FAER
Foundation for Anesthesia Education and Research

Medical Student Anesthesia Research Fellowship (MSARF) – Summer Program

2018 Host Departments and Projects

Institution: **Beth Israel Deaconess Medical Center**

Project Topic: Effects of Gender on Incidence and Consequences of Postoperative Respiratory Complications
Overview: The incidence rate of postoperative respiratory complications (and most of these comprise of reintubation, acute respiratory failure, pulmonary edema, pneumonia and atelectasis) ranges from 3-9%,. These complications are clinically relevant as they increase hospitalization times, hospital costs, as well as mortality. In order to promote the future use of feasible personalized medicine, we will examine in this cohort study the effects of gender on incidence and consequences of postoperative respiratory complications.
Student Role: The student will be introduced by our team members to the basic concepts of statistical analysis and gain a broad understanding of the research topic. S/he will work with our database and apply the STATA codes used in previous studies on similar topics (cite Ladha et al BMJ, Shin et al Ann Surg). The student will then create the tables and figures for a manuscript on that topic and will make substantial contributions to writing of the results section. S/he will work in close supervision with the mentor and will be fully integrated into his research team. Study updates will be formally reported at the team-meeting on a weekly basis. The successful student will be offered coauthorship on a manuscript on that topic based on the contributions made.
Research Type: Clinical
Mentor(s): Matthias Eikermann, M.D., Ph.D.; Shahzad Shaefi, M.D.; Maria Patrocinio, M.D.

Institution: **Beth Israel Deaconess Medical Center**

Project Topic: Prevention of Early Postoperative Decline
Overview: Exposure to surgical stress and general anesthesia is associated with the occurrence of postoperative cognitive decline (POCD), with an incidence found to be between 26-40% after the first postoperative week and 15% incidence after three months compared to age matched controls (Moller 1998, Ballard 2012). POCD has been found to be especially prevalent after cardiac surgery, with incidences reported between 30-80% in the first postoperative week and persistent decline found in 24% of patients at six months (Arrowsmith 2000, Newman 2001). So far, preventative strategies targeting these areas have not been shown to be effective. In this prospective, randomized, assessor-blinded feasibility trial, enrolled patients (N=45) will be randomized into one of two research arms (neurocognitive training with Lumosity or control group) and assessed for the development of postoperative cognitive decline and the incidence of delirium in the perioperative period.
Student Role: The student will assist in data collection and administration of postoperative neurocognitive exams. Furthermore, educational opportunities will be made in order to participate in similar prehabilitative studies, in order to gain a broader understanding of the research topic. S/he will work in close supervision with the mentor and will be fully integrated into his research team. The successful student will be offered coauthorship on an abstract or manuscript on that topic based on the contributions made.
Research Type: Clinical
Mentor(s): Brian O'Gara, M.D.; Balachundhar Subramaniam, M.D.

Institution: **Beth Israel Deaconess Medical Center**

Project Topic: Hyperoxia in the Intensive Care Unit
Overview: The purpose of this study is to evaluate the relationship between the level of administered oxygen (FiO2) and arterial partial oxygen pressure (PaO2) or oxygen saturation (SaO2) and outcome on the intensive care units here at BIDMC through retrospective data collection from electronic medical records.
Student Role: The student will assist in collection, analysis and interpretation of the data. Furthermore, additional educational opportunities will be provided in which the student can learn more about other hyperoxia research projects and the role of hyperoxia in a clinical setting. S/he will work with the research group and statistician in order to gain a basic knowledge of statistics and help to identify the relationship between oxygen administration and outcome. Furthermore, the student will assist in the preparation of abstracts and a manuscript related to the topic, in which their contributions will be acknowledged.
Research Type: Clinical

Mentor(s): Shahzad Shaefi, M.D. M.P.H.

Institution: **Boston Children's Hospital**

Project Topic: Photoactivatable nanoparticles
Overview: We are developing nanoparticles with light-triggered surface properties for a wide range of biomedical applications. We will investigate differential binding of nanoparticles coated with a range of ligands to various cell types under light and dark conditions.
Student Role: Nanoparticle production and characterization, surface modification, cell culture, data acquisition.
Research Type: Basic Science
Mentor(s): Daniel S. Kohane, M.D., Ph.D.

Institution: **Boston Children's Hospital**

Project Topic: Development of a selective filter for Gram negative bacteria
Overview: Many ICU admissions are complicated by bacteremia (bacterial in the blood). Some studies have suggested that the bacterial load in the blood when antibiotic treatment is initiated correlates with mortality and morbidity. If the bacterial load in the blood could be decreased relatively quickly when initiating antibiotic treatment, patients with bacteremia might have better outcomes. We are developing a filter device and testing its ability in vitro and in vivo to filter bacteria out of blood samples contaminated with E. coli.
Student Role: Student responsibilities include production and characterization of filters, measurement of their effectiveness in vitro and in vivo in an animal model of sepsis, and data collection and analysis. Publication opportunities exist depending on contributions made and luck.
Research Type: Basic Science
Mentor(s): Daniel S. Kohane, M.D., Ph.D.

Institution: **Boston Children's Hospital**

Project Topic: Prolonged duration local anesthesia
Overview: The goal is to help develop formulations that provide prolonged local anesthesia from a single injection, injectable formulations that can provide on-demand local or regional anesthesia triggered by external energy sources, and improved drug combinations for local anesthesia
Student Role: Formulation of materials, neurobehavioral testing of animals.
Research Type: Basic Science
Mentor(s): Daniel S. Kohane, M.D., Ph.D.

Institution: **Cleveland Clinic**

Project Topic: Intravenous acetaminophen and postoperative hypoxemia
Overview: Using a randomized design and blinded assessments, our goal is to determine the effect of intravenous acetaminophen (versus placebo) infusion on a variety of important opioid-related complications and outcomes in postoperative patients. The proposed research will have the following aims, all of which will be assessed over 48 hours or the duration of hospitalization if shorter:

Primary Aim: To assess whether intravenous acetaminophen decreases postoperative opioid-related respiratory depression.

Hypothesis: Our primary hypothesis is that total duration of hypoxia (defined as time with SpO2 < 90%) is less in patients given intravenous acetaminophen than placebo.

Student Role: Identify suitable patients, obtain consent, randomize patients, implement the protocol, and record data.
Research Type: Clinical
Mentor(s): Prof. Alparslan Turan

Institution: **Cleveland Clinic**

Project Topic: Mild perioperative hypothermia and myocardial injury
Overview: Myocardial injury is the most common cause of death in the 30 days after non-cardiac surgery. Hypothermia increases sympathetic activation, promotes tachycardia, and causes hypertension — all of which may increase the risk of myocardial injury. Only one small study evaluated the relationship between moderate hypothermia and myocardial infarction, and was unable to make definitive conclusions. Moderate perioperative hypothermia is now uncommon, but mild hyperthermia (≈35.5°C) remains common. Whether aggressive warming to a truly normothermic level (≈37°C) improves outcomes remains unknown. We therefore propose to test the primary hypothesis that aggressive warming reduces the incidence of major cardiovascular complications.
Student Role: Identify suitable patients, obtain consent, randomize patients, implement the protocol, and record data.
Research Type: Clinical
Mentor(s): Prof Daniel Sessler

Institution: **Duke University Hospital**

Project Topic: In the US alone, over 500,000 heart operations per year require a regulated drop of 5-20°C in body core temperature (hypothermia) during cardiopulmonary bypass to provide organ protection. Likewise, neuroprotection in ~300,000 traumatic brain injuries (TBI) and ~300,000 cardiac arrest patients require appropriate targeted temperature management. Current temperature monitoring, acquired through nasopharyngeal or bladder probes, inaccurately reflects brain thermal status. Accurate brain temperature tracking can prevent notable complications, such as prolonged surgical recovery and hospitalization, excessive blood loss, ischemic neuronal injury/death, and myocardial outcomes. To ultimately improve patient health in a variety of scenarios, accurate and direct tracking of brain temperature remains an unmet clinical need. Thus, we have created the non-invasive Brain Temperature Monitor (BTM).
Overview: Our goal is to optimize our current BTM™ prototype into a wearable device that outperforms indirect, surrogate temperature measurements for the brain in patients with TBI and during cardiac surgery. In patients with intracranial probes, we can compare our noninvasive BTM™ data with invasive, intraparenchymal temperature measurements. Since intracranial thermal probes are not available in cardiac surgery, we can correlate BTM™ data with cardiac surgery complications. Although the BTM™ clinical validation will be focused on TBI and cardiac surgery patients, our long-term objective is to develop and demonstrate a novel deep thermal sensing technology with broad applicability to clinical practice and biomedical research. The rationale for this approach is we can track tiny thermal changes in deep tissues with unrivaled sensitivity by integrating the latest advances in microwave electronics and wearable technology into our multiband radiometric array.
Student Role: In severe TBI patients, the student will compare our brain temperature monitor to existing invasive, temperature probes. Measurements from nasopharyngeal, tympanic, bladder, and skin probes will be compared to BTM™ volumetric thermal data in terms of tracking delay and temperature accuracy versus invasive intracranial probes (intraparenchymal or ventricular thermistors). The student will be involved in screening, enrolling, executing, and analyzing this clinical trial.
Research Type: Clinical
Mentor(s): Michael L. “Luke” James, M.D.

Institution: **Duke University Hospital**

Project Topic: Rotational thromboelastometry (ROTEM) is an established viscoelastic method for hemostasis testing in whole blood. In an effort to guide transfusion therapy in obstetric hemorrhage we incorporated ROTEM viscoelastic clot testing into our obstetric hemorrhage protocol in 2014. We expected that this would allow a more targeted transfusion strategy. We have been using ROTEM to guide early replacement of fibrinogen in cases of bleeding associated with hypofibrinogenemia, which may decrease blood component transfusion requirements. The ROTEM parameters used to guide fibrinogen administration in the algorithm (either as cryoprecipitate or fibrinogen concentrate) are based on a few studies in obstetric patients, but there are no

studies correlating these with conventional coagulation laboratory monitoring in our population. The impact of using ROTEM on transfusion and transfusion related complications in obstetric patients has not ben well documented.

Overview: Over the last two years, we have collected and simultaneously analyzed blood samples from bleeding obstetric patients using both ROTEM and conventional coagulation monitoring. This would be a retrospective analysis to correlate ROTEM parameters and conventional laboratory values at diagnosis of hemorrhage and following transfusion therapy in bleeding obstetric patients in this cohort. We will also assess: 1. transfusion requirements including fibrinogen and other component therapy before and after introduction of ROTEM guided therapy, 2. transfusion-associated complications, ICU admissions and duration of hospital stay before and after introduction of ROTEM guided transfusion therapy. This would contribute to the literature in this area, which remains sparse, helping guide and refine transfusion strategies for the management of bleeding obstetric patients.

Student Role: The medical student will be tasked with reviewing the literature in this area so that he or she understands the background of the research questions, and is prepared to write a manuscript with the results of his or her project. The medical student will review the extracted data and conduct any necessary chart reviews to complete the dataset. The medical student will work closely with the team of mentors to prepare the data for statistical analysis by the Department of Anesthesiology biostatistics team.

