinal cord intrathecally or intraperitoneally. Mouse genetic is used as in the other project in order to identify the isoform of T-type calcium channels that is involved in hyperalgesia post-surgery. We hope that we can establish new pain therapies in the perioperative period that do not cause dangerous side effects and addiction.

Institution: **University of Colorado Denver**

Mentor: Ana Fernandez-Bustamante, P.h.D.
Project(s) Available:
1) Research Topic:Postoperative pulmonary complications in surgical patients after general anesthesia
The overall goal of this research is to reduce the incidence of respiratory complications after general anesthesia in surgical patients. Specific aims of this study include, among others: understanding the incidence and risk factors possibly related to postoperative pulmonary complications (e.g. pain, nausea, ability and intensity of ambulation); quality improvement interventions, and their impact on the incidence and severity of postoperative pulmonary complications. The student will participate in the study protocol implementation as well as collection, analysis and interpretation of data.

2) Electroencephalography (EEG) in patients undergoing hepatic surgery
The overall goal of this study is to evaluate the correlation between the EEG signaling and the level of sedation and analgesia/anesthetic requirements in patients undergoing hepatic surgery. Specific aims of this study include the correlation between sedation levels obtained with perioperative EEG monitoring and analgesic/anesthetic requirements in patients during liver transplantation, living liver donation or hepatic resections for various reasons. The student will participate in the study protocol implementation as well as collection, analysis and interpretation of data.

3) Effect of kidney insufficiency on thromboelastography (TEG) parameters
The overall goal of this research is to analyze the effect of presence and severity of kidney insufficiency on coagulation (or coagulopathy) as assessed by TEG, in patients with and without concomitant liver dysfunction. Specific aims of this study include to assess the effect of blood urea levels on TEG parameters in patients with and without concomitant liver dysfunction. The student will participate in the study protocol implementation (including help with collection, processing and TEG testing of blood samples from study patients), analysis and interpretation of data.

Institution: **University of Colorado Denver**

Mentor: Tobias Eckle, MD, PhD

Project(s) Available: Epidemiologic studies in humans indicate that susceptibility to hypoxic events such as ischemic myocardial tissue injury is time-of-the-day dependent, with more severe injury occurring after a longer period without daylight. Current findings from my lab indicate that light-exposure could function to attenuate ischemic myocardial injury. In fact, we observed a time-dependent reduction in myocardial infarct size and troponin I release following light treatment. A search for light inducible circadian rhythm proteins revealed a robust induction of cardiac Period 2 (Per2) protein levels upon intense light exposure. Based on these findings, we hypothesize that intense light therapy provides robust cardio-protection by stabilizing cardiac Per2. The student will assist with studies using intense light exposure in mouse models for myocardial ischemia or assist with a clinical trial on intense light therapy in patients undergoing cardiac surgery.

Institution: **University of Kansas, Medical Center- Kansas City**

Mentor: Julie Christianson, PhD
Project(s) Available: Hippocampal neurogenesis: This project involves measuring newly-formed neurons in the dentate gyrus of the hippocampus of mice that underwent neonatal maternal separation (NMS) and have been given free access to a running wheel. The scholar would be involved in processing hippocampal slices for immunohistochemical identification of important markers and analyzing the number of new neurons.

Hippocampal MRI/MRS: Mice that underwent NMS and were given free access to a running wheel will be subjected to magnetic resonance imaging/spectroscopy to determine changes in size and metabolic responsiveness of the hippocampus to exposure to an adult stressor. The scholar would assist in performing MRI/MRS and analyzing the resulting data.

Metabolic characterization: Mice that underwent NMS and were fed a high fat/high sucrose (HFS) diet will be housed in indirect calorimetry cages to determine total energy intake and expenditure. The scholar will assist in performing this experiment and analyzing the resulting data.

Appetite assessment: Mice that underwent NMS and were fed a HFS diet will be assess for diet intake following treatment with appetite altering compounds. The scholar will assist in performing these assessments and analyzing the resulting data.

Institution: **University of Kansas, Medical Center- Kansas City**

Mentor: Douglas Wright, PhD
Project(s) Available: Chronic Pain and Peripheral Innervation: Chronic low back pain (cLBP) is an extremely common chronic pain syndrome and opioids continue to be used frequently by practitioners for the treatment of cLBP. Quantitative analysis of cutaneous innervation of the epidermis using intraepidermal nerve fiber (IENF) density is a safe method to status of peripheral sensory axons. Various chronic pain conditions (e.g., painful diabetic neuropathy, painful chemotherapy-induced neuropathy, complex regional pain syndrome, and fibromyalgia) report that reductions in IENF density are associated with pain in the feet and hands. This finding begs the question of whether these reductions in IENF in various pain conditions point to an underlying small fiber neuropathy. In this project, we will determine 1) how chronic pain in cLBP and opioid use affects epidermal innervation; and 2) how centralization of pain in a subset of patients affects peripheral innervation. We hypothesize that 1) epidermal innervation is altered in patients with cLBP compared to healthy controls; 2) chronic opioid use in patients with cLBP contributes to additional detrimental changes in epidermal axons and works against pain-relieving actions of opioids to reduce pain, and 3) is possibly linked to the development of abnormal pain sensitivity and/or opioid-induced hyperalgesia. Our studies will recruit patients to each of 3 groups: 1) healthy controls 2) cLPB patients not on opioid therapy and 3) cLBP patients taking opioid therapy. Patients will receive skin biopsies on both ankles to quantify IENF density. We will compare quantitative measurements of IENF density to total daily oral morphine equivalents (OME) taken by the patients. We also will perform quantitative sensory testing (QST) to assess pain sensitivity and determine whether heightened pain sensitivity is affected in patients with cLBP, affected by opioid use, and associated with abnormal IENF density. We will also determine if patients with clear CNS amplification of pain as exacerbated pain sensitivity and abnormal IENF density. These results may provide provocative information about how changes in peripheral sensory anatomy are related to central-nervous system mediated pain control. The student will be involved in all parts of this ongoing study, including learning to collecting patient data, performing QST, obtaining skin biopsies, and learning immunocytochemistry to quantify IENF density.

Institution: **University of Kansas, Medical Center- Kansas City**

Mentor: Seth Holwerda, PhD
Project(s) Available: Examining the association between chronic pain and hypertension using real-world clinical data. Results will potentially lead to novel insights to improving outcomes for patients with chronic pain.

Institution: **University of Kansas, Medical Center- Kansas City**

Mentor: Erin Young, PhD
Project(s) Available:
1) Chronic abdominal pain is particularly difficult to treat due the gastrointestinal side effects that accompany many therapeutic options. Identifying genetic contributions to differential susceptibility for chronic abdominal pain can provide novel insights into how to better treat pain at the level of the underlying mechanisms. Using a mouse model of irritable bowel syndrome, characterized by bowel pain in the absence of ongoing disease or inflammation, we have identified genetic factors that contribute to risk for development of chronic bowel pain. We are currently focusing ongoing projects on the interactions between genetic factors and the intestinal microbiome that may play a role in the increased risk for pain AND on potential therapeutic strategies to increase resilience to chronic pain in susceptible mouse strains.

2) Spinal cord injury is most often characterized by loss of motor function but when you ask patients about their priorities, they report chronic medically intractable pain as a higher priority than locomotor recovery. Persistent bowel pain after spinal cord injury is particularly difficult to treat because of alterations in bowel motility (i.e. constipation) and the negative side effects of opioid-based therapies. We are currently examining the gene expression profile in the bowel following spinal cord injury to identify processes and pathways that are engaged following injury and may contribute to persistent bowel pain later one. By identifying these novel targets we have the unique opportunity to act at the time of injury to prevent the development of chronic pain and preserve patient quality of life.

3) Patients with chronic cancer pain often find that they need escalating doses of opioids to adequately control their pain. This can ultimately require the implantation of an intrathecal analgesic pump to optimize pain control but a significant number of patients report poor pain control and/or a re-emergence of their pain even with increasing doses of intrathecal pain medication. Using clinical research strategies, we are attempting to characterize the somatosensory, psychological and biological marker profiles associated with failure to achieve and maintain adequate analgesia with intrathecal opioids therapy. We are using a combination of quantitative sensory testing, patient self-report surveys and biological sample collection/analysis to address this unique knowledge gap.

Institution: **University of Kansas, Medical Center- Kansas City**

Mentor: Kyle Baumbauer, PhD
Project(s) Available:
1) Unresolved inflammation is a leading contributor to the development of chronic pain. Our laboratory has been examining the neuronal and non-neuronal mechanisms underlying the development and persistence of chronic inflammatory pain, and we have recently shown that the extracellular protein tissue inhibitor of metalloproteinases (TIMP)-1 is a novel regulator of inflammatory pain and sensory neuron function. Mice lacking TIMP-1 develop pathological pain states, including widespread pain, resulting from aberrant neuronal activity. Administration of TIMP-1 prevents these processes. Ongoing projects are working to identify the receptor-dependent cell signaling processes responsible for attenuating inflammation and inflammatory pain.