Research Type: Clinical

Mentor(s): Ashraf Habib, MBBCh, M.Sc., MHSc, F.R.C.A.; Terrence Allen, MBBS; Jennifer Dominguez, M.D., MHS

Institution: **Duke University Hospital**

Project Topic: Impact of vasopressor administration on maternal and neonatal outcomes in women with pre-eclampsia

Overview: Historically ephedrine was considered to be the vasopressor of choice for management of spinal induced hypotension in women undergoing cesarean delivery. Studies have shown that phenylephrine is associated with improved maternal and neonatal outcomes compared to ephedrine, and therefore phenylephrine is now considered the vasopressor of choice in this patient population. A comparison between the two in women with placental insufficiency, such as those with pre-eclampsia has not been studied and therefore it is not clear whether ephedrine or phenylephrine should be the vasopressor of choice in pre-eclamptic patients. The purpose of this ongoing randomized controlled study is therefore to compare the effects of phenylephrine versus ephedrine on maternal and neonatal outcomes in women with pre-eclampsia undergoing cesarean section under spinal anesthesia. Specifically, blood pressure, cardiac output, cerebral tissue oxygen saturation and cord gases will be compared between the two groups.

Student Role: Collection and analysis of data and preparation of data for statistical analysis and writing up presentation/manuscript.

Research Type: Clinical

Mentor(s): Ashraf Habib, MBBCh, M.Sc., MHSc, F.R.C.A.

Institution: **Duke University Hospital**

Project Topic: The incidence of failed spinal anesthesia for postpartum bilateral tubal ligation.

Overview: Pregnancy enhances the spread of hyperbaric local anesthetic in the intrathecal space of parturients at term. This results in 25% reduction in dose requirement for these patients. This decreased requirement is attributed to a decrease in CSF volume, increased susceptibility of neuronal tissue to local anesthetics, and the increased rostral spread of local anesthesia associated with pregnancy induced anatomical changes. Studies suggest that this decreased dose requirement returns to that of the non-pregnant state within 24-48 hours postpartum. Studies have conflicting results regarding the optimal dose of bupivacaine needed to achieve adequate spinal anesthesia for postpartum bilateral tubal ligation. The aim of this study is to retrospectively review the practice in terms of the dose of local anesthetic used for spinal anesthesia for BTL and the success rate of different doses of spinal local anesthetic, and identify the optimal dose that is associated with the highest success rate.

Student Role: Collection and analysis of data and preparation of abstract for presentation.
Research Type: Clinical
Mentor(s): Ashraf Habib, MBBCh, M.Sc., MHSc, F.R.C.A.

Institution: **Duke University Hospital**

Project Topic: Impact of local anesthetic wound infiltration on postoperative pain following cesarean delivery
Overview: Adequate control of pain following cesarean delivery is crucial to optimize recovery, facilitate early mobilization and thereby reducing thromboembolic complications, reduce the risk of persistent pain, and facilitate beastfeeding. Currently the gold standard regimen for postoperative analgesia in women undergoing Cesarean delivery involves a multimodal approach with neuraxial opioids, regular non-steroidal anti-inflammatory drugs (NSAIDs), and regular acetaminophen. However, despite this multimodal analgesic regimen, postoperative pain remains inadequately controlled in this patient population. A promising technique in this patient population is local anesthetic wound infiltration using an elastometric pum. The goal of this study is to test the hypothesis that wound infiltration with local anesthetic plus a NSAID will result in significantly improved analgesia after Cesarean delivery.
Student Role: Collection and analysis of data and preparation of abstract for presentation.
Research Type: Clinical
Mentor(s): Ashraf Habib, MBBCh, M.Sc., MHSc, F.R.C.A.

Institution: **Duke University Hospital**

Project Topic: Identification of risk factors for postoperative pain and postoperative nausea and vomiting following cesarean delivery
Overview: This prospective observation study aims to identify risk factors for severe pain and postoperative nausea and vomiting following cesarean delivery, so that targeted interventions could be directed to those high-risk patients in order to improve their outcomes. Methods used include a combination of questionnaires, quantitative sensory testing and hemodynamic testing.
Student Role: Collection and analysis of data and preparation of abstract for presentation.
Research Type: Clinical
Mentor(s): Ashraf Habib, MBBCh, M.Sc., MHSc, F.R.C.A.

Institution: **Duke University Hospital**

Project Topic: Delirium and postoperative cognitive dysfunction (POCD) affect ~40% of the >16 million older Americans (age>60) who undergo anesthesia/surgery each year, and both delirium and POCD are associated with decreased quality of life, long term cognitive decline, and increased 1 year mortality, and a possible increased risk of developing dementia (such as Alzheimer's disease). Animal models suggest neuroinflammation, such as increases in brain monocyte influx and brain levels of monocyte chemoattractant protein 1 (MCP-1), may cause delirium and POCD. However, little work has been done to evaluate this theory in actual patients. To determine the role of these neuroinflammatory processes in delirium and POCD, and postoperative functional brain connectivity changes, and possible long term dementia risk, we recently started the NIH-funded INTUIT study- Investigating NeuroinflammaTion UnderlyIng postoperative brain connecTivity changes, POCD, and Delirium in Older Adults.
Overview: In the INTUIT study, older surgical patients undergo pre and postoperative cognitive testing and delirium assessments, CSF sampling, and functional neuroimaging. CSF cytokines and monocytes (as well as other leukocytes) are measured by multiplex ELISA assays and polychromatic flow cytometry, respectively, and resting state functional MRI scans are examined for changes in the connectivity of the brain's default mode network. Intraoperative brain activity (i.e. electroencephalography, or EEG) recordings are also performed to search for brain response patterns to anesthesia and surgery that are associated with later development of delirium and/or POCD. Taken together, these INTUIT data will provide important insights into the role of postoperative neuroinflammation in delirium and POCD, and their underlying brain connectivity changes, and will help clarify

possible mechanisms through which delirium and POCD may contribute to the long term risks of developing dementia.

Student Role: Student will assist in screening and enrolling subjects, and will develop insight into the psychology and perspective of older adults about to undergo major non-cardiac surgery. Students will observe lumbar punctures, intraoperative EEG recordings, and other procedures on study patients. Students will learn how to process and prepare CSF and blood samples for biomarker studies, ranging from polychromatic flow cytometry to multiplex ELISA assays. Students will perform a small amount of data entry, which will help them learn important aspects of data provenance and quality assurance. We will help students in navigating and reviewing literature in this area, so they develop a mature understanding of the scientific basis for this project. Active engagement in this capacity should expose students to all facets of clinical trial management in the perioperative setting. We expect the student to serve as a co-author on a publication from this study and as 1st author of a poster on the study.

Research Type: Clinical

Mentor(s): Miles Berger, M.D., Ph.D.

Institution: **Duke University Hospital**

Project Topic: Delirium affects ~40% of the >16 million older Americans (age>60) who undergo anesthesia/surgery each year, and is associated with decreased quality of life, long term cognitive decline, and increased 1 year mortality, and a possible increased risk of developing dementia (such as Alzheimer's disease). Prior data suggests that decreasing anesthetic dosage in older adults can help reduce delirium risk, yet there is currently no "gold standard" method for titrating anesthetic dosage to minimize delirium risk while also ensuring intraoperative amnesia. We recently completed the DREAMER study (Developing a Real Time EEG guided Anesthesia Management program to Eliminate deliRium), to evaluate the feasibility and efficacy of an online education module to teach anesthesia residents how to titrate anesthetic drugs to reduce delirium risk in response to intraoperative EEG readings.

Overview: In the DREAMER study, anesthesia residents were randomized to complete an online EEG education modulate in addition to standard anesthesia resident education versus standard anesthesia resident education alone. Preliminary data shows that this intervention resulted in statistically significant improvements in intraoperative EEG interpretation skills in the intervention residents (as compared to controls), a significant reduction in the fraction of anesthetic cases with greater than 1 MAC of anesthetic gas administered by intervention arm residents, and a significant improvement in patient alertness/wakefulness in the PACU. DREAMER also provided a wealth of qualitative data on obstacles to the implementation of EEG-based anesthetic titration in the OR environment. Here, we will analyze this DREAMER data and use insights from it to design a next-generation study to measure the efficacy of implementation strategies for OR EEG-based anesthetic titration to reduce delirium.

Student Role: Student will assist in analyzing data from the DREAMER study, including not only "hard" outcome variables such as end tidal anesthetic gas concentrations but also extracting themes from the lists of obstacles identified by anesthesia residents in implementing EEG-based anesthetic titration strategies in the OR. The student will assist in identifying the main obstacles to the use of OR EEG-based anesthetic titration, and will move forward to help design strategies to circumvent these obstacles for a future study. The student will thus gain practical experience not only in reading intraoperative EEG data but also in the challenges of anesthesia resident education and OR implementation science. Towards these goals, the student will spend at least 1 day per week in the OR shadowing, and talking with residents about the challenges of intraoperative anesthetic management in the busy OR environment. Th

Research Type: Clinical

Mentor(s): Miles Berger M.D. Ph.D.; Ankeet Udani M.D. MSEd.

Institution: **Emory University School of Medicine Program**

Project Topic: What sequence of brain network activation is involved in recovery from anesthesia?

Overview: It is becoming increasingly apparent that the recovery from anesthesia is not a passive activity. Instead, requiring the initiation of networks specific for arousal and consciousness. The MSARF student will

participate in a multi-site study intended to develop a taxonomy of the sequence of brain events on emergence from anesthesia. Frontal EEG electrodes (applied via standard BIS or SedLine sensors) will be used to continuously monitor patients from induction through maintenance and emergence. The EEG signatures that define the transition from unconscious to conscious will be characterized during the implementation of a standard emergence protocol.

Student Role: The student will be responsible for consenting patients, adherence to protocol, data entry, and introduced to data analysis and EEG interpretation. In addition to the advanced scientific techniques to be learned, there will be ample opportunity for the MSARF student to shadow Dr. Garcia in the operating room, learn statistical techniques and scientific communication skills.

Research Type: Clinical

Mentor(s): Paul S. Garcia, M.D., Ph.D

Institution: **Emory University School of Medicine Program**

Project Topic: Feasibility Study: fMRI Evaluation of Auricular PENFS for Fibromyalgia (fMRI)

Overview: Given recent increasing opioid-related deaths and evidence showing against the use of opioids for non-malignant chronic pain, there is growing need for non-narcotic pain management. Fibromyalgia is a difficult to treat chronic pain condition that is often treated with opioids despite existing evidence. The prevalence of fibromyalgia is increased among Veterans returning from the gulf war and is already a significant burden in senior Veterans who may have suffered with chronic pain for decades already. Many treatment options for fibromyalgia carry intolerable side effects. PENFS (percutaneous electrical neural field stimulation) is a FDA-approved, non-pharmacologic therapy that is currently utilized within the military and VA system, but sufficient evidence regarding its outcomes and neural mechanisms have not been adequately investigated.