2) Traumatic spinal cord injury (SCI) is a complex neurophysiological insult that results in pain through mechanisms that are poorly understood. While pain results from a lesion to the spinal cord, there are mechanisms outside of the lesion site that contribute its development and persistence. For example, SCI increases the

excitability of peripheral sensory neurons that drive the development and persistence of chronic SCI pain. Importantly, our lab has recently shown that increases in sensory neuron activity occur within 24 hr of injury, and given that patients don't report pain for months or years following injury, our data suggest that the early onset of aberrant neuronal activity help to establish pain that is difficult, if not impossible to reverse. We have identified a collection of gene networks that contribute to SCI-induced increases in neuronal activity. Current projects are characterizing how early interference with these genes prevents pathologic neuronal activity. We are also working to understand how alternative gene splicing, epigenetic regulation of gene expression, and DNA damage also contribute to these processes.

The laboratory uses a variety of techniques, including behavior, electrophysiology, molecular genetics, gene and protein expression and activity analysis, RNA sequencing and interference, and RNA and protein imaging.

Institution: **University of Kentucky College of Medicine**

Mentor: Kevin Hatton, M.D.
Project(s) Available: Haptoglobin is essential for free hemoglobin metabolism and elimination.
In humans, there are three different haptoglobin phenotypes, each with a different effect on vasospasm risk after subarachnoid hemorrhage. The student will work with the primary mentor in his lab to determine the haptoglobin phenotype of subjects with aneurysmal subarachnoid hemorrhage (aSAH). The student will be taught basic laboratory safety and laboratory techniques for ELISA testing of blood plasma. In addition, the student will be expected to collect baseline demographic information from the electronic medical record. Students will transfer study data to an online database. Finally, the student will be expected to work on statistical analysis and present significant findings at a departmental research conference and a regional or national meeting.

In a different but related study, our lab is also evaluating changes in adaptive immunity in aneurysmal subarachnoid hemorrhage and its effect on vasospasm to further elucidate the neuroinflammatory cascade and investigate potential acquired immunity effects in vasospasm. The student will be taught basic laboratory safety and laboratory techniques for Flow cytometry and ELISA testing of blood and CSF. Students will transfer study data to an online electronic database. The student will work on statistical analysis and present significant findings at a departmental research conference and a regional or national meeting.

Finally, our lab is co-investigating the predictive potential of a miRNA panel on vasospasm and neurologic outcome after aSAH. Students will transfer study data to an online electronic database and collect baseline demographic information. Students will also learn about miRNA and the process to isolate and measure miRNA from plasma and CSF samples. The student will work on statistical analysis and present significant findings at a departmental research conference and a regional or national meeting.

Institution: **University of Kentucky College of Medicine**

Mentor: Daniel Wambold, M.D.
Project(s) Available: Thermal Effects on Roprivacaine.
This is a double-blinded, randomized, investigational study of Ropivacaine, administered via single injection block pre-operatively, either at room temperature (20° to 25°C) in Arm A versus 4°C in Arm B, evaluated for time to onset of analgesia, cold sensitivity, and morphine equivalency units of adjunct pain medication in the 24 hours following administration. The student will be expected to work with the primary mentor in recruiting and consenting patients, collecting baseline demographic information from recruited patients, and facilitating research-focused data collection for study aims, including skin pinch and ice glove patient data. Students will also be expected to transfer study data to an online electronic database. Finally, the student will be expected to work with the primary mentor in the statistical analysis plan and will be expected to present significant findings at a departmental research conference and a regional or national meeting.

Institution: **University of Kentucky College of Medicine**

Mentor: Syed Ali, M.D.
Project(s) Available: Duration of Various Factors Contributing to the Operating Room Turnover Time
This study investigates the duration of turnover by anesthesia technician, anesthesia resident, certified registered nurse anesthetist, surgical technician, operating room registered nurse, and the hospital environmental service. Students may help time events or record data, facilitating research-focused data collection for study aims. Students will also be expected to transfer study data to an online electronic database. Finally, the student will be expected to work with the primary mentor in the statistical analysis plan and will be expected to present significant findings at a departmental research conference and a regional or national meeting.

Noise Levels in Operating Rooms and Procedural Units During the Anesthesia Peri-Induction Period. This study investigates the noise levels in the OR during the induction period. Students may record noise levels and collect

other data, for completion of study aims. Students will also be expected to transfer study data to an online electronic database. Finally, the student will be expected to work with the primary mentor in the statistical analysis plan and will be expected to present significant findings at a departmental research conference and a regional or national meeting.

Institution: **University of Maryland School of Medicine**

Mentor: Tibor Kristian, Ph.D.
Project(s) Available: Cell-type specific mitophagy in post-ischemic brain tissue
The student will learn and assist with brain tissue processing for immunohistochemistry, learn to quantify morphological alterations of cell-type specific mitochondria using our transgenic animals expressing mitochondria targeted fluorescent marker in brain sections by utilizing confocal microscopy and Volocity software.

Institution: **University of Maryland School of Medicine**

Mentor: Gary Fiskum, Ph.D.
Project(s) Available:
1) Deleterious effects of hyperoxic resuscitation on brain region selective energy metabolism proteins following global cerebral ischemia Student will conduct high level stereologic quantification of specific proteins using light microscopy and immunoblots.
2) Quantitative assessment of neuroinflammatory proteins after polytrauma consisting of traumatic brain injury plus mild hemorrhagic shock. Student will conduct high level stereologic quantification of specific proteins using light microscopy and immunoblots.

Institution: **University of Maryland School of Medicine**

Mentor: Wei Chao, MD, Ph.D., FAHA
Project(s) Available: Targeting inflammation in trauma
Traumatic injury is a major cause of combat casualty and modality. It has been well documented that traumatic injury rapidly activates the innate immune system and induces profound systemic hyper-inflammatory responses. These systemic inflammatory responses can cause severe collateral damage to the body by causing profound hemodynamic instability, tissue hypoxia, metabolic dysfunction, and organ failure. However, the mechanism leading to innate immune activation and organ failure after traumatic injury is unclear. microRNAs are a group of small and single-stranded non-coding RNAs. We have recently reported that cellular miRNAs are released from injured tissues during septic shock and cardiac hypoxic injury. In this project, we propose to test the specific role of circulating extracellular (ex) miRNAs in innate immune activation in a mouse model of poly-trauma.

The student will learn to perform the trauma model in mice, which include superior mesenteric artery (SMA) occlusion, tibia fracture, and muscle crash injury. Under supervision, the FAER student will measure multiple inflammatory markers such IL-1□, IL-6, TNF□, and tissue injury markers such as KIM-1 and Ngal. Finally, the student will examine the plasma level of a panel of miRNAs in sham and trauma animals.

Institution: **University of Maryland School of Medicine**

Mentor: Junfang Wu, BM, MS, Ph.D.,
Project(s) Available:
1) The Function and Mechanisms of Voltage-Gated Proton Channel Hv1 in Spinal Cord Injury (SCI) and traumatic brain injury (TBI)
2) Dementia Following Spinal Cord Injury: Mechanism and Therapeutic Targeting
3) Spinal Mechanisms Underlying SCI-Induced Pain: Implications for Targeted Therapy

Institution: **University of Maryland School of Medicine**

Mentor: Peter Hu, Ph.D.,
Project(s) Available: Our research is focused on developing machine learning based predictive algorithms for near and long-term patient outcomes based on the continuous analysis of vital signs from the field to in-hospital resuscitation to the intensive care unit bedside. Currently, we have over 10 extramural funded projects. We have developed and tested a Bleeding Risk Index (BRI) Monitor for a minute-by-minute analysis of continuous

photoplethysmograph (PPG) waveform. This monitor could be used for predicting future transfusion need in the field.

Institution: **University of Maryland School of Medicine**

Mentor: Konstantin Birukov, M.D., Ph.D.,
Project(s) Available: One of the current projects investigates pathologic effects of circulating extracellular histones that become released by damaged host cells into circulation upon traumatic or infections injury. Analysis of histone levels in the animal models of sepsis or traumatic injury as well as in plasma of patients with trauma, sepsis and possibly COVID-19 is a critical step in this study.

A student will be using ELISA method for analysis of histone levels in plasma and BAL samples obtained from mouse models of ARDS, sepsis and polytrauma, as well as in plasma of patients with sepsis and trauma. He/she will be also involved in collaborative project with the Bioengineering Department (UMCP) aimed at development and validation of a new biosensor device for express-analysis of plasma histone levels at point-of-care.

Institution: **University of Maryland School of Medicine**

Mentor: Megan Anders, M.D.,
Project(s) Available: Two available projects involve using electronic anesthesia record to screen for adverse events and analyzing how this compares to self-reported adverse events, and a project that uses electronic anesthesia record data to highlight some common observational study pitfalls. We also have a rich clinical dataset that can be queried for a project of specific interest to the student.

Institution: **University of Michigan Hospitals and Health Centers**

Mentor: Chad Brummett, MD

Project(s) Available: The Michigan Opioid Prescribing Engagement Network (Michigan OPEN, www.michigan-OPEN.org) was launched in 2016 to develop and disseminate best practice for opioid prescribing after acute care (surgery, dentistry, trauma, and emergency medicine). Michigan OPEN is a collaboration between the Departments of Anesthesiology and Surgery at the University of Michigan in collaboration with the Michigan Department of Health and Human Services, Blue Cross Blue Shield of Michigan and hospitals throughout the state. Using a robust data feed from all 72 major hospitals in Michigan, our team created surgery-specific post-discharge opioid prescribing recommendations for 25 common surgical procedures. These data have been used to reduce prescribing after common surgery for opioid naïve patients by ~70% throughout the state without changes in pain or satisfaction. The MSARF student fellowship would focus on the new work by Michigan OPEN to develop and disseminate best practice for patients using opioids and those with opioid use disorder (addiction) presenting for acute care. Our team has 7 full time analysts and access to several major administrative and prescribing datasets, as well as prospectively collected quantitative and qualitative data. The specific project will be based on the student interest and current activities in this rapidly moving space. If in person activities are allowable at the time of the fellowship, the student will be given outstanding clinical exposure across multiple domains of the Department of Anesthesiology. Given the multi-PI nature of Michigan OPEN, the student will get exposure to diverse mentorship from and exposure to researchers, research fellows, and junior faculty from diverse backgrounds, including anesthesiology, pain medicine, surgery, pediatrics, psychiatry, public health, dentistry, and engineering and psychology. The team also has a strong social mission and will offer opportunities for community service and engagement.

Institution: **University of Pittsburgh**

Mentor: Marsha Ritter Jones, M.D., Ph.D.
Project(s) Available: The role of neuronal-derived immune-related proteins on the neural-immune communication
Neural-immune communication is important in many inflammatory processes and chronic pain. While peptidergic sensory neurons, ones that release cgrp and substance P, have been demonstrated to play a role in this interaction, nonpeptidergic neurons have not been evaluated as extensively. Nonpeptidergic afferents penetrate to the most superficial layers of the epidermis, suggesting they play an important role in the innate response to pathogens. We have found that these neurons express mRNAs of some innate immune-related genes, i.e. S1008a.

To understand how nonpeptidergic neurons use these proteins to communicate with the immune and nervous systems, we have developed a transgenic mouse line in which the mice do not express some of these proteins. We will examine how the absence of these proteins affect skin and neuronal development, sensation and pain, both acute and chronic. We will also examine the immune response to peripheral injury. These studies will help elucidate the neural-immune relationship and potentially identify intervenable targets for pain management.

The student will perform immunohistochemistry staining and Image J analysis on neuronal and skin tissues from wildtype and transgenic mice. Student will also perform behavioral tests on mice such mechanical and temperature sensitivity in the presence and absence of inflammation. The student will participate in data collection and analysis, and ultimately develop an abstract and contribute to manuscript preparation.

Institution: **University of Pittsburgh**

Mentor: Bradley Taylor, Ph.D.
Project(s) Available:
1) Surgery Establishes an Opponent Process of Opioid Receptor Analgesia and Neuronal Pain Sensitization
This project tests a new conceptual model of the transition from acute to chronic pain, based on the delicate balance between latent pain sensitization (LS) and endogenous analgesia that develops after painful tissue injury. First, injury activates pain pathways. Second, the spinal cord establishes MOR constitutive activity (MORCA) as it attempts to control pain. Third, over time, the body becomes dependent on MORCA, which paradoxically sensitizes pain pathways. The manuscript underlying this working hypothesis was featured on the cover of the September 20, 2013 issue of Science. The summer project will study how stress or drugs modulate opposing inhibitory and excitatory influences on nociceptive processing in a mouse model of postoperative pain.

Hands-on participation in animal surgery and behavioral testing, immunohistochemistry, in situ hybridization, and data analysis. The student will produce a research abstract with data from the summer project that would fit into a larger manuscript. This type of student project should ultimately result in co-authorship on a peer reviewed publication.

2) Surgery Establishes an Opponent Process of Opioid Receptor Analgesia and Neuronal Pain Sensitization
This project tests a new conceptual model of the transition from acute to chronic pain, based on the delicate balance between latent pain sensitization (LS) and endogenous analgesia that develops after painful tissue injury. First, injury activates pain pathways. Second, the spinal cord establishes MOR constitutive activity (MORCA) as it attempts to control pain. Third, the subject rests within a pain-free period, although LS continues to render vulnerability to the transition to chronic post-operative pain. The summer project will study whether LS develops in humans after surgery.

The student will conduct Quantitative Sensory Testing, observe administration of drug infusions, and perform data analysis. The student will produce a research abstract with data from the summer project that would fit into

a larger manuscript. This type of student project should ultimately result in co-authorship on a peer reviewed publication.

Institution: University of Pittsburgh

Mentor: Keith Vogt, M.D., Ph.D.
Project(s) Available: Functional Imaging in Perioperative Neuroscience
We have several ongoing studies that utilize functional and structural neuroimaging techniques to better understand systems-level neuroscience of anesthetic action. Primary aims include determination of the neural markers for memory function, and how this is modulated by the combined experience of pain and anesthesia. Additional work to determine how the perioperative experience might influence delirium and postoperative cognitive function will use complementary techniques.

Students will primarily be performing analysis of structural and functional MRI datasets. Assistance with data acquisition (scanning human subjects) will be integrated, as scheduling allows. Some of these analyses are novel, and development of analysis techniques (rather than following a protocol) will require original intellectual input. Though the MSARF student would be closely mentored through the project, some experience with functional MRI analysis and comfort with computer programing (coding) will be required. Remote work on this project would be completely possible, should distancing guidelines require. The student will produce a research abstract with data from the summer project that would fit into a larger manuscript.

Institution: University of Pittsburgh

Mentor: Jonathan Waters, MD
Project(s) Available:
1) Modification of Shear Induced Hemolysis by Anesthetic Agents
The aim is to determine if red blood cell exposure to commonly used anesthetic agents will alter the cells' ability to withstand mechanical stress & shear forces. Subjects are non-pregnant adults, w/ no known hemoglobinopathy, coagulopathy, or anemia, and scheduled to receive general anesthesia. A blood sample (control) is collected from the IV line prior to the operation. After patient induction with propofol, another blood sample (experimental) will be obtained by venipuncture. A control sample will be used to perform ABO typing & measure total hemoglobin. 4 samples from will be tested w/ standard protocol to determine the mechanical fragility index. Comparisons will be made using 1-way analysis of variance. The student will help with patient consenting, blood drawing, inducing hemolysis utilizing a validated shear model, blood centrifugation, measurement of hemolysis through spectrophotometry.

2) Development of a Patient Blood Management Program
Blood transfusion occurs in 11% of hospitalized patients and is the most common hospital therapy. While transfusion can be life-saving, overuse of blood products has been identified by the AMA, the Joint Commission and the British National Health System as one of the most commonly overused therapies. Patient blood management (PBM) is a developing discipline aimed at optimizing a patient's hospital outcome and minimizing exposure to allogeneic blood products, using them only when the evidence best supports it. The UPMC patient blood management program is the leading program in the US. Since this program is pioneering, research questions arise constantly. These questions arise in how best to use computerized physician order entry systems; how to present data in order to influence transfusion decisions; how to structure electronic alerting systems; how to reduce waste in the healthcare system, etc. As such, there are multiple research questions which arise as the program develops. Trainees will help with a wide variety of projects (which may include database management, consenting patients, etc.) which change as the PBM program develops and evolves.

For both projects: The student will produce a research abstract with data from the summer project that would fit into a larger manuscript.

Institution: University of Pittsburgh

Mentor: Brian Williams, MD, MBA
Project(s) Available: Psychometric Evaluation of Patient Responses to MultiModal PeriNeural Analgesia (MMPNA)
Our group reported in vitro and in vivo safety of a 4-drug MMPNA drug combination comprised of preservative-free bupivacaine, buprenorphine, clonidine, and dexamethasone (BPV-BCD). To better characterize its analgesic potential, we completed a prospective clinical trial of patients undergoing knee or hip replacement, comparing BPV-BCD against plain BPV. Data were collected and analyzed include descriptive statistics addressing analgesic duration, rebound pain, and various physical therapy parameters. The mentor (Dr. Williams) possesses investigational new drug approval from the FDA for this 4-drug nerve block mixture.

The student will accompany the mentor on clinical activities in observing the MMPNA blocks that are being used for select prospective cases, and will observe some of the physical therapy processes for these patients after surgery. The student will be responsible for some prospective data review and verification, and mentored analysis of data (specifically, the SF-8 health status survey, the opioid-related Symptom Distress Scale, and the Quality of Recovery 15-item scale). The student will also work with Dr. Galen Switzer, Professor of Medicine, an expert in psychometric research. For more than 20 years, he has developed and evaluated clinical and psychosocial research measures and compiled validated measures for research projects across multiple contexts. Specifically for this project, Dr. Williams, Dr. Switzer, and the student will compare these surveys to assess validity, reliability, and responsiveness to change. The student will be introduced to new software (SPSS statistical software) and will produce a research abstract with data from the summer project that would fit into a larger manuscript. This type of student project should ultimately result in co-authorship on a peer reviewed publication.