Student Role: The student is expected to perform functional assessments and recruit patients into the study. The student is also expected to pre-process neuroimaging data and perform data analysis when appropriate. MSARF students are free to shadow Dr. Woodbury in clinic and during interventional pain procedures.

Research Type: Clinical

Mentor(s): Anna Woodbury, M.D.

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

Project Topic: The proposed research project is examining the impact that elevated intraoperative serum lactate has on clinical outcomes in patients undergoing craniotomy

Overview: Hundreds of thousands of craniotomies are performed annually in the United States. During craniotomy, elevated serum lactate is a concerning and not infrequent occurrence. Elevated intraoperative serum lactate may occur as a result of global hypoperfusion or localized intracerebral ischemia from surgical retraction or inadequate blood supply. The distinction between systemic and hypoperfusion confined to the brain is important because the treatment differs. For example, fluid resuscitation may be indicated in the former but not the latter.

Student Role: The medical student will have few tasks: (1) assist in compiling the de-identified data from different centers into one large database (2) meeting regularly with the departmental statistician to act as a contact person to provide them with the data and contact others centers for posed questions (3) assist in performing literature search for the proposed manuscript (4) assist in making tables and figures of the proposed draft (5) review and critique the proposed manuscript draft (5). In addition, during the eight-week period, the student will also partake in observing both deceased donor and living related donor liver transplant surgeries at Mount Sinai Hospital.

Research Type: Clinical

Mentor(s): Jess Brallier, M.D.

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

Project Topic: Postoperative cognition in the elderly.

Overview: We are looking at whether intraoperative burst suppression can predict whether older patients have cognitive dysfunction after surgery

Student Role:

1. Learn about cognitive testing in the older surgical patient
2. Assist with analyzing cognitive data and generating hypotheses regarding frailty, pain, and cognition after surgery

Research Type: Clinical

Mentor(s): Stacie Deiner, M.D.

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

Project Topic: The Influence of Race and Ancestry on Regional Cerebral Oxygen Saturation Measurement During Cardiac Surgery

Overview: Near-infrared spectroscopy is a non-invasive technique that provides continuous monitoring of regional cerebral brain tissue oxygen saturation ("Cerebral oximetry"). It allows for the immediate recognition and treatment of brain hypoxia events that would otherwise be undetected by conventional monitoring. Cerebral oximetry has been used for many years in cardiac surgery, however the effect of race/ancestry/genotype on the measured values has not been well studied. The purpose of this study is to explore the effect that self-reported race and ancestry may have on the measured oximetry values and to establish normative ranges that are race/ancestry/genotype specific.

Student Role: The student will be responsible for extracting data from the data sources using SQL and then performing preliminary data cleanup and analysis in R or Python. The student will write an abstract to present at a large national meeting. In addition, there are many days of observing in the OR.

Research Type: Clinical

Mentor(s): Matthew Levin, M.D.

Institution: **Johns Hopkins University School of Medicine**

Project Topic: The US FDA has recently disseminated a safety announcement warning that repeated or lengthy exposure to anesthetic and sedative drugs during between the third trimester and third year of life may have adverse consequences on brain development. The same announcement contains a call for further research on the mechanisms of developmental anesthetic neurotoxicity. Our laboratory is pursing the hypothesis that anesthetics cause a chronic pathologic increase in activity in the mTOR system which disrupts synapse development.

Overview: We have previously shown that increased tone in the mTOR system results in a reduction in the number of mature dendritic spines in dentate gyrus neurons in the hippocampus that were born shortly before the anesthetic exposure occurred. Development of this population of cells is strongly dependent on depolarizing GABA signaling from surrounding interneurons, and in this project we will ask whether anesthetics exert their effect in this system through their actions on GABA receptors.

Student Role: The student will work under the direction of the PI and a senior postdoctoral fellow in order to design, carry out, and interpret experiments in a mouse model of developmental anesthetic neurotoxicty. Techniques will include animal surgery, immunhohistochemistry, confocal microscopy, and calcium imaging.

Research Type: Basic Science

Mentor(s): Cyrus David Mintz, M.D., Ph.D.

Institution: **Johns Hopkins University School of Medicine**

Project Topic: Natural history of intracerebral hemorrhage and perihematomal edema in patients with systemic malignancy or primary brain tumors, and the effect of mutations in genes affecting tumor growth

Overview: Intracerebral hemorrhage (ICH) accounts for 10% of strokes, but has higher morbidity and mortality. Patients with cancer who develop ICH have been reported to have higher mortality, however there is an incomplete understanding of the mechanisms and natural history of ICH in patients with cancer. Distinct mechanisms such as intratumoral hemorrhage, alterations in the fibrinolytic cascade, and overexpression of

proteins such as VEGF and matrix metalloproteinases are suspected to contribute to ICH in patients with cancer. Hematoma expansion contributes to both primary and secondary injury after ICH, and contributes to both mortality and functional outcome. Perihematomal edema (PHE) is thought to be a radiological marker of secondary injury after ICH due to the presence of inflammation, and PHE expansion has been linked to outcomes after ICH. We hypothesize that hematoma and PHE expansion rates will differ significantly in ICH patients with primary brain tumors or systemic malignancy.

Student Role: The student will be involved in data collection and analysis, image analysis, and manuscript preparation. The project will be performed in collaboration with the Johns Hopkins Brain Tumor Center and the Department of Neuro-oncology at Memorial Sloan Kettering Cancer Center. The student will assist in collection of demographic and laboratory values from the electronic medical record. The student will also be instructed in imaging techniques for the quantification of perihematomal edema and hematoma volumes from computed tomography (CT) scans of patients with ICH. The student will assist in the analysis of data and subsequent manuscript preparation. Opportunities will exist for the student to develop new directions for independent projects from the dataset.

Research Type: Clinical

Mentor(s): Aaron Guson, M.D.

Institution: **Johns Hopkins University School of Medicine**

Project Topic: The aim of this study is to describe the neurological complications and their outcomes in patients with ECMO support by retrospectively looking at the Johns Hopkins ECMO database. We will look to see if there are any non-invasive neurophysiologic monitoring devices implemented in this population including CT brain, electroencephalography (EEG), near-infrared spectroscopy (NIRS), transcranial Doppler (TCD) and TCD emboli monitoring (TCDe). We will determine the predictors of ischemic stroke, hemorrhagic stroke, seizure, and brain death in ECMO. We will further characterize the patterns of strokes in CT imaging studies.

Overview: A single center retrospective observational study in patients admitted to the cardiac intensive care unit (CICU) or medical intensive care unit (MICU) of The Johns Hopkins Hospital. We plan to look consecutive patients with cardiopulmonary failure requiring ECMO support past 5 years (2012-2017).

Student Role: The student will establish the complete ECMO database by collecting demographic, clinical, and imaging variables in all ECMO patients. If the student is willing and capable, he or she can be a first author on the paper. I will provide the statistical analysis support for the student.

Research Type: Clinical

Mentor(s): Sung-Min Cho, D.O.

Institution: **Johns Hopkins University School of Medicine**

Project Topic: Despite the feasibility and potential benefits of rehabilitation in the early postoperative period, common practice is a culture of immobility to promote rest and healing. The research topic for this FAER Medical Student project is the barriers, facilitators and impact of early rehabilitation for children in the perioperative period.

Overview: Optimizing mobility in the postoperative period is instrumental in recovery from surgery and general anesthesia. Emerging adult literature has demonstrated that early rehabilitation can decrease the risk of delirium, decrease sedation and pain requirements, improve sleep-wake patterns, and decrease length of mechanical ventilation and hospital length of stay. However, the impact of early rehabilitation for infants and children undergoing active neurocognitive development is not well understood. Although early mobilization is safe and feasible (demonstrated by a quality improvement study at Johns Hopkins), impact on functional outcomes is not well understood. In this prospective, observational study, barriers and facilitators of early rehabilitation for children undergoing anesthesia will be characterized, and a pilot investigation will begin to explore the causal pathway between early rehabilitation as an intervention to promote sleep, decrease pain and decrease delirium incidence.

Student Role: The student will have the opportunity to lead this project with the mentorship of Dr. Kudchadkar. The student will learn about clinical research design, database management, and statistical analysis as it relates to

the research project. There will be direct patient contact on a daily basis. They will be responsible for initiation of study procedures including obtaining informed consent from families, initiation of accelerometry (actigraphy) to measure sleep-wake patterns in children admitted to the hospital after surgery, reviewing the medical record for delirium incidence, pain scores and opioid administration and collecting data about barriers and facilitators of early rehabilitation in children after surgery.
Research Type: Health Services
Mentor(s): Sapna Kudchadkar, M.D.

Institution: **Keck School of Medicine of the University of Southern California**

Project Topic: Hypocalcemia and microvascular bleeding in spine surgery patients
Overview: Microvascular bleeding is a common complication during prolonged spinal surgery. Hypocalcemia is frequently encountered in chronically ill spine patients and has been shown to worsen bleeding in trauma patients. We propose to study whether pre-operative hypocalcemia is associated with worsen bleeding outcomes in spine surgery patients, using a large retrospective database.
Student Role: The student will be involved in data collection and analysis, under the supervision of the faculty mentor. Activities will include: database management, data quality control, mentored statistical analysis, and manuscript preparation. The student will also participate in the department's perioperative "anemia clinic" and assist with the implementation of a perioperative coagulation bundle. Finally, the student will be matched with both anesthesia providers and spine surgeons during spine surgeries, to receive a general education on perioperative hemostasis in spine surgery patients.
Research Type: Clinical
Mentor(s): Kevin Blaine, M.D., M.P.H.; Philip Lumb, MBBS, Ph.D.

Institution: **Keck School of Medicine of the University of Southern California**

Project Topic: Implementing an "Enhanced Recovery After Surgery" bundle across 3 hospital systems to reduce community exposure to opiate medications
Overview: In partnership with 3 area hospitals and the Los Angeles County Department of Health Service, the Department of Anesthesiology is rolling out an "Enhanced Recovery After Surgery" (ERAS) protocol as a community intervention to reduce the prescription and use of opiates for post-operative pain. The majority of chronic opiate abuse begins from medications prescribed to control post-procedural pain. ERAS has been shown to reduce the use of opiates in the immediate perioperative period and may have a persistent benefit after discharge. We hope to follow patients after the adoption of ERAS to determine whether their use of opiates has decreased following implementation. The study results will be presented at both the medical school and at the Department of Health Services.
Student Role: The student will assist in the rollout effort, including provider and nursing education, monitoring of protocol adherence, patient follow-up, and audits using the California Controlled Substance Utilization Review and Evaluation System, a statewide database of all prescriptions for controlled substances from providers within the state. The student will learn about implementation science and ERAS protocols.
Research Type: Clinical
Mentor(s): Shihab Sugeir, M.D.; Kevin Blaine, M.D., M.P.H.