Institution: University of Pittsburgh

Mentor: Grace Lim, M.D., M.S.
Project(s) Available: Quantitative and Qualitative Pain Phenotypes in Pregnant Women with Substance Use Disorder
Best practices for the treatment of pain in pregnant women with substance use disorder (SUD) are not well-established. Existing clinical guidelines for treatment of this population are limited by the lack of high-quality evidence on basic differences between women with and without SUD. The primary aims of this prospective, longitudinal, clinical observational trial is to: 1) enroll a cohort of prenatal and postpartum women with and without SUD; 2) quantify objective clinical assessments of pain by mechanical and thermal temporal summation as well as analgesia endpoints including pain ratings and opioid requirements; 3) collect patient-reported variables related to pain experience such as catastrophizing, resilience, expectations, and physical and affective dimensions of pain; 4) thoroughly assess qualitative characteristics around the pain experience in prenatal and postpartum periods using semi-structured interview across the peripartum spectrum. The results of these investigations will shed light on key differences in obstetric pain and analgesia between women with and without SUD, thereby supporting future discovery of effective treatments tailored to the needs of this under-represented population.

The student may learn skills in: pain score modeling; data abstraction; qualitative research; quantitative research; clinical research using health record information; abstract and manuscript development and submission.

Institution: **University of Rochester**

Mentor: Andrew Wojtovich, Ph.D.

Project(s) Available: Optogenetic control of mitochondrial reactive oxygen species - Reactive oxygen species (ROS) contribute to cellular damage in many pathologic processes, such as stroke. Mitochondria are a main site of ROS production and are central mediators of cell death. However, global antioxidant supplementation had little effect in clinical trials for diseases associated with increased oxidative damage. These clinical trials may have failed since mild levels of ROS are required to maintain cellular homeostasis. Moreover, ROS are emerging as signaling molecules that are required for the efficacy of several types of protective interventions. Thus, like many other physiological challenges, specific details such as dose, timing, and local environment contribute to ROS outcomes.

Oxidative damage is a major contributor to many diseases. However, in some situations reactive oxygen species (ROS) can help to protect the cell. We will take an optogenetic approach and utilize novel proteins that can generate ROS in response to light to determine what factors make some ROS beneficial and other ROS toxic. These new tools will be expressed as protein fusions using CRISPR/Cas9 technology with genes that encode known sites of ROS production. Using the genetic model organism C. elegans will further allow us to integrate our results with conserved stress response pathways and determine the role of ROS signaling in the context of neuronal ischemic sensitivity. This approach could potentially yield new therapeutic strategies for diseases in which ROS homeostasis has been disrupted.

The student would be involved in C. elegans and cell culture, designing of experiments and collection of data. In addition, the student will learn how to isolate mitochondria and measure mitochondrial function. The student will be expected to keep accurate lab records and present at lab meetings.

Institution: **University of Utah**

Mentor: Markus Amann, PhD

Project(s) Available: This research in patients with heart failure with preserved ejection fraction (HFpEF) will provide new information on the mechanisms determining the patients' exercise intolerance and the efficacy of regular physical activity to improve this shortcoming by alleviating the patients' neurocirculatory abnormalities. Specifically, we will focus on the role of nerves originating in working limb muscles in determining the patients' exercise intolerance and compromised fatigue resistance before and after a chronic exercise intervention. By focusing on a specific mechanism, this project will evaluate the validity of exercise as an alternative treatment strategy with the overall purpose of improving the quality of life of veterans with HFpEF. Opportunities for study design, data collection, and dissemination.

Institution: **University of Utah**

Mentor: Ken Johnson, MD

Project(s) Available:

1) Genetic And Inflammatory Biomarkers In Neuropathic Symptoms Secondary To Chemotherapy (Genie-B)
The specific aim is to perform genome-wide, epigenome-wide, miRNome-wide, and metabolome-wide analyses to identify novel biomarkers predictive of neuropathic symptoms in patients receiving taxane treatment. In this study blood samples will be collected for unbiased assessment of the genome, epigenome, miRNome, and metabolome associated with pain before, during, and after taxane treatment as measured by CIPN20, PCS, and PROMIS scores. This study has been funded by the NIH and is in collaboration with Cleveland Clinic. Opportunities for study design, data collection, and dissemination.

2) Anesthesia Perioperative Analytics at the U of U Covered Entity
Our department has an IRB umbrella to allow internal approval and electronic medical record data pull for retrospective research. This allows members of the department of anesthesiology who have completed IRB training requirements to quickly perform these types of studies without submitting full applications to the IRB. Data collected as standard of care may be reviewed.

3) Pain and inflammation biomarker signatures before and after total joint replacement: A look at opioid consumption.
The specific aims of this project are to determine the profile of differential mRNA expression, and plasma concentrations of selected proteins in pain, metabolism, and neuroinflammatory pathways, determine the profile of gene variants of selected proteins in pain, metabolism, and neuroinflammatory pathways., and explore the relationship between phenotype markers associated with physical function, pain interference, anxiety, depression, and pain catastrophizing with measures of gene variants, differential mRNA expression, and circulating concentrations of proteins involved in pain, metabolism, and neuroinflammatory pathways. Opportunities for involvement include data collection and analysis, abstract, grant and manuscript writing/authorship.

Institution: **University of Utah**

Mentor: Kai Kuck, PhD

Project(s) Available:

1) Measurement of Renal Blood Flow
There is a 30% incidence of Acute kidney injury (AKI) after cardiac surgery. AKI may be reduced by tailoring intra-operative hemodynamics to maintain renal perfusion and prevent renal ischemia. Currently there is no monitor of renal perfusion or renal ischemia available to guide kidney-protective hemodynamic management. Medullary ischemia is one of the important mechanisms of AKI. Urine oxygen tension (pUO2) correlates well with medullary oxygen tension and renal blood flow, but is more easily accessible. We intend to develop and test a continuous monitor of urinary bladder pUO2 and create a pUO2 based goal-oriented

hemodynamic management protocol. In this proposal, a fiber optic or hydrogel based pUO2 probe will be integrated into the tip of a urinary catheter. Continuous pUO2 measurements can then be used to guide therapy and hemodynamic management in the operating room and the intensive care unit. Opportunities for study design, data collection, and dissemination.

2) Google Cardboard
We have developed a virtual reality game platform for pediatric anesthesia that provides a deeply immersive distraction. It is based on inexpensive, disposable hardware. The patient controls the game through breathing. The game incentivizes the patient to breathe in a way that promotes pre-oxygenation and deep inhalation of volatile anesthetic agent for induction. We propose to create a functional prototype and compare it in a clinical study to midazolam pre-medication. Opportunities for study design, data collection, and dissemination.

3) Advanced Video Laryngoscope
Laryngoscopes have hardly changed in the past 75 years. Video laryngoscopes have much more potential than what they deliver today, including the ability to detect anatomical features and the ability detect number of intubation attempts. The investigators are building a video database of intubation recordings and developing machine learning algorithm for video laryngoscopes. They need help classifying intubation videos, developing a survey, and provision of input for algorithm development. Opportunities for study design, data collection, and dissemination.

Institution: **University of Utah**

Mentor: Akiko Okifuji, PhD
Project(s) Available: OPIOID-INDUCED HYPOGONADISM IN WOMEN TAKING OPIOIDS FOR CHRONIC PAIN: IMPACT ON BONE HEALTH AND DEPRESSION [Women's Health & Pain Study]

The project has two aims:
1) Evaluate hypogonadism in women taking opioids for chronic pain: Hypothesis: women taking opioids for their chronic pain will exhibit significantly lower levels of female sex hormones (estradiol, progesterone) than women with chronic pain who are not taking opioids
2) Evaluate the link between OIHg and bone and mental health. Hypothesis: Women taking opioids for their chronic pain will show lower BMD and higher depression than women with chronic pain who are not taking opioids. There will be relationships between estradiol level and BMD and between estradiol and depression in those taking opioids.

A student will participate in data collection, analyses, and writing reports (conference abstract and manuscript) under the direct supervision of the mentor.

Institution: **University of Utah**

Mentor: Jeffery Woodbury, PhD
Project(s) Available: Real-time imaging of skeletal muscle innervating sensory neurons that signal pain and fatigue
Project Topic Description (brief background)
Muscle pain and fatigue affect nearly all people at some point in their lives costing over 800 billion dollars each year in medical costs. At present, effective treatments for short term muscle pain are clearly inadequate and adequate treatment for chronic pain is even worse. This project uses state of the art imaging in transgenic mice to determine the fundamental mechanisms that signal intense muscle pain, ache, and fatigue so that rational treatments can be developed.

Small diameter afferents comprise the vast majority of muscle sensory innervation and are hypothesized to convey the senses of muscle fatigue and pain, to match blood flow with muscle activity, and ultimately to protect

against energy depletion and potential tissue damage from overuse. There is increasing evidence that signaling by these afferents becomes deranged across many disease states affecting a large swath of the population and causes or contributes to chronic excessive fatigue, exercise intolerance, dyspnea, and intractable musculoskeletal pain. Our long-term goal is to determine the fundamental cellular and molecular mechanisms that signal muscle pain and fatigue to sensory, autonomic, respiratory, and motor systems. The specific aims to be addressed are: 1) define the different types of mechano-sensitive and metabolite-sensitive sensory neurons innervating skeletal muscle based on their responses to muscle contraction during fatiguing trials; 2) determine if metabolites and other chemical mediators produced during muscle contraction are responsible for the potentiation observed across a large subset of mechanosensitive muscle sensory neurons during muscle contraction; 3) determine if metaboreceptors and metabo-nociceptors also respond to mechanical forces generated during muscle contraction; and 4) determine the location and structure of skeletal muscle sensory neurons signaling pain and fatigue via direct imaging of neuron terminals in muscle.

The medical student may participate in all phases of experimentation including: literature updates, participation in laboratory protocol development and group meetings, mouse anesthesia, surgery, and imaging in vivo, data analysis, manuscript preparation, and presentation.

Institution: **University of Utah**

Mentor: Lara Brewer, PhD
Project(s) Available: Prompting Post-Op Patient to Breathe
The investigators are evaluating a "robonurse" device to keep patients safe. Opportunities for involvement include gaining clinical study experience, performing data analysis, and writing abstracts, manuscripts, and grants.

Institution: **University of Utah**

Mentor: John Pearson, MD
Project(s) Available:
1) Air Pollution & Peri-op Outcomes
The Wasatch Front suffers from seasonal pollution events due to cold weather and our valley setting, resulting in episodes of "inversions" whereby the local region obtains some of the worst air quality globally, especially in regards to fine particulates. These types of pollutants have been tied to adverse cardiopulmonary outcomes in populations across the globe, yet few studies to date have examined the impact of such pollutants on perioperative outcomes (periop Myocardial Infarction rates for instance). The purpose of this study will be for students to assist with the collection, collation, and analysis of locally available peri-op outcomes data from the MPOG database, as well as coordinate the collection and analysis of locally obtained air pollution data from County, State and National sources, in order to assess whether any relationship exists between local air pollution events and adverse cardiopulmonary outcomes.

2) Digital Health Apps for Clinical Decision Support (CDS): Local and Global
Access to point of care clinical decision support is critical for patient safety. Often, clinical staff is assigned to an unfamiliar location with unfamiliar patient pathophysiology and different instruments and machinery. To reduce the risks to patient safety, the department has developed a variety of guidelines and best practices that we make available through our internal website at the University of Utah. However, this repository is not easily nor is it frequently accessed. To facilitate access to this CDS system, we are now actively converting various clinical guides to web-based "apps" that are available via one-click from any smartphone. This project has developed apps for both ROTEM interpretation and is in process with our OB anesthesia guide. This project would involve students assisting the department in identifying high priority clinical guidelines for conversion to apps, assisting in the conversion process, and then adding relevant evidence-based support to the app version of guidelines and decision aids. Assignments can include literature searches, manual conversion of app content to web-based

formats (coding skills not required), working with international partners to generate apps for their use, and analyzing utility of apps in place at clinical sites.

Both projects have a high likelihood in resulting in abstract presentations or publications.

Institution: **University of Utah**

Mentor: Dorothea Rosenberger, MD
Project(s) Available: Phenotype for increased risk of hemorrhage in ECMO, LVAD/RVAD and septic patients
The purpose of the study is to determine risk factors and phenotype (observable individual characteristics) for excessive bleeding (hemorrhage) in patients dependent on and supported with cardiac assist devices. We believe that whole blood protein levels identify a phenotype for increased risk of hemorrhage in cardiac assist device and septic patients compared with heart failure patients (no surgical procedure) and healthy volunteers. In this study will are enrolling healthy volunteers, patients with ECMO and/or assist cardiac devices (cardiothoracic, neurosurgical patients, surgical) and septic patients in the ICU, and patients with and without cardiac assist devices scheduled for their routine assessment and lab work per physician's recommendation. Opportunities for study design, data collection, and dissemination.

Institution: **University of Utah**

Mentor: Norman Taylor, MD
Project(s) Available: Utah Neurobiology of Pain Lab
Chronic pain has a profound cumulative impact on our nation, affecting over 100 million Americans a day, at a cost of $500 billion in health care and lost productivity each year. Pain is a complex, subjective experience that displays considerable variability compared to other sensory modalities. For instance, in some people intense noxious stimuli are not reported as painful, whereas others can experience excruciating pain from light touching of the skin. Some people are highly sensitive to pain relief from placebo administration, while others are insensitive to even high doses of morphine. Following nerve injury, only a small proportion of people go on to develop neuropathic pain. Our research is focused on uncovering and explaining the sources of variability in these phenomena. Opportunities for study design, data collection, and dissemination.

Institution: **University of Utah**

Mentor: Talmage Egan, MD
Project(s) Available: A study to investigate the relationship between BIS™ and inhaled anesthetics across a wide range of anesthetic concentration and hypnotic states, and to provide evidence to support BIS™ performance in use with Isoflurane, Sevoflurane and Desflurane in combination with opioids will be performed in 2021. A student would have the opportunity to collect data and assist with manuscript preparation.

Institution: **University of Vermont Medical Center**

Mentor: Melissa Davidson, M.D.
Project(s) Available: Self Determination Theory is a theory of human motivation addressing 3 universal, innate psychological needs (competence, autonomy, relatedness), which must be met in order for individuals to become more self-determined and intrinsically motivated. A multitude of SDT studies have been conducted in a variety of educational and health settings, including undergraduate and graduate medical education. Anesthesiology residents often complain they are not afforded enough autonomy during training, which according to SDT potentially thwarts their intrinsic motivation to learn. This study will compare resident and faculty perceptions of resident autonomy in one specific training activity (preoperative planning) using the UVM Medical Center Department of Anesthesiology as a pilot prior to national survey. A validated SDT tool will be adapted for use and distributed to UVMMC faculty and residents. Data analysis and focus group meetings will be used to revise the survey for implementation nationally.

The student will work with principal investigator to adapt a validated tool for use in this study, which will include conducting focus groups with UVM Anesthesiology residents and faculty to elicit their impressions of and feelings about resident autonomy in preoperative anesthesia planning. The student will be responsible for distribution of the survey, data collection and analysis, and survey revision as needed. The student will also prepare the survey for national distribution, which may include assisting the PI in securing permission for survey distribution from relevant Anesthesiology organizations and/or identifying Anesthesiology Residency Programs' point persons. If time permits, the student may be involved in national distribution of the survey.

Institution: **University of Vermont Medical Center**

Mentor: Mitchell Tsai, M.D., M.M.M.
Project(s) Available: Given the extent of research on OR management in the literature, it is surprising that there is little agreement across institutions on how to apply basic OR management metrics. For example, with trauma surgery services, managers may find it difficult to rationalize capacity-based services with traditional OR metrics: Higher utilization rates may decrease the capacity of the service, while allocating large blocks of OR time may need lead to poor utilization rates. The objective measurements, in essence, are conflicting. A Pareto optimal posits that none of the objective measurements can be improved without degrading another. By applying Pareto charts to OR management, this project will aim to demonstrate that the "optimum" for a surgical services within an institution and across multiple health care systems. This goal is very different from traditional OR management, which attempts to find a single solution that satisfies the subjective preferences of a human decision maker under the pretense of objective data (aka benchmarking). The student will have the opportunity to explore operational and tactical issues directly affecting patient care and learn to understand the barriers and mechanisms to create change. The student will use a variety of resources to gather information, incorporate changes, and track outcomes, including database extraction tools and explore the limitations of machine learning.

Institution: **University of Vermont Medical Center**

Mentor: Gabe Tharp, M.D., Ph.D.
Project(s) Available: Mechanisms of postoperative pulmonary complication (PPC) are not well defined. The current incidence of PPC is approximately 5% of all surgical cases. These complications range from mild respiratory failure to death. Patients at particularly high risk for PPC include those having laparoscopic abdominal surgery and the obese. This study is designed to measure markers of lung inflammation before and after robotic-assisted laparoscopic surgery in conjunction with state-of-the-art lung mechanics measurements. We hypothesize that subjects with impaired intraoperative lung mechanics will show elevated markers of lung injury following robotic-assisted laparoscopic abdominal surgery. We also hypothesize that obese patients will demonstrate more evidence of lung injury under these conditions. The results of this study will help us both understand novel mechanisms of PPC and also begin to design therapies to prevent PPC. The student will assist the principal investigator and co-investigators in the conduct of this prospective, observational study. The student will act as a

member of the research team, including identifying and recruiting patients, assisting with data recording and sample gathering in the OR, and also with sample processing and storage. The student will have the opportunity to participate in data analysis.

Institution: **University of Wisconsin**

Mentor: Karin Zuegge, MD
Project(s) Available: Sustainability Medical Student Project
Pollution prevention is the new patient safety movement. Climate change is going to be one of the biggest concerns for public health in the 21st century. (UW population health institute: https://www.countyhealthrankings.org/explore-health-rankings/measures-data-sources/2019-measures)

How does health care contribute to climate change?
The health care sector is the largest contributor to carbon emissions in the United States after the food service industry. Having a more accurate picture of the carbon footprint of an organization and where the emissions stem from can help identify areas of improvement and potentially drive policy for change. (https://jamanetwork.com/journals/jama/fullarticle/184856)

The sustainability program has data on waste and energy usage across the organization. Compiling this data into a comprehensive report describing the emissions profile of UW Health as a whole would be the main goal of this project. Another aspect of this project could be to seek data where it does not exist in the form of, e.g. waste audits.