Institution: **Keck School of Medicine of the University of Southern California**

Project Topic: Multidisciplinary rounding with psychiatrist in the intensive care unit: a block-randomized trial
Overview: Delirium is a major cause of morbidity and mortality in the intensive care unit. ICU survivors who's course was complicated by delirium demonstrate delayed return to pre-morbid function and a higher 6-month mortality. There is no treatment for delirium, and most centers focus on prevention by the implementation of delirium bundles. Elements of bundles include the minimization of deliriogenic medications, early mobilization, and sleep hygiene. We currently implement a delirium bundle in our surgical ICUs. We will be testing the added value of including psychiatrists on multidisciplinary ICU rounds as a means to further reduce delirium incidence in the ICU.

Student Role: The medical student will participate in all aspects of this block-randomized clinical trial. This will include attending multidisciplinary rounds with both the ICU and psychiatry teams, data collection including CAM-ICU and delirium screenings, and patient follow-up. The student will compile 2 monthly progress reports to the clinical trial team regarding for interim analyses.
Research Type: Clinical
Mentor(s): Catherine Kuza, M.D.; Carol Peden, MBBS

Institution: **Keck School of Medicine of the University of Southern California**

Project Topic: The reliability of the Cheetah NICOM non-invasive cardiac output monitor in liver transplantation patients
Overview: The NICOM (Cheetah Medical, Newton Center, MA) is a non-invasive cardiac output monitor based on a bioimpendence and bioreactance mechanism. The device has been explored in a variety of clinical settings, including septic shock, cardiac surgery, and healthy athletes. We propose to compare the NICOM to the gold standard pulmonary artery catheter to determine the accuracy and trending ability of the cardiac output measurement. All patients undergoing liver transplantation at our institution have a pulmonary artery catheter placed to monitor perioperative cardiac output. A NICOM will also be applied and simultaneous cardiac outputs recorded for Bland-Altman and polar plot analysis.
Student Role: The student will carry a liver transplantation pager and will help collect data during liver transplantation surgery. The student will apply the NICOM device, monitor cardiac outputs serially during surgery, and continue to collect measurements at standard time points after arrival in the ICU. The student will also participate in liver transplant anesthesia and surgical intensive care. Finally, the student will be exposed to statistical analysis and will assist in manuscript preparation.
Research Type: Clinical
Mentor(s): Subarna Biswas, M.D., MS

Institution: **Loma Linda University Health Education Consortium Program**

Project Topic: Impact Assessment of a Perioperative Point of Care Ultrasound (POCUS) Service
Overview: Recently Point-of-care (POC) ultrasound (US) has proven to be vital in the assessment of the patient's acute condition. The investigators have designed a perioperative POCUS examination, termed FORESIGHT (Focused, PeriOperative, Risk, Evaluation, Sonography, Involving, Gastro-Abdominal, Hemodynamic, and Trans-Thoracic US). This group published on the utility of this examination. This project seeks to definitively assess the impact of POCUS for perioperative care by longitudinal evaluating the impact of a POCUS service. The project will capture all POCUS exams for the upcoming year and will assess clinical impact by comparison to historical data in the following areas:

1. time to acute event diagnosis
2. primary provider surveys
3. formal diagnostic tests
4. patient morbidity and mortality.

Importantly the project highlighted in this publication was a FAER sponsored study and the current lead investigator of this project is a FAER Research in Education grant receipt.
Student Role: The student will be involved in education of the FORESIGHT point of care ultrasound (POCUS) curriculum, performing and capturing POCUS exams, data gathering, and analysis. It is the goal of the investigators to provide training on all of the POCUS topics discussed in the FORESIGHT exam to the FAER medical student. Further details on the FORESIGHT exam can be found at www.foresightultrasound.com.
Research Type: Clinical
Mentor(s): Davinder Ramsingh M.D.; Jason Gatling M.D.

Institution: **Loma Linda University Health Education Consortium Program**

Project Topic: Evaluation of Clinical Impact of Non-Invasive Hemodynamic Monitoring to Optimize Perioperative Care in Moderate to High Risk Patients with Poor Functional Status

Overview: This project is designed to assess the impact of non-invasive hemodynamic monitoring technologies in two different clinical environments:

1. outpatient heart failure clinic
2. pre-operative clinic.

The goal of the project is to assess if the use of non-invasive hemodynamic monitoring technologies helps with the management of patients in both of these outpatient environments. For the preoperative clinical the goal is to help identify patients with reduced cardiovascular function and evaluate its impact on perioperative care. The primary marker will be evaluation for an improved detection of patients with reduced cardiovascular function and secondary markers will include various perioperative outcomes. For the heart failure clinic, the goal is to evaluate if the device can facilitate the detection of improvement or worsening of these patients' cardiovascular function. The primary marker will be hospital admission and secondary markers will include signs of CHF exacerbation.
Student Role: The student will be involved in patient enrollment, device application, data gathering and analysis. In addition, the student will be working in a preoperative clinic and heart failure clinic that has embraced a collaborative patient focused approach. The students will have the opportunity to work with our perioperative medicine team and heart failure management teams as well.
Research Type: Clinical
Mentor(s): Davinder Ramsingh M.D.; Jason Gatling M.D.

Institution: **Massachusetts General Hospital (The General Hospital Corp.)**

Project Topic: Novel Pharmacological Treatment of Opioid-induced Hyperalgesia
Overview: 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.
Student Role: 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.
Research Type: Clinical
Mentor(s): Jianren Mao, M.D., Ph.D.; Lucy Chen, M.D.

Institution: **Massachusetts General Hospital (The General Hospital Corp.)**

Project Topic: Establishing zebrafish as a platform for discovering new potent general anesthetic drugs.
Overview: 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 screening of general anesthetics.
Student Role: Students will:

1. Learn how to perform zebrafish anesthesia assays and will be responsible for performing screening tests on libraries of new compounds.
2. Learn to maintain a research notebook, analyze their data using statistical software tools, participate in weekly lab meetings, and present their results in written and oral form.
3. Participate in weekly reading and discussions of literature related to anesthetic pharmacology and mechanisms. Attendance at weekly Grand Rounds conferences will be encouraged.
4. Observe and learn about clinical anesthesia in the MGH operating rooms and affiliated divisions (OB, Pain, ICU).

Research Type: Basic Science
Mentor(s): Stuart A. Forman, M.D., Ph.D.

Institution: **Massachusetts General Hospital (The General Hospital Corp.)**

Project Topic: The Tau protein associated anesthesia neurotoxicity in developing brain

Overview: Recent population studies have suggested that children who undergo anesthesia and surgery at an earlier age could have an increased risk for cognitive impairment. We have proposed to develop and validate biomarkers in mouse models that can later be used to inform and effectively translate to clinical trials in children to study anesthesia- and surgery-induced cognitive impairment. Our Preliminary studies show that anesthetic sevoflurane can increase levels of brain P-Tau, inhibit neurogenesis, cause cognitive impairment and increase blood Tau levels in young mice. Therefore, we hypothesize that Tau and P-Tau in blood and urine serve as the biomarkers for anesthesia- and surgery-induced cognitive impairment in young mice, and P-Tau inhibits migration of neural progenitor cells (NPCs) by de-stabilizing their microtubules. The results of this project would ultimately lead to safer anesthesia care and better postoperative outcomes for children.
Student Role: The student would perform the research under the supervision of the mentors. Specifically, the student would do animal studies to determine whether anesthesia is able to increase the blood Tau level in the young mice. The student will also assess whether anesthesia can induce Tau protein phosphorylation, which can inhibit the immigration of NPCs in vitro.
Research Type: Basic Science
Mentor(s): Zhongcong Xie, M.D., Ph.D.; Yiying (Laura) Zhang, M.D.

Institution: **Massachusetts General Hospital (The General Hospital Corp.)**

Project Topic: This project will focus on the preclinical investigation of mechanisms through which adeno-associated virus mediated delivery of inflammasome components leads to destruction of experimental schwannomas. There is intellectual property related to the work and our hope is to eventually work with an industry partner to move at least one of our therapies to clinical trials.
Overview: Schwannoma tumors are benign (non-malignant) in that they grow slowly and are neither invasive nor metastatic. They can have devastating consequences for patients including intense pain and loss of motor and sensory function. Our proposal focuses on a new therapeutic approach to these nerve-associated tumors involving intratumoral injection of an adeno-associated virus vector carrying pro-apoptotic and pro-pyroptotic genes under the control of a Schwann cell specific promoter. Adeno-associated viral vectors have proven safe in clinical trials for multiple other diseases. Our initial pre-clinical studies have shown a remarkable ability of our therapeutic vectors to produce a prolonged reduction in tumor volume without nerve damage or other forms of apparent toxicity.
Student Role: A FAER medical student would assist with a variety of components of the project which will be determined based on the experiments that are running during the summer. It is very likely that there will be a need for behavioral testing of mouse sensory and motor function. This would require that the student become proficient with von Frey filament and rotarod tests. Further, we regularly perform immunohistochemical analyses of tumor bearing nerve. It is very likely that an FAER medical student would be involved in tissue preparation (cryostatic sectioning) and subsequent immunohistochemical staining, image capture, and analysis.
Research Type: Basic Science
Mentor(s): Gary J. Brenner, M.D., Ph.D.; Sherif Ahmed, Ph.D.

Institution: **Massachusetts General Hospital (The General Hospital Corp.)**

Project Topic: Mechanical ventilation (MV) is life-saving but if not used properly is harmful. MV affects normal interactions between the respiratory and the cardiovascular systems (heart-lung interaction). Initiation of MV can disturb the delicately balanced heart-lung interaction, especially the function of right side of the heart. MV plays a pivotal role in management of ARDS. This leads to collapsed/consolidated lungs and severe hypoxemia. The hallmark of ARDS is refractory hypoxemia. In ARDS, a positive end-expiratory pressure (PEEP) prevents collapse keeping opened previously collapsed lung units. The proposed physiologic trial will compare two different methods of choosing PEEP: incremental titration vs. decremental titration after a lung recruitment maneuver (LRM). LRM is a transitory and controlled increase in airway pressure to open collapsed alveoli. We'll compare two methods, simultaneously evaluating impact of PEEP on right heart function (RHF) and distribution of increased lung volume.

Overview: 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).
Student Role: The student will join the research team led by Drs. Berra and Kacmarek, with 2 MD research fellows and 1 post-graduate student. 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
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 and 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

Research Type: Clinical
Mentor(s): Lorenzo Berra, M.D.

Institution: Massachusetts General Hospital (The General Hospital Corp.)