Sustainability program website: https://www.uwhealth.org/sustainable-conservation-healthy-environment/green-steps/40629
Literature collection: http://anesthesia.wisc.edu/index.php?title=Green

Institution: **University of Wisconsin**

Mentor: Misha Perouansky, MD
Project(s) Available: Anesthetic Effects on Mortality in a Drosophila Model of Polytrauma:
An ongoing collaboration between Misha Perouansky, MD (Dept. of Anesthesiology), and David Wassarman, PhD (Department of Genetics), investigates the effect of general anesthetics on the outcome of traumatic brain injury in a fruit fly model. Part of the project is oriented towards testing flies of various genetic backgrounds. In order to be able to compare anesthetic sensitivity between genetically different fly strains, we are developing robust behavioral measures of anesthetic depth.

The student will test one or more strains of flies with respect to one or more behavioral measures. Testing of one strain with one drug can be accomplished within two to three weeks. In addition to conducting experiments, analyzing and graphically presenting the results, the student will be encouraged to familiarize her/himself with literature pertinent to models of anesthetic mechanisms, models of traumatic brain injury, non-canonical actions of anesthetic agents and with the potential of flies as genetically accessible models of human disease.

Institution: **University of Wisconsin**

Mentor: Matthew Banks, PhD
Project(s) Available: Mechanisms of loss of consciousness under anesthesia (basic)
Ongoing research in our lab seeks to understand the neural mechanisms of changes in consciousness observed under anesthesia, sleep, and delirium. We record electrophysiological signals from neocortical electrodes in human subjects and in mouse models, and relate changes in neuronal activity and connectivity to changes in arousal state.

Opportunities are available for the student to be involved in either mouse electrophysiological and pharmacological experiments, or human intracranial electrophysiological experiments. For the mouse project, this includes surgical implants of cortical electrode arrays, postoperative care of the animals, electrophysiological

recordings, and data analysis. For the human subject project, the student role will focus primarily on data analysis. Data analysis for both projects can be done remotely.

Institution: **University of Wisconsin**

Mentor: Robert Pearce, MD, PhD

Project(s) Available: We are interested in understanding how anesthetics prevent memories from being formed, and more generally how the brain regulates memory formation. We focus on the hippocampus, which is known to be important for episodic memory, and on the GABAergic inhibitory circuitry. Experiments are performed using genetically modified mice that lack anesthetic targets in specific types of interneurons or have anesthetic-insensitive receptor subtypes. Memory formation and recall is measured using behavioral tasks and optical recordings from awake behaving mice and mice administered anesthetic agents. The student will be involved in one or both aspects of these studies, depending on the timing of the student's availability and status of the ongoing experiments.

Institution: **Vanderbilt University Medical Center Program**

Mentor: Matthias Riess, MD, PhD, FASA
Project(s) Available: Various compounds and drugs frequently used in the Operating Room have been shown to attenuate myocardial infarction from ischemia/reperfusion injury, while others have antagonizing, or even detrimental, effects. Altered mitochondrial function plays a key role in many of the associated signaling pathways. Numerous comorbidities and chronic medications for their treatment modify these effects further. In several different cell culture and animal models, our laboratory focuses on translationally relevant projects to improve survival following myocardial infarction, stroke and/or cardiac arrest.

Student/s will be fully integrated and actively participate in current research projects including in- and ex-vivo models of myocardial and/or cerebral ischemia/reperfusion, tissue and cell preparation for molecular and biochemical analyses, and/or specific mitochondrial assays. Student/s will work with team members such as research technologists, graduate students, fellows, and junior faculty on a daily basis. Student/s will acquire all necessary technical skills for the summer project, and will be mentored on data collection and analysis, as well as scientific writing. Subsequent local and national poster presentations are encouraged. This focused basic science experience will be complemented by frequent opportunities to shadow anesthesiologists in different clinical environments and simulation, and to network at a first-class academic institution.

Institution: **Vanderbilt University Medical Center Program**

Mentor: Julia Bohannon, BS, PhD
Project(s) Available: Enhancing Resistance to Infection after Burn Injury with Toll-like Receptor Agonists
Severely burned patients often acquire deadly opportunistic infections due to the loss of the protective skin barrier, and significant injury-induced immune alterations that prevent proper response for effective pathogen clearance. We have demonstrated that Toll-like receptor (TLR) agonists can prime the immune response in burn-injured animals, leading to enhanced antimicrobial responses and resistance to several clinically relevant pathogens; however, the underlying mechanisms which drive host resistance to infection are unknown. This project aims to examine gene expression changes that occur after burn injury and post-burn infection in mouse and human leukocytes. RNA will be isolated from leukocytes and RNA-seq analysis will be used to examine the effect of burn and infection on the expression of key genes involved in metabolism and antimicrobial responses. Further bioinformatics analyses, which can be performed remotely, will be performed. These studies will be conducted in both mouse circulating monocytes and splenic macrophages before and after severe burn injury and after post-burn infection. In parallel, such analyses will be performed on circulating monocytes from healthy volunteers and severely burned patients from the VUMC burn unit. Additional studies will examine the impact of various immunomodulatory treatments on gene expression in mouse and human leukocytes. All mRNA samples will be acquired and submitted for RNAseq by a postdoctoral fellow in the lab. The FAER student will be provided with access to online tutorials for RNAseq analysis. After training, the student will conduct the analyses of differentially expressed genes and will make comparisons among the groups, including burn, infection, burn with infection, and immunomodulatory treatments. All analyses will be performed under the guidance of the team through weekly virtual meetings. These studies will provide an important building block for understanding the effect of burn injury, burn-associated infection, and immunomodulation after burn on cellular metabolic and antimicrobial processes.

Institution: **Vanderbilt University Medical Center Program**

Mentor: Frederic Billings, MD, MSCI
Project(s) Available: Perioperative Organ Injury
We have several well-phenotyped cohorts in which we measure association between factors of interest and assess mechanisms of organ injury. These cohorts include the Statin AKI Cardiac Surgery RCT (JAMA, 2016), the Risk of Oxygen during Cardiac Surgery (ROCS) trial (TRIALS, 2017) and the outcomes database, an observational cohort study of all cardiac surgery patients since November 2009 (n=15,000). In these cohorts we are assessing

candidate mechanisms of organ injury including oxygen toxicity, oxidative damage, hemeprotein-mediated injury (cell free hemoglobin), and inflammation and comparing markers of these pathways to incidence and severity of organ injury including AKI, delirium, myocardial injury, postoperative atrial fibrillation, and lung injury.

We will develop informatics tools to measure organ injury and associated factors in our patient population. To do this we will examine results of VAPIR IT queries and cross reference these results with the medical records of select groups of patients. As we validate additional variables, we will build a query that will allow us to know rates of different organ injuries across our patient population and in different groups of patients, and we will be able to measure the associations of different preoperative, intraoperative, and postoperative factors with organ injury.

Research a specific organ injury, relative to cardiac surgery by reviewing the literature and discussing with the mentor. Measure the rates of that organ injury in our patient population by validating informatics queries designed to identify said organ injury. This will require examining data in a systematic fashion and cross-referencing data with patient charts. This is not a random process. A systematic approach will be taught that is efficient and productive.

Scholars will examine the independent association between a risk factor of interest and his or her organ injury of interest and will learn how to design and execute a multivariable regression model. Scholars will write an abstract that describes the rates of the organ injury in our patient population and the independent association or lack thereof of the candidate risk factor and the organ injury. This abstract will be submitted to a national meeting. Depending on the success of the project and the interest of the scholar the project may be written up as a manuscript and published in the peer-reviewed literature.

Institution: **Washington University**

Mentor: Ben Palanca, M.D., Ph.D., M.Sc.
Project(s) Available:
1) Inpatient Preoperative Sleep Quality in Cardiac Surgical Patients. Sleep satisfies a fundamental need for health. Postoperative sleep quality is often poor with unclear implications for surgical recovery. The trainee will become an integral member an R01-funded investigation on the relationships between postoperative delirium and EEG markers of sleep and wakefulness. (S)he will be involved in patient recruitment, data acquisition, and analyses of the EEG markers. The student will also have direct interactions with sleep technologists and sleep medicine physicians. If needed, the trainee can analyze electroencephalographic data using remote desktop software.

2) EEG Markers Associated with Anesthetic-Induced Unconsciousness. EEG changes accompany the transition from wakefulness to the unconscious states induced during general anesthesia. Many of these markers that arise during these states of unconsciousness resemble those of non-rapid eye movement (NREM) sleep. The student will have the opportunity to work with sleep technologists and engineers to evaluate EEG markers recorded during general anesthesia. If needed, the trainee can analyze electroencephalographic data using remote desktop software.

3) EEG Markers During the Recovery from Electroconvulsive Therapy (ECT). ECT is an effective therapy for depression but requires the induction of generalized seizures through the electrical stimulation of the scalp. EEG is typically employed to evaluate the initiation and cessation of seizure activity. A trainee with an analytical background will analyze EEG recorded during the recovery from ECT. The student will learn fundamentals of ECT and quantitative EEG analysis through custom-written MATLAB software. S(he) will have direct interactions with collaborating epileptologists and psychiatrists. Remote data analyses opportunities exist.

4) Functional and Structural Magnetic Resonance Imaging (MRI) Markers Associated with Postoperative Delirium. Delirium after surgery is associated with poor clinical, functional, and cognitive outcomes. The neural substrates contributing to delirium remain unclear. Thirty-nine cardiac surgical patients underwent perioperative MRI and serial delirium assessments. A student with a prior background in MRI will evaluate relationships among diffusion tensor imaging and resting-state functional connectivity measures in these patients. Students will have the opportunity to contribute to data analysis remotely, if needed.

Institution: **Washington University**

Mentor: Michael Avidan, MBBCh, FCASA
Project(s) Available: Telemedicine Control Tower for the Operating Room: Navigating Informatics, Care and Safety (TECTONICS) R01 NR017916-01A1
Perioperative morbidity and mortality is a public health priority. With the annual increase of surgical cases, there is a need for research into the potential utility of a telemedicine-based control center for the operating room to assess risk, diagnose negative patient trajectories, implement evidence-based practices, and improve outcomes.

The student's primary role will be to participate in the Anesthesiology Control Tower together with an attending anesthesiologist and a resident anesthesiologist. In this role, the student will learn about perioperative telemedicine, machine learning, randomized clinical research, and the clinical practice of anesthesia. The student will have a specific project related to determining if the Anesthesiology Control Tower can improve, through structured communications with anesthesiologists, fellows, residents and CRNAs, perioperative quality of care metrics including temperature, antibiotic re-dosing, mean arterial pressure, mean airway pressure with mechanical ventilation, blood glucose, anesthetic concentration, and efficient fresh gas flow.
This project has been ongoing for over five years and is continuously gaining momentum. Its feasibility is demonstrated by this successful track-record, and by funding from NSF, AHRQ and the Washington University Faculty Practice Plan. Participation in TECTONICS is an exciting opportunity for a medical student to participate in

a unique perioperative telemedicine experiment. Through their participation, they will gain insights into technological advances in healthcare and the modern practice of anesthesiology

Institution: **Washington University**

Mentor: Michael Montana, MD, PhD
Project(s) Available: Bilateral Pectoralis Nerve Block for Postoperative Pain Management in Pediatric Patients undergoing Cardiac Surgery - This project will be a double-blinded prospective pilot study of pectoralis nerve blocks for the treatment of postoperative pain in pediatric patients undergoing elective surgeries that require median sternotomy. The inclusion ages are 2-18 year olds and there is a target enrollment of 50 patients, 25 in each arm (placebo vs. treatment). Regional anesthesia for median sternotomy is understudied in general, and in pediatric patients specifically. Furthermore, many pediatric patients with congenital heart disease undergo multiple staged surgeries early in life, and are exposed repeatedly to sedatives and opioids. Given the risks of sedative habituation, tolerance, and withdrawal in children administered opioids, alternative approaches for analgesia are needed. The pediatric cardiac surgery group at our institution has enthusiasm for this project. A medical student team member would receive an opportunity for learning, and to be a primary team member (with appropriate mentorship) in multiple critical arenas, including IRB protocol drafting and submission, trial design, implementation of clinical studies/trials, collection of clinical research data, multimodal analgesia, cardiac anesthesia, cardiac surgery, and statistical analysis. Additionally Virtual learning opportunities are available including chart review for this study or other similar studies.

Institution: **Washington University**

Mentor: Joanna Abraham, PhD
Project(s) Available: Postsurgical transitions of care
Poor discharge care transitions of surgical patients are recognized as a common cause for emergency and hospital readmissions. Readmissions after surgery reflect a multitude of complications, some of which develop before the patient even leaves the hospital, and are linked to major morbidity, costs, and death. Postsurgical discharge transition failures are mostly related to information sharing and communication breakdowns among care team, poor patient education and communication about postsurgical recovery and discharge instructions.
We are planning to conduct a two-part study: (1) Observational study to understand the postsurgical discharge care transition process, its breakdowns, factors contributing to these breakdowns, and its impact on readmissions. (2) Retrospective study to develop a machine learning algorithm to identify and predict (at the time of discharge) surgical patients at high risk of readmission using pre- and intraoperative data. This is a collaborative study involving team members from anesthesiology, surgery, computer science and informatics.

The medical student will assist with the research tasks and also gain skills in the following:
• Data collection (shadowing, interviews, focus groups) and data analysis using mixed-methods
• EHR data processing and modeling

Institution: **Washington University**

Mentor: Brian Fuller, MD, MSCI, FCCM
Project(s) Available:
1) COVID-SED Study. This is a retrospective observational cohort study that aims to assess the impact of sedation practices on outcome in the era of COVID19. Specifically, we hypothesize that deep sedation and neuromuscular blockade are employed with increased frequency, and contributed negatively to clinical outcome. Student role: data collection and entry into REDCap. Can be done completely virtual.

2) Prehospital mechanical ventilation and sedation practices. This is a cohort study examining a very large dataset of mechanically ventilated patients transported by helicopter in the prehospital domain. This work extends our ED-based research into improving outcomes for mechanically ventilated patients, by studying these patients at the earliest point in the chain of survival. This study will describe how mechanical ventilation and sedation is

employed in the prehospital domain, identifying processes for quality improvement and hypothesis-generation for future studies. Student role: cleaning, managing, and getting the database ready for biostatistical analysis. This dataset will contain data from 50-70 thousand patients, so this data management will be mission critical to success. Can be done completely virtual.

3) The ED-SED Pilot Trial. This is a NIH-funded clinical trial examining the feasibility of implementing targeted sedation in the ED for mechanically ventilated patients. We will be in the after/implementation phase of the trial in the summer. Student role: data collection and entry into REDCap, which can be done completely virtual. As COVID allows, student would also interview patients for potential awareness with paralysis events.

Institution: **Washington University**

Mentor: Wayland Cheng, MD, PhD
Project(s) Available:
1) Lipid modulation of pentameric ligand-gated ion channels (pLGICs). pLGICs such as the GABA(A) receptor are key targets of anesthetics and also strongly modulated by endogenous bioactive lipids. This project seeks to understand the structural and biophysical mechanisms by which lipids modulate pLGIC function, which may provide novel mechanisms of modulation to facilitate drug design. One facet of this project, that is not currently being explored in the lab, is to investigate the role of phospholipid tail length on pLGIC structure and function. Lipid bilayer thickness, determined by phospholipid tail length, varies throughout the cell membrane, and may be an important mechanism by which pLGIC channels are activated or silenced in different cellular domains. The student would utilize a stopped-flow fluorescence assay to define the effect of phospholipid tail length on pLGIC function. Then the student will use a brominated lipid fluorescence quenching assay to examine binding affinity of phospholipids to a specific site in the channel. The results will test whether short-chained phospholipids modulate pLGIC function by occupying a specific binding site.

2) Neurosteroid activation of the TPRM3 channel. TRPM3 is a temperature-sensitive TRP channel that is a key mediator of sensitivity to noxious heat and inflammatory pain. TPRM3 is specifically activated by the neurosteroid, pregnenolone sulfate (PS). Specific antagonists of TRPM3 could be useful analgesics. The structure of TPRM3 and the mechanism by which PS activates TRPM3 is unknown. This project seeks to address this knowledge gap by determining high resolution structures of TRPM3 in lipid nanodiscs with and without agonists such as PS by cryo-electron microscopy. In addition, photo-affinity labeling will be used to map PS binding sites in TRPM3. The student would support a senior scientist and postdoc who are working on this project.

Institution: **Washington University**

Mentor: Anne Drewry, MD, MSCI
Project(s) Available: Available Project
Approximately 20 percent of septic patients present with hypothermia, rather than fever, at the onset of infection. These patients have twice the mortality of non-hypothermic patients, but there is limited data as to why these patients have worse outcomes. The objective of this group's research is to determine whether critically ill septic patients who present with hypothermia exhibit impaired immunity which prevents pathogen clearance and increases susceptibility to opportunistic infections. We expect that our results will provide significant insight into the timing and pathogenesis of sepsis induced-immunosuppression.

We are performing a prospective clinical study to examine the immunological phenotypes of critically ill septic patients who present with and without hypothermia and to determine whether hypothermic septic patients have increased susceptibility to opportunistic infections and reactivation of latent viruses.

We identify critically ill septic patients who present with and without hypothermia and measure cell surface receptor expression and cytokine secretion serially throughout the septic course.

We also monitor the patients for acquisition of opportunistic infections and measure serial blood levels of commonly reactivated viruses.

The student involved in this project would assist with the following.

- Screen the patient censuses of the medical and surgical ICUs to identify appropriate patients for inclusion.
- Approach patients and families to obtain consent for participation.
- Assist with data collection from the electronic medical record and enter data into an online data management system.
- Opportunity to observe and/or participate in performing cytokine secretion assays in the research laboratory.

Institution: **Washington University**

Mentor: Simon Haroutounian, BSc.Pharm, MSc.Pharm, PhD
Project(s) Available: Cognitive flexibility as a modifiable risk factor for pain
Cognitive control of pain is an important contributor to human pain experience, and can provide avenues for targeted non-pharmacological approaches for preventing and managing pain. We are currently completing a clinical trial aimed at assessing the effects of specialized neurocognitive training, to improve cognitive flexibility in patients with chronic pain. We use neurocognitive testing, comprehensive pain assessment, as well as neuroimaging to understand the effect of neurocognitive training on pain, and the potential neural mechanisms that mediate possible pain-relieving effects.