Project Topic: Small-bodied hibernators such as ground squirrels successfully and repeatedly execute cycles of metabolic depression, tissue ischemia-reperfusion, and severe global hypoxemia without harm. One of the many physiological mysteries of small-bodied hibernators is their marked tolerance to severe hypoxia, which occurs during rewarming arousal from deep torpor bouts. Hydrogen sulfide (H2S) is an evolutionarily conserved O2 sensor that importantly modulates metabolism and signaling in modern cells. Interestingly, ground squirrels express higher levels of enzymes that synthesize or catabolize H2S in their brain compared to mice. Enhanced capacity to metabolize H2S may enable the hibernators to use it as an organic substrate for energy production when O2 supply is limited. The goal of this project is to elucidate the role of H2S metabolism in the innate hypoxia tolerance of 13-lined ground squirrels.
Overview: This project uses in vivo, in vitro and in silico analyses to examine the hypothesis that the brain cells of deep hibernators innately posses the ability to metabolize H2S, and that this ability underlies their ability to survive severe hypoxic events. The proposed analyses will address three specific objectives in the brain of 13-lined ground squirrels. Objective 1 will determine the responsiveness of ground squirrels to inhaled H2S, exploring innate versus seasonal elements of this species natural capacity for sulfide metabolism by comparing rats to both summer and winter euthermic ground squirrels. Objective 2 will test H2S production and metabolism over in vitro hypoxia exposure in isolated mitochondria and primary brain cell cultures, and directly test the ability of H2S to inhibit the electron transport chain in isolated brain mitochondria. Objective 3 will evaluate selective pressures on the genes of key H2S production and metabolism within the rodent lineage.
Student Role: Student will be integrated into the laboratory to perform in vivo and in vitro studies with 13-lined squirrels and rats.

1. Learn to perform anesthesia and surgery to implant telemetric transmitter
2. Learn to measure body temperature changes and VO2 and VCO2
3. Learn to harvest tissues for post-mortem biochemical studies
4. Learn to isolate mitochondria and measure oxygen consumption rate
5. Participate in data analysis and manuscript preparation

Research Type: Basic Science
Mentor(s): Fumito Ichinose, M.D., Ph.D.; Allyson Hindle, Ph.D.

Institution: **Massachusetts General Hospital (The General Hospital Corp.)**

Project Topic: Minimizing ICU Neurological Dysfunction with Dexmedetomidine-induced Sleep (MINDDS) Study
Overview: Delirium is an acute brain dysfunction characterized by disturbances in attention, awareness, and cognition not explained by a preexisting neurocognitive disorder. It is associated with increased mortality, prolonged hospitalization/institutionalization, and long-term cognitive deficits. Following a systemic challenge such as critical illness, activated glial cells aid a neuroinflammatory state that contributes to delirium. Sleep deprivation is a modifiable risk factor for development of delirium. Presently, no current medication (benzodiazepines, antipsychotics) induces natural sleep or reduces incidence of delirium. We've recently found that dexmedetomidine can be administered to induce REM sleep and non-REM I-III sleep. Our overall objective is to evaluate the efficacy of dexmedetomidine induced sleep in preventing delirium in extubated cardiac surgical patients,and investigate whether recently described intraoperative EEG signatures of the aging brain are associated with delirium.
Student Role: By participating in this research project, the student will learn fundamental of randomized controlled clinical trials such as randomization procedures, study recruitment, data acquisition, and data analysis. More specifically, he/she will be involved in patient recruitment, and EEG data analysis using spectral estimation techniques.
Research Type: Clinical
Mentor(s): Oluwaseun Johnson-Akeju, M.D., M.M.Sc.

Institution: **Massachusetts General Hospital (The General Hospital Corp.)**

Project Topic: Using the Electroencephalgram to Characterize the Anesthetic State of Elderly Patients Receiving General Anesthesia or Sedation
Overview: We have recently established that the unprocessed electroencephalogram (EEG) and its spectrogram can be used to track reliably the brain states of patients receiving general anesthesia and sedation. Each anesthetic has a specific EEG signature that relates to its neurophysiological mechanism of action in brain circuits. We've established also that each of these signatures changes as a function of age. We're now systematically collecting data on elderly patients (60 years and older) to precisely define EEG signatures for the commonly used anesthetics, propofol, sevoflurane, ketamine and remifentanil. We're collecting the data in our operating rooms and using the spectral analysis techniques that we've developed to analyze the data. This provides a unique opportunity for medical student to join my colleagues and me in the operating room during the cases, to watch the brain states on the EEG in real time, download the data from the monitor and take it back to the laboratory for analysis.
Student Role: The medical student will have the unique opportunity to join my colleagues and me in the operating room during the cases, to watch the brain states on the EEG in real time, download the data from the monitor and take it back to the laboratory for analysis. The student will prepare a powerpoint presentation to give at the laboratory meeting and will be included as an author on the manuscript when it is submitted for publication. The student will also give a poster presentation at the ASA/FAER meeting.
Research Type: Clinical
Mentor(s): Emery N. Brown, M.D., Ph.D.

Institution: **Massachusetts General Hospital (The General Hospital Corp.)**

Project Topic: 1) TASK tandem pore potassium channel molecular pharmacology. We are interested in the molecular mechanism(s) by which inhaled volatile anesthetic gases activate TASK potassium channels and how breathing stimulant compounds (e.g., doxapram) inhibit TASK channels. 2) Characterization of the breathing stimulant effects of TASK tandem pore potassium channel inhibiting compounds. We are interested in how a new class of breathing stimulants compounds (TASK potassium channel antagonists) alter breathing in rodents, where they act anatomically to stimulate breathing, and if they can reverse opioid-induced respiratory depression. We have also recently begun characterizing several neuropeptides, which provide excellent reversal of even deep levels of opioid-induced respiratory depression.

Overview:

1. 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 inhibition by breathing stimulant compounds and for activation by volatile anesthetics. We will assess effects on potassium channel function using an Ussing chamber system and/or using a high throughput yeast-based system combined with next generation sequencing.
2. We will inject breathing stimulants compounds into rats, systemically or regionally (e.g., into CSF or carotid artery), and study its effect on breathing. We will inject the compounds systemically into rats treated with an opioid and quantify its effect on opioid-induced respiratory depression.

Student Role: 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.
Research Type: Basic Science
Mentor(s): Joseph F. Cotton, M.D., Ph.D.

Institution: **Medical College of Wisconsin**

Project Topic: Nerve injury - effects on pain and CNS connectivity
Overview: Damage to peripheral nerves is common, and initiates diverse consequences. My lab investigates underlying cellular and molecular mechanisms of dysfunction following injury and explores novel treatments, including genetic therapy and electrical neuromodulation. Additionally, we are investigating altered brain activity following peripheral sensory disconnection and possible treatments to limit post-repair disability.
Student Role: Hands-on participation in animal surgery and behavioral testing, functional magnetic resonance imaging, and data analysis.
Research Type: Basic Science
Mentor(s): Quinn H. Hogan, M.D., Vice Chair for Research, Professor of Anesthesiology

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Institution: **Medical College of Wisconsin**

Project Topic:

1. Implementing perioperative surgical home (PSH) pathways across disciplines.
2. Cardiovascular and autonomic effects of reversing neuromuscular blockade (NMB).

Overview:

1. Perioperative pathways using evidence based medicine and leveraged resources can have a major benefit for the health of the patient, surgical outcomes and hospital length of stay. Surgical procedures can result in unwanted health events and unanticipated longer hospital stays. The PSH model is not new but is often too standardized to account for individual patient health status, such as frailty and decreased mobility and often does not fit patients with certain socio-economic challenges. Ongoing studies are using data extraction methods and resource allocation to implement pathways and assessing outcomes.
2. Reversal of neuromuscular blockade with sugammadex has been associated with bradycardia and asystole. Ongoing studies are evaluating this response in both volunteers and patients.

Student Role: Assist with the conduct of study, including patient recruitment, adherence to protocols and data collection. Some studies involve anesthesia led group meetings and planning. Data analysis and summary both graphically and statistically is needed. Submission of research findings for presentation at local, regional or national meeting is expected.
Research Type: Clinical
Mentor(s): Thomas J. Ebert, M.D., Ph.D., Professor of Anesthesiology

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Institution: **Medical College of Wisconsin**

Project Topic: Novel Pharmacological Treatments of Intraoperative and Post-Operative Vasoplegia

Overview: Intraoperative and post-operative vasoplegia, or refractory hypotension, is commonly observed in specific patient populations including those undergoing liver transplant, cardiac bypass,and patients who continue their angiotensin converting enzyme inhibitor (ACEI) or angiotensin receptor blocker (ARB) prior to surgery.Through collection of discarded surgical specimens,human resistance arterioles dissected from adipose tissue are cannulated and pressurized in order to study novel pharmacological treatments of vasoplegia. Specifically this study will examine the effectiveness and mechanism of A779 in ACEI-induced vasoplegia as well as investigate the mechanism of how hydroxocobalamin (vitamin B12) increases vascular tone in patients who are resistant to commonly used vasoconstrictors.Overall this study will impact the guidelines of perioperative use of ACEIs and ARBs and how vasoplegia is treated not only in the operating room but in critically ill patients with refractory hypotension.
Student Role: Assist with vessel set-up, cannulation, and vascular reactivity studies. The student will also assist in data acquisition, analysis, and manuscript preparation. Submission of research findings for presentation at local, regional or a national meeting.
Research Type: Basic Science
Mentor(s): Julie K. Freed, M.D., Ph.D., Assistant Professor of Anesthesiology

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Institution: Medical College of Wisconsin

Project Topic: The Stowe laboratory is currently active in several areas: A) Mechanism and timing of activation of cardiac mitochondrial small and large K+-sensitive Ca2+ (SKCa and BKCa) channels; their protective role against acute cardiac injury; identification of specific mitochondrial SKCa splice variants in several species, including human; and the molecular and biophysical mechanisms underlying protection by opening of these mitochondrial channels. B) Mitigation of Ca2+ dysregulation and excess reactive oxygen species emission in acute cardiac injury. C) Regulation of mitochondrial Ca2+ flux through Ca2+ channels and Ca2+ exchangers with H+, K+ and Na+; and exploration of dynamic mitochondrial Ca2+ buffering mechanisms. D) Ischemia-induced nitration of nucleotide transporters VDAC and ANT on promoting mitochondrial and cell damage with identification of specific residues that are causative in impeding nucleotide transport and mitochondrial dysfunction.
Overview: Dr. Stowe is funded by the following grants:

- VA BX002539-01 Merit Grant Proposal (04/01/16-03/31/20) - "Differential cardioprotection by mitochondria Ca2+ sensitive potassium channels." The aim of this proposal is to compare the effects and timing of the small and large potassium sensitive calcium channels in protection against acute cardiac injury. David Stowe, M.D., Ph.D. Role: Principal Investigator
- 1K99HL121160-01 National Institutes of Health (01/01/15-12/31/19) –"Mechanistic characterization of calcium and ROS induced mitochondrial dysfunction." The aim of this training grant is to mentor Dr. Jason Bazil in research on the interaction of calcium and ROS in cardiac injury and to model how interventions may reduce the injury. David Stowe, M.D., Ph.D. Role: Mentor and Co-Investigator

In addition, Dr. Stowe collaborates in several other funded projects with researchers who share similar goals but who have different skills sets and knowledge.
Student Role: An individual FAER student under my mentorship would be responsible for researching the literature, learning research techniques, conducting experiments with the proper controls, application of unbiased treatment of the data, data analysis, data compilation, data interpretation, preparation of abstracts and posters related to the findings. Each step will be supervised by the mentor. Dr. Stowe has mentored 4 PhD students, and 7 MS students, and co-mentored many others. He has had 25 post-doctoral fellows, 31 NIH or FAER medical students in research training and 22 pre-doctoral students interested in pursuing research careers. His role as a FAER mentor, at any level of training, is to expose the student to high quality research projects with plenty of collaborators to share in the training.The goal is successful approaches for completing comprehensive but well-rounded proposals that will lead to independent and successful researchers, particularly those who also have clinical ambitions.
Research Type: Basic Science
Mentor(s): David F. Stowe, M.D., Ph.D., Professor of Anesthesiology and Physiology

Institution: **Medical College of Wisconsin**

Project Topic: Post-translational modifications of mitochondrial ion channels in response to stress
Overview: Mitochondrial dysfunction is central in the etiology of numerous human maladies, including neoplastic, neurodegenerative and cardiac diseases. The voltage dependent anion channel 1 (VDAC1) on the outer mitochondrial membrane is a major regulatory gateway in and out of the organelle. It plays pivotal roles in the exchange of metabolites and ions, and mediates cell death. Post-translational modifications (PTMs, for example phosphorylation) of VDAC1 have been implicated in diseases, but their impact on VDAC1 function and subsequently on mitochondrial and cellular functions are not well understood. Our goal is to unravel the functional significance of PTMs on VDAC1. We employ a highly orchestrated multi-faceted approach (electrophysiology, molecular biology, proteomics and transgenic animal models) to investigate how functional changes in VDAC1 tip the balance between cell survival and death, and contribute to the pathogenesis of ischemic heart and other mitochondrial-related diseases.
Student Role: The student will participate in various aspects of the research program, including acquiring proficiency in various laboratory techniques. The techniques to be learned will be project specific. The student will also participate in research group meetings, contribute to the design of experiments, and learn data analysis.
Research Type: Basic Science
Mentor(s): Wai-Meng Kwok, Ph.D., Director of Basic Science Research, Professor of Anesthesiology and Pharmacology & Toxicology

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Institution: **Medical College of Wisconsin**

Project Topic: My laboratory focus is studying brain reorganization following injury and disease using modern neuroimaging methodology.
Overview: My research is targeted at understanding brain reorganization in the context of injury/disease and its corresponding relevance to clinical practice. We are currently studying these phenomenon in three distinct and clinically relevant contexts; chronic hypertension, peripheral nerve injury/repair, traumatic brain injury. For hypertension, we investigate how the brain's small blood vessels are affected by high blood pressure. We measure structural / functional cerebrovascular properties using magnetic resonance imaging, electrophysiology, and optical imaging. For nerve injury/repair, we study how the brain reorganizes after peripheral nerve injury/repair. Neuromodulation is being explored as a possible therapeutic by utilizing electrical nerve stimulation to improve connectivity between the central and peripheral nervous system. For traumatic brain injury (TBI), we are developing novel MR imaging methods to develop a comprehensive timeline of metabolic changes post-injury.
Student Role: A student in my laboratory can expect to assist with animal surgery/anesthesia, be trained in MR imaging methods, perform image data analysis, help with animal behavior testing, and learn critical thinking skills.
Research Type: Basic Science
Mentor(s): Christopher Pawela, Ph.D., Assistant Professor of Anthesiology

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Institution: **Medical College of Wisconsin**

Project Topic: Mitochondrial dysfunction in mild repetitive traumatic brain injury (mTBI) in a rat model
Overview: Mitochondria are responsible for the ATP (energy) produced in cells, especially in excitable cells, e.g. heart and brain. Mitochondria are also important in myriad of other cellular activities for maintaining homeostasis or propagation of cell injury. Our recent studies show that events that lead to cell death emanate from mitochondria leading by release of signaling molecules. The initiators of the signaling events are excess mitochondrial Ca2+ or reactive oxygen/nitrogen species production that culminate in damage to mitochondria and concurrently cell demise. We have also reported that therapeutic strategies that target mitochondria bioenergetics could represent novel approaches to attenuate cell death during ischemic stress. We will focus on the role of mitochondria as the cornerstone of neuronal damage following mild traumatic brain injury, and to elucidate the molecular mechanisms involved in the brain injury.
Student Role: The student will conduct research that will involve acquiring tissue biopsies from regions of the brain susceptible to brain injury following mTBI. Specific brain regions showing damage will be delineated using

brain scanning and mapping techniques. Tissue biopsies from the injured brain regions will be obtained. Mitochondria will be isolated from the damaged regions of the brain, to carry out bioenergetics studies.
Research Type: Basic Science
Mentor(s): Amadou KS Camara, Ph.D., Professor of Anesthesiology

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Institution: **Medical College of Wisconsin**

Project Topic: Effects of general anesthetics on respiratory control and airway patency
Overview: This project is part of our NIH-funded research investigating the effects of opioids and general anesthetics on respiratory function. The research is conducted in an in vivo, decerebrate rabbit model. After surgically exposing the brainstem we record single respiratory neurons and cell nuclei with microelectrodes and inject neurotransmitter agonists and antagonists to determine the function of individual respiratory sub-areas. Local or systemic application of opioids and general anesthetics allows us to identify drug effects on these areas. We found that much of the respiratory rate depression with intravenous remifentanil was mediated by the Parabrachial Nucleus. We are currently investigating whether the residual depression of drive is due to an effect on the Retrotrapezoid Nucleus. The use of clinical doses and drug concentrations makes this research of significant clinical importance.
Student Role: The student will conduct his/ her own project gathering pilot data on the effects of an opioid or general anesthetic in a specific area of the respiratory pattern generator. With help of the mentor and an experienced technician the student will perform part of the surgical procedure on the anesthetized rabbit including line placement, tracheostomy, craniectomy and decerebration. This includes maintaining general anesthesia and cardiorespiratory homeostasis. Prior completion of the mandatory VA animal training and safety modules is mandatory. The student will conduct the neuronal recording/ drug injection protocols and will later analyze the data and prepare histology slides. The data will be presented as a poster at the Medical College of Wisconsin Research Days or at the annual meeting of the American Society of Anesthesiologists. One day per week, the student will join me in the operating room at Children's Hospital of Wisconsin where I am a pediatric anesthesiologist.
Research Type: Basic Science
Mentor(s): Astrid Stucke, M.D., Associate Professor of Anestheslogy

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Institution: **Medical University of South Carolina**

Project Topic: Simulation Education for Ebola Healthcare Team Competency
Overview: The purpose of this project is to determine the efficacy of the Medical Unit Specialized Simulation Training (MUSST) in other medical facilities. It is important to test the effectiveness of this product away from its home and away from those who created it.
Student Role: The students will be involved in the assessment of simulation education. Specifically they will learn to use a digital grading tool that grades individuals and teams who are performing such tasks as donning and doffing Personal Protection Equipment (PPE). The students will be responsible for creating tables regarding the performance of 13 scenarios and work with a statistician to analyze the data looking for trends in areas of poor performance in the simulated tasks. The students will learn about experimental design, educational research and the publication of this type of investigation. The study is funded by the CDC. The reports will be presented at the annual meeting of Simulation in Healthcare, possibly the ASA. The study will be submitted for publication in the Journal of Healthcare Simulation. The role of the medical student in writing will be editing the methods section and reviewing the results.
Research Type: Clinical
Mentor(s): Jerry Reves, M.D.; John Schaefer, M.D.

Institution: **Medical University of South Carolina**

Project Topic: Comparison of Propofol and Sevoflurane as a Primary Anesthetic for Caridac Ablation of Atrial Fibrillation

Overview: A side effect of some volatile anesthetics, such as isoflurane and desflurane, is enhanced automaticity, accounting for secondary atrial pacemakers. Volatile anesthetics also have varying effects on the AV node and His-Pukinje system. These agents also prolong the QT interval and, for this reason, volatile anestheics as a group have at times been avoided for atrial fibrillation ablation due to the fear that they may affect the efficacy of the ablation and increase recurrence. However, sevoflurane does not have the effects shown for other volatile anesthetics cardiac conduction. At this point there has not been a study comparing propofol, a non volatile anesthetic typically used in these cases, to sevoflurane, a volatile anesthetic, to determine if volatile anesthetics should be avoided during these procedures. This study will challenge the existing belief that sevoflurane increases the length of time to ablate atrial fibrillation and also decreases the efficacy of the ablation.
Student Role: The student will be involved in data acquisition, obtaining informed consent, and assisting in data entry and analysis. During times without research activity, they will be welcome to spend time with the investigators learning about operative anesthesia or other research based on their interest.
Research Type: Clinical
Mentor(s): Eric Nelson, D.O.

Institution: **Medical University of South Carolina**

Project Topic: Effect of Midazolam Premedication on Respiration During General Anesthesia in Children Receiving Povidone-Iodine Prep Solution Prior to Strabismus Surgery
Overview: Determine whether premedication with midazolam influences the effect of povidone-iodine ophthalmic prep solution on respiration in children undergoing strabismus surgery with general anesthesia.
Student Role: The student will be involved in data acquisition, obtaining informed consent, and assisting in data entry and analysis. During times without research activity, they will be welcome to spend time with the investigators learning about operative anesthesia or other research based on their interest.
Research Type: Clinical
Mentor(s): Michelle Rovner, M.D.

Institution: **Medical University of South Carolina**

Project Topic: Grading Aortic Stenosis: A Compariosn of Pre-Cardiopulmonary Bypass Transesophageal Echocardiography (TEE) to Preoperative Transthoracic Echocardiography (TTE)
Overview: The overall aim of this project is to provide insight into the accuracy and clinical utility of transesophageal echocardiocraphy (TEE) derived aortic stenosis grading parameters during the pre-cardiopulmonary bypass (pre-CPB) period. We aim to compare values obtained during pre-CPB TEE with values already obtained previously during transthoracic echocardiography (TTE) for patients undergoing aortic valve replacement (AVR) for aortic valve stenosis (AS).
Student Role: The student will be involved in data acquisition, obtaining informed consent, and assisting in data entry and analysis. During times without research activity, they will be welcome to spend time with the investigators learning about operative anesthesia or other research based on their interest.
Research Type: Clinical
Mentor(s): George Whitener, M.D.

Institution: **Medical University of South Carolina**

Project Topic: A Work Systems Analysis of Sterile Processing
Overview: Work Systems Analysis (WSA) is an analytical process by which features of a socio-technical system are revealed, going beyond traditional engineering, design, behavior or process to model whole systems of work(1-3). The human-centered approach central to work systems analysis provides a new understanding of the challenges and enablers of effective performance in sterile processing, and an understanding of how the work context contributes to success or failure. This would be the first study to deploy a WSA in SPD to explore these issues and to model the function of such facilities. This will provide a platform to undertake future improvement and evidenced-based work. This is a unique opportunity to define a new area of healthcare safety research and to advance the science and practice of sterile processing.

Student Role: The student will be involved in data acquisition, obtaining informed consent, and assisting in data entry and analysis. During times without research activity, they will be welcome to spend time with the investigators learning about operative anesthesia or other research based on their interest.
Research Type: Clinical
Mentor(s): Ken Catchpole, Ph.D.

Institution: **Medical University of South Carolina**

Project Topic: "The effect of Percutaneous Endoscopic Gastrostomy (PEG) placement on Hospital Length of Stay and Patient Morbidity"
Overview: We hypothesize that patients with certain comorbidities will have an increased hospital length of stay after PEG placement, thus increasing healthcare burden after a procedure that is thought to aid in discharge and patient lifestyle. In patients who cannot maintain their own needs for oral intake, PEG allows the delivery of nutrients directly to the gastro-intestinal tract. This mode of nutrient delivery is preferred over other modes of nutrient delivery because of decreased risk of complications. Research has shown that PEG placement is associated with high short term mortality. Specific comorbidities have been shown to adversely affect outcomes of PEG placement and should therefore be considered in the timing and selection process for those receiving a PEG tube. A universal criteria or understanding the effect of patient morbidity has not been established for PEG tubes. This research would help improve use of healthcare resources and maximize patient care.
Student Role: The student will be involved in data acquisition, obtaining informed consent, and assisting in data entry and analysis. During times without research activity, they will be welcome to spend time with the investigators learning about operative anesthesia or other research based on their interest.
Research Type: Clinical
Mentor(s): Carlee Clark, M.D.

Institution: **Medical University of South Carolina**

Project Topic: The presence of subclinical Harlequin Syndrome in subjects receiving thoracic epidural analgesia
Overview: The purpose of this study is to determine the presence of subclinical Harlequin Syndrome in subjects receiving thoracic epidural analgesia.

Hypothesis**:** A proportion of subjects with thoracic epidural analgesia will have subclinical Harlequin Syndrome as manifested by a temperature difference between the left and the right side of the face.

Student Role: The student will be involved in data acquisition, obtaining informed consent, and assisting in data entry and analysis. During times without research activity, they will be welcome to spend time with the investigators learning about operative anesthesia or other research based on their interest.
Research Type: Clinical
Mentor(s): Cory M. Furse, M.D.

Institution: **Medical University of South Carolina**

Project Topic: Birthing Experience of Obese Partuients: Quality of Care During Pregnancy, Labor and Delivery
Overview: The purpose of this study is to determine whether the perceptions of quality of anesthesia care differs between obese and non-obese pregnant patients during the perinatal period.

Hypothesis: Obese patients may express less satisfaction with anesthesia care during labor/delivery and immediate postpartum period.

Student Role: The student will be involved in data acquisition, obtaining informed consent, and assisting in data entry and analysis. During times without research activity, they will be welcome to spend time with the investigators learning about operative anesthesia or other research based on their interest.
Research Type: Clinical
Mentor(s): Ebony Hilton, M.D.

Institution: **Medical University of South Carolina**

Project Topic: Identifying Risk Factors for Increased Perioperative Bleeding with Surgical Dilation and Evacuation

Overview: Certain variables may be associated with an increased risk of perioperative bleeding during a dilation and evacuation procedure (D&E). Our primary objective is to retrospectively examine patients who underwent first or second trimester D&E at MUSC to potentially identify factors which may be associated with an increased risk of perioperative bleeding, in order to improve care. A secondary endpoint will be the prevalence of hemorrhage among this group of D&E patients.
Student Role: The student will be involved in data acquisition, obtaining informed consent, and assisting in data entry and analysis. During times without research activity, they will be welcome to spend time with the investigators learning about operative anesthesia or other research based on their interest.
Research Type: Clinical
Mentor(s): Sylvia Wilson, M.D.

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

Project Topic: Extracorporeal membrane oxygenation (ECMO) continues to expand its indication and has substantially increased in use over the past several years.The improved survival has increased the number of adult patients receiving ECMO for many applications, however, the clinicians are forced to deal with a number of complications associated with the application.The most commonly occurring complications are infection, renal failure, sepsis, bleeding tendency, neurological events, venous thrombosis and limb ischemia, hemorrhage and vascular injury. For the purpose of this study, we are utilizing non-invasive sensors for monitoring the distal perfusion of the limb during antegrade/retrograde catheter assisted perfusion. NIRS (near-infrared spectroscopy) tissue sensors will be able to detect the difference in oxygen saturation between the two extremities. The underlying assumption is that the extremity where femoral cannulation was performed will show signs of oxygen desaturation.
Overview: In this single-center prospective cohort study, we are evaluating the ability of NIRS sensors in detecting limb ischemia in subjects on V-A ECMO with femoral artery cannulation. This ongoing study is recruiting patients 18 years and older who are requiring the use of V-A ECMO with femoral cannulation for any indication. ECMO procedure and other treatments regimes will follow the standard of care practiced in our hospital.After obtaining informed consent NIRS sensors will be placed on the gastrocnemius muscle and the readings will be recorded for 24 hours. Also, information regarding blood pressure, heart rate, amount of inotropes and other medications used and physical signs of limb ischemia will be monitored at periodic intervals.
Student Role: The student will be working closely with the critical care team and the ICU team in identifying ECMO patients according to the protocol. Preparing the informed consent documents and facilitate the consenting process. Placement of NIRS sensors and collecting study specific data points at prespecified time points
Research Type: Clinical
Mentor(s): Jonathan Leff M.D.; Singh Nair Ph.D.

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

Project Topic: Perioperative HbA1C values and their association with surgical outcomes are studied extensively. However, the role of different anesthesia regimes in this equation has not been fully elucidated. In this single-center retrospective study, we plan to evaluate the association between different ambulatory anesthesia regimes, perioperative HbA1C values, intraoperative and postoperative glycemic changes and 30-day postoperative complications and re-admissions. We hypothesize that patients with higher HbA1C values undergoing ambulatory surgery under general anesthesia are having a higher propensity for developing complications.
Overview: For the purpose of this retrospective study, medical records will be reviewed for all the patients who had undergone ambulatory surgery during the time period 2015-2016. Following data points will be collected: Patient demographic characteristics, type of surgery, anesthesia method and drugs used, use of other intraoperative and postoperative medications relevant for the study purpose, 3 and 6-month HbA1C values, available blood glucose values intraoperative and postoperative complication, 30-day readmission, and ED visits.

Student Role: Student will be reviewing the medical charts and will be collecting information on to an excel datasheet, will participate in the research discussions. The final week of the fellowship will be devoted to data analysis (meeting with statistician) and learning about data analysis.
Research Type: Clinical
Mentor(s): David Adams M.D.; Singh Nair Ph.D.

Institution: **New York Presbyterian Hospital (CORNELL CAMPUS) Program**

Project Topic: Global Health Elective Location as compared to Poverty Indicators
Overview: This project involves a comparative analysis of global health elective location mapped against poverty indicators. As background, global health work in surgery and anesthesia typically consists of medical missions abroad. This involves a team of surgeons, anesthesiologists, nurses, and staff going abroad and completing a specific number of surgeries. While this may decompress the surgical need globally (as published by the Lancet Commission on Global Health, 5 billion people worldwide lack access to safe and affordable surgical and anesthesia care), there seems to be a disconnect between where surgical need is the greatest versus where care is provided. For example, medical missions typically take place in South Africa rather than Burundi or Brazil rather than Haiti. The proposed project will evaluate the data on where medical missions take place versus where need is the greatest (using World Bank poverty indicators).
Student Role: The student's role in this project will be two-fold:

1. To learn how to conduct a rigorous literature review and retrospective study.
2. To apply these skills to capture all relevant publications on medical missions.
3. To collect and collate all World Bank data on major poverty indicators (maternal mortality rates, income status, GDP/GNI, education rates, etc).
4. To work with our biostatistician to map where medical missions occur as compared to where the need is greatest in the world.

Research Type: Health Services
Mentor(s): Gunisha Kaur, M.D.; Kane Pryor, M.B. B.S.; Sheida Tabaie, M.D.

Institution: **Northwestern University Feinberg School of Medicine**

Project Topic: Finding solutions to disparities in labor analgesia
Overview: Racial and ethnic disparities exist in epidural labor analgesia use. Hispanic and African American women are less likely than non-Hispanic white women to use neuraxial labor analgesia. Our group has done significant work at the patient-, provider-, and systems-level to help understand factors that contribute to racial and ethnic disparities in epidural analgesia use. We plan to use the knowledge gained from these previous projects to develop a patient-centered website to help patients better understand their analgesic options. We have several projects that can be completed during the eight-week fellowship; the student will be assigned one component of the overall study. This may include experiences using both quantitative and qualitative methodologies
Student Role: The student will have an active role in this project. The medical student will participate in participant recruitment, data collection and analysis, as well as abstract and manuscript preparation.

PLEASE NOTE: The student will need to come to the university one week before their start date to visit Corporate Health so that we can get clinical privileges by the time the student begins.

Research Type: Health Services
Mentor(s): Paloma Toledo, M.D., M.P.H.

Institution: **Northwestern University Feinberg School of Medicine**

Project Topic: Evaluation of the implications of acute postpartum pain
Overview: Childbirth is the most common reason for admission to a hospital in the United States and labor is considered to be one of the most painful experiences a woman will experience in her lifetime. There are several

implications, both in the short-term, and long-term for both mothers and their infants, of untreated pain. Our group is undertaking studies that will elucidate the role of acute pain management on long-term outcomes.
Student Role: The student will have an active role in this project. The medical student will participate in data collection and analysis, and abstract and manuscript preparation.

PLEASE NOTE: The student will need to come to the university one week before their start date to visit Corporate Health so that we can get clinical privileges by the time the student begins.

Research Type: Health Services
Mentor(s): Paloma Toledo, M.D., M.P.H.

Institution: **Northwestern University Feinberg School of Medicine**

Project Topic: Reducing the risk of preventable postpartum nerve injuries
Overview: The objective of this project is to improve identification of at-risk women and deconstruct the factors contributing to nerve injuries in order to develop targeted interventions that will ultimately reduce the risk of preventable injuries. Maternal, fetal, and anesthetic, and obstetric factors related to new onset lower extremity nerve injury will be explored using individual-level electronic health record data for a cohort of women who delivered between 2007 and 2017. Engineering risk assessment methods will be used to assess the failures in the systems and processes of delivery care that lead to lower extremity nerve injury.
Student Role: The student will have an active role in this project. The medical student will participate in data collection and analysis, and abstract and manuscript preparation.

PLEASE NOTE: The student will need to come to the university one week before their start date to visit Corporate Health so that we can get clinical privileges by the time the student begins.

Research Type: Health Services
Mentor(s): Paloma Toledo, M.D., M.P.H.

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

Project Topic: Airway GABAA receptors and reactive airway disease.
Overview: 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 in vitro. Assist with cell based assays measuring intracellular calcium, plasma membrane potential and intracellular second messengers. ELISA and western blotting of intracellular proteins will also be performed.
Research Type: Basic Science
Mentor(s): Charles Emala, MS, M.D.

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

Project Topic: Use of palliative care and end-of-life care in the ICU, long-term outcomes of critical illness
Overview: The project consists of a series of epidemiologic and retrospective studies aimed at understanding the intersection between palliative care and critical care, and the availability and impact of palliative care services for critically ill patients and high-risk surgical patients.
Student Role: The data are already in existence, and thus, there should be no need for data collection. The student will be involved in conducting the analysis of the data (with help), interpreting the data after analysis, generating tables and figures, and conducting a literature review to facilitate writing the manuscript for publication. The student would be responsible for preparing the first draft of the manuscript.
Research Type: Health Services
Mentor(s): May Hua, M.D., M.Sc.

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

Project Topic: Epidemiology of perioperative complications and adverse outcomes in pediatric patients.

Overview: 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 adverse outcomes.
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.
Research Type: Clinical
Mentor(s): Caleb Ing, M.D., MS

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

Project Topic: Acute kidney injury and remote organ dysfunction
Overview: 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 ischemic preconditioning on acute kidney injury in vivo as well as in vitro.
Student Role: Under careful supervision by laboratory staff including the PI, the student will learn to perform cell culture, immunoblotting, RT-PCR and cell death assays. The student will be instructed in detail how to collect data and maintain laboratory notebook for data recording. In addition, the student will be instructed to use statistical software for data analysis and preparation. If data generated by the student is included in a manuscript for publication, he/she will be placed as one of the authors in the paper.
Research Type: Health Services
Mentor(s): H.T. Lee, M.D., Ph.D.

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

Project Topic: Carbon monoxide and Fragile X Syndrome
Overview: Fragile X syndrome is the leading genetic cause of autism. Recently, traffic-related pollution was identified as a risk factor for developing autism. In this project, we are evaluating the effect of exposing Fragile X mice to a common component of air pollution (carbon monoxide).
Student Role: Assist in rodent exposures. Assist in measuring various aspects of the apoptosis pathway in the mouse brain through a variety of basic science techniques.
Research Type: Basic Science
Mentor(s): Richard J. Levy, M.D.

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

Project Topic: Physical activity and neurocognitive outcome in children with congenital heart diseases
Overview: The goal is to test the hypothesis that regularly structured physical activity can improve neurocognitive functions in children ages 3-7 years with congenital heart diseases.
Student Role: Assist faculty in recruiting patients, tracking reports of physical activity and wearable devices-documented physical activity.
Research Type: Clinical
Mentor(s): Lena Sun, M.D.

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

Project Topic: Lung Smoke Exposure and Injury
Overview: Studies in the laboratory have identified a shift in cholesterol transporter proteins in the lung upon smoke exposure and injury. These changes correlate with increased inflammation and protease activity. Present studies are exploring the consequences of lipid changes on lung injury and emphysema.
Student Role: Summer students will perform Western Blot analysis and PCR analysis to explore the mechanism by which shifts in lipid proteins upon smoke exposure leads to tissue destruction.
Research Type: Basic Science
Mentor(s): Jeanine D'Armiento, M.D., Ph.D.

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

Project Topic: Anesthesia and neuropathogenic pathways associated with Alzheimer's Disease.
Overview: The main focus of this research is to determine the impact of commonly used anesthetic agents on neuropathogenic pathways associated with the development of Alzheimer's disease. Specifically, using transgenic mouse models of AD as well as in vitro methods, we are focusing on the effects of these anesthetics and surgery-induced neuroinflammation on tau protein (a microtubule-associated protein) function and pathology, with the long-term goal of identifying anesthetics that are safest for patients with or at risk for AD.
Student Role: Assist with cellular biochemistry in mice.
Research Type: Basic Science
Mentor(s): Robert Whittington, M.D.

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

Project Topic: A retrospective case review for transsphenoidal skull base surgeries
Overview: When tumors involve the base of the skull, cranial nerves and blood vessels lie in close proximity and present challenges to the neurosurgical and anesthesiology teams. A common approach is to use minimally invasive endoscopic endonasal surgery to resect these skull base tumors. This study aims to examine the use of endoscopic endonasal surgical procedures for the treatment of skull base tumors. Previous studies have demonstrated the effectiveness of the endoscopic endonasal approach for tumor resection, but larger analyses are needed in order to make stronger comparisons to other surgical techniques. In this study we will look specifically at intraoperative complications, remission rates, hospital readmissions, and survival rates at 30 days and 6 months postoperatively.
Student Role: As this is a retrospective study, students will have the opportunity to review medical charts for outcomes of this type of surgery. organization into a database for analysis. The student will be trained on data interpretation and will have the opportunity to write the manuscript. First-authorship will be offered if the project and manuscript is completed during the summer.
Research Type: Clinical
Mentor(s): Sergio D Bergese, M.D.

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

Project Topic: ACTIVE EMERGENCE FROM ISOFLURANE GENERAL ANESTHESIA INDUCED BY METHYLPHENIDATE
Overview:

HYPOTHESIS: Based on this significant arousal stimulatory effect, we hypothesize that methylphenidate (inhibitor ofdopamine and norepinephrine transporters) decreases the emergence time from isoflurane general anesthesia.

PRIMARY OBJECTIVE: To assess whether methylphenidate affects time of emergence from isoflurane general anesthesia.

SECONDARY OBJECTIVES**:** To assess the efficacy of methylphenidate in preventing PONV (limited opioids consumption).To assess the efficacy of methylphenidate in preventing opioids dose escalation (fast cognitive improvement with better pain control).

Student Role: The Student will be involved in screening, consenting and enrolling patients into the study. He/she will be trained to identify possible candidates for the study, perform the informed consent, and once the patient is enrolled, the student will perform an interview to collect demographics, medical history and medications. The student will have the opportunity to interact and assist the anesthesiologist on the case with any study procedures. He/she will perform the necessary assessments intraoperatively and will record the data on the case report forms. Finally, the student will transfer the data to a database for analysis and will be trained to interpret the data. The student will be expected prepare an abstract and/or poster to present at the local OSUMC Research Day and at an Anesthesiology National Meeting. There will be an opportunity for the student to be a co-author on the manuscript if sufficient work is completed.

Research Type: Clinical
Mentor(s): Nicoleta Stoicea, M.D., Ph.D., study PI

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

Project Topic: Postoperative Delirium in Patients Undergoing Hip Arthroplasty
Overview: Specific circulating microRNA's have been identified in patients with neurological diseases or deficits, and specifically those with neurodegenerative conditions. Furthermore, available evidence primarily in preclinical/ animal models supports the hypothesis that post-surgical/anesthesia – induced neuroinflammation leads to post-operative cognitive decline or dysfunction. We hypothesize that specific circulating microRNA's involved in the pro-inflammatory response to surgery/anesthesia are a suitable biomarker of Delirium and/or POCD in surgical hip-arthroplasty patients.
Student Role: The Student will be involved in screening, consenting and enrolling patients into the study. He/she will be trained to identify possible candidates for the study, perform the informed consent, and once the patient is enrolled, the student will perform an interview to collect demographics, medical history and medications. The student will have the opportunity to interact and assist the anesthesiologist on the case with any study procedures. He/she will perform the necessary assessments intraoperatively and will record the data on the case report forms. In order to collect the data, the student will be trained on how to administer the neuropsychological testing as part of the study procedures. Finally, the student will transfer the data to a database for analysis and will be trained to interpret the data. The student will be expected prepare an abstract and/or poster to present at the local OSUMC Research Day and at an Anesthesiology National Meeting.
Research Type: Clinical
Mentor(s): Nicoleta Stoicea, M.D., Ph.D.

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

Project Topic: Perioperative Risk Factors for Postoperative Respiratory Complications in Patients at Risk for Obstructive Sleep Apnea
Overview: Our study had the following specific aim: To study the incidence of postoperative respiratory complications (PRCs) based on cumulative minutes per 24 hours of oxygen desaturation events ≤ 90% , in patients with and without risk factors for obstructive sleep apnea (OSA) undergoing elective noncardiac surgery (NCS). The clinical outcome end points for this study are significant postoperative respiratory complications (PRCs), acute respiratory failure (ARF), and tracheal reintubation. Postoperative hypoxemia will be considered present if the patient will develop postoperative RF or oxygen desaturations ≤ 90% or a sustained 4% reduction from last recorded value, or if confirmed by arterial blood gas measurements postoperatively. Postoperative RF will be defined as the inability to maintain adequate oxygenation requiring assisted ventilation (within 24 h) including PEEP and CPAP, endotracheal reintubation (within 48 hours), or tracheostomy.
Student Role: To export Nelcor data, analyze data and create a sub study regarding demographics, type of surgery, length of surgery and anesthesia and hemodynamic variability in OSA patients.
Research Type: Clinical
Mentor(s): Nicoleta Stoicea, M.D., Ph.D.; Sergio Bergese, M.D.; Alberto Uribe, M.D.

Institution: **Oregon Health & Science University**

Project Topic: Neuroinflammatory Mechanisms of Vascular Cognitive Impairment
Overview: The project investigates the role of the peripheral immune system in aging-related vascular cognitive impairment.
Student Role: The student will assist in administering treatment and extracting tissue for immune cell profiling.
Research Type: Basic Science
Mentor(s): Nabil Alkayed, M.D., Ph.D.

Institution: **Oregon Health & Science University**

Project Topic: Role of microglia in neurogenesis and regeneration after cardiac arrest

Overview: The project explores how microglia, the brain resident immune cells, support formation of new neurons in the hippocampus, and how these adult-born neurons improve memory function of mice after cardiac arrest.
Student Role: The student will assist with image acquisition and analysis to quantify adult-born neurons.
Research Type: Basic Science
Mentor(s): Ines Koerner, M.D., Ph.D.

Institution: **Oregon Health & Science University**

Project Topic: Targeting TNFα to reduce cell death and cognitive deficit after cardiac arrest
Overview: The project investigates how cytokines released by neurotoxic microglia contribute to delayed neuronal death and resulting memory dysfunction after cardiac arrest.
Student Role: The student will assist with image acquisition and analysis of existing histological sections. Some molecular work (quantifying cytokine expression and release by ELISA and immunoblotting) is possible.
Research Type: Basic Science
Mentor(s): Ines Koerner, M.D., Ph.D.

Institution: **Oregon Health & Science University**

Project Topic: Proteomics of Glomerular Filtrate in Acute Cardiorenal Syndrome after Cardiac Arrest
Overview: Within minutes after cardiac arrest and resuscitation, glomerular barrier integrity is transiently opened, altering the composition of the primary urine. This project investigates the hypothesis that reversing or preventing this acute hyperpermeability will prevent or ameliorate acute kidney injury, using a mouse model of cardiac arrest and cardiopulmonary resuscitation and advanced outcome measures including multiphoton microscopy, molecular ultrasound, proteomics, and others.
Student Role: The student will participate in ongoing in vivo imaging studies and analyze existing in vivo renal imaging data. The student will conduct analysis of proteomic data using scientific Python and other big-data tools and assist in the authoring of a scientific manuscript.
Research Type: Basic Science