Under the guidance of the PI and a post-doctoral fellow (Holzer), the student will have an opportunity to understand clinical trial design, obtain experience in reviewing, cleaning, and analyzing complex multi-source data, as well as contribute to the preparation of a poster and/or a scientific manuscript.
Since data collection is expected to be completed prior to March 2021, there will be a possibility of a fully remote fellowship, should the COVID-19 pandemic necessitate that.

Characterization of risk factors and time-course of oxaliplatin-induced peripheral neuropathy
Oxaliplatin is a first-line chemotherapy agent for colorectal cancer. Despite its antitumor efficacy, it causes painful peripheral neuropathy in about 20% of patients receiving oxaliplatin-based chemotherapy regimens. We are currently completing a clinical trial aiming as the prevention of oxaliplatin-induced peripheral neuropathy (expected completion November 2020). The primary clinical trial will be described in a separate paper. In addition, we have collected a wealth of longitudinal clinical, behavioral, and psychophysical data over 26 weeks, to allow careful characterization of risk factors, as well as progression time-course of oxaliplatin-induced peripheral neuropathy

Under the guidance of the PI and a post-doctoral fellow (Alaverdyan), the student will have an opportunity to understand clinical trial design, obtain experience in reviewing, cleaning, and analyzing complex multi-source data, as well as contribute to the preparation of a poster and/or a scientific manuscript.
Since data collection is expected to be completed prior to December 2020, there will be a possibility of a fully remote fellowship, should the COVID-19 pandemic necessitate that

Institution: **Washington University**

Mentor: Thomas Kannampallil, PhD
Project(s) Available: Using machine learning to predict pediatric postoperative outcomes
Over 200 million surgeries are performed globally per year. Over 10% of surgical patients experience major postoperative complications (e.g., heart attack, infection and blood clots) leading to increased mortality, increased need for higher-level of care and management, increased length of postoperative hospital stay and increased costs of care. Although some of these postoperative complications are unavoidable due to patient and surgical risk factors, others are modifiable, and potentially preventable through early identification of patient risk

factors, and interventions using evidence-based treatment approaches (e.g., timely administration of antibiotics in postoperative care settings). In this study, we will utilize a large dataset of preoperative and intraoperative data to predict postoperative complications during pediatric surgeries (including cardiac, gastrointestinal, infection, respiratory, urinary), 30-day mortality, and 30-day readmissions. Towards this end, we will evaluate the performance of multiple machine learning algorithms and develop model-agnostic explanations to characterize the causal contributors of these predictions.

The student will be involved in all aspects of this project including data preparation and management, development of machine learning models, and manuscript preparation and submission. Given the short time for the onsite internship, the focus will be on the data preparation, analysis and generating the results, working together with the PI and his graduate student. The results will be then used for submission of abstracts and journal manuscripts.

Institution: **Washington University**

Mentor: Meaghan Creed, PhD
Project(s) Available: Our lab is interested in understanding how experience of chronic pain and exposure to prescription opioids re-wire the brain's mesolimbic reward system, and how this rewiring leads to cognitive and mood symptoms. Ultimately, our goal is to use this insight to develop novel neuromodulation therapies to treat symptoms of chronic pain and addiction. To this end, we have multiple projects suited for summer scholars. All projects would focus on building custom-made devices for reward delivery that go in the mouse's homecage (for example, see Godynuk et al., eNeuro 2019), and using these devices to assess a) patterns of drug intake in models of addiction b) changes in cognition, motivation and anhedonia in models of chronic pain. These projects are perfectly suited to COVID-19, since data is posted to the cloud in real-time, allowing for much of the work to be done remotely if required. If some level of on-campus activity is possible, these behavioral experiments will be coupled with neural recordings of reciprocally-connected brain areas involved in nociception and reward, to determine how plasticity within neural circuits emerges through pain centralization or transition to compulsive drug use. We focus specifically on periaqueductal grey and its projections to ventral tegmental area, to understand how nociceptive brain areas communicate with the reward system, and how this information transfer goes awry in models of chronic pain and addiction.

Institution: **Yale-New Haven Medical Center Program**

Mentor: Laura E. Niklason, M.D., Ph.D.
Project(s) Available: Vascular Regeneration in vitro - This project studies the growth and remodeling of tissue engineered vessels that are cultured from differentiated vascular cells. The impact of discrete physical cues, growth factors, and cell source are studied for their impact on graft mechanics in vitro and host cell remodeling in vivo. In addition, students will have the opportunity to work with whole organ lung culture models, to study the key elements of the alveolar cell biological niche and determine the key cell-cell contacts needed for alveolar homeostasis.

Students will perform experiments in cell biology, biochemistry, and molecular biology to study events involved in vascular regeneration from differentiated and precursor cells in vitro. Specifically, students will learn the mechanics of vascular smooth muscle cell culture, as well as characterization by immunostaining and RT-PCR. Students will screen differentiated and stem cell-derived smooth muscle cells for markers of differentiation.

Institution: **Yale-New Haven Medical Center Program**

Mentor: Robert Brian Schonberger, M.D., M.H.S.
Project(s) Available:
1) Integrating perioperative care into the treatment of poorly controlled cardiovascular risk-factors: Atherosclerotic cardiovascular disease (ASCVD) is common, treatable, and deadly. While comprehensive guidelines assist physicians in the diagnosis and management of ASCVD, numerous studies show that patients consistently suffer from ongoing and widespread diagnostic and treatment failures. We propose to use the surgical encounter as a pathway for identifying and addressing these failures. Students will obtain training on accessing our local perioperative database in order to gain access to diagnostic histories of patients involved in Dr. Schonberger's clinical studies. Students will learn basics of informatics, observational research, and possible roles of anesthesiologists in ASCVD treatment.

2) Childhood Lead Poisoning and the Anesthesiologist: While many modifiable factors may influence long-term cognitive outcomes in children, exposures to anesthetics do not appear to be among them. In contrast, overwhelming evidence demonstrates the long-term morbidity incurred by children due to modifiable environmental lead exposures. This project seeks to describe the prevalence of undertreated childhood lead poisoning among patients presenting for pediatric surgery at a tertiary care medical center. It will provide the foundation for possible prospective interventional studies.

Institution: **Yale-New Haven Medical Center Program**

Mentor: Paul Heerdt, M.D., Ph.D.
Project(s) Available: Integrative models of cardiopulmonary dynamics: The goal of these studies is to develop methods for combining data generated by independent monitoring systems into a common platform and then use these data to build near real-time models of cardiac dynamics. The student's role will be to use existing data sets generated in the experimental laboratory, clinical operating rooms, ICU, and cardiac catheterization facility to test hypotheses related to novel analytic methods.

Institution: **Yale-New Haven Medical Center Program**

Mentor: Robert LaMotte, Ph.D.
Project(s) Available: Assessment of Mechanisms of Cutaneous Itch and Pain: Cutaneous itch is an under-studied phenomenon that is associated with substantial discomfort and morbidity in some cases. The cutaneous neurons signaling itch are "nociceptors" that are also activated by noxious stimuli that evoke pain. Our laboratory is working as part of a consortium of investigators to tease out how peripheral sensory neurons signal itchy and painful stimulation of the skin. Studies of cutaneous itch and pain are performed in healthy human volunteers, using controlled pruritic and nociceptive stimuli. Students will learn methods of collecting and analyzing sensory responses to these stimuli and participate in experiments designed to modulate the neuronal signaling of itch and pain.

Institution: Yale-New Haven Medical Center Program

Mentor: Miriam Treggiari, M.D., Ph.D., M.P.H.
Project(s) Available:
1) Pre-hospitalization sleep duration and quality in relation to subsequent postoperative complications: Poor sleep quality and short sleep duration have been associated with elevated risk for several complications; however, the relationship between sleep and surgical outcomes has not been well characterized. In this study, we plan to assess the association between pre-operative sleep attributes and subsequent postoperative complications.

2) Anesthetic management and postoperative sleep changes among older surgical patients: It is known that sleep quality is disrupted, and sleep architecture is altered after surgery. In this study, we will focus on elderly patients and determine changes in sleep quality, characteristics, and circadian dysregulation occur after surgery and the role of exposure to various anesthetic techniques anesthetics.

Medical students participating in either of these projects will work with Dr. Treggiari on recruiting participants and collecting preoperative and postoperative data on sleep characteristics and other risk factors. They will then collect and analyze the data with the goal of writing an abstract for submission to the ASA and then completing a full manuscript.

Institution: Yale-New Haven Medical Center Program

Mentor: Aymen Alian, MBChB
Project(s) Available: Assessment of cardiovascular status during surgery is a growing field, with an overarching goal of obtaining more patient information using less invasive means. Our laboratory is using advanced signal acquisition and data processing techniques on signals obtained from the pulse oximeter and the peripheral venous canula to glean information regarding patient volume status.

Students will participate actively in studies of autonomic reactivity in patients and controls, as well as the non-invasive assessment of intravascular volume status. In particular, students will assist in collection of real-time physiological data such as blood pressure, heart rate, and plethysmographic waveforms in normal subjects who undergo acute changes in intravascular volume status. Changes in volume are affected by changes in orthostatic positioning, and phlebotomy. Students will assist in quantitative analysis of acquired datasets to extract new relationships that can be used to non-invasively understand changes in volume status in the surgical patient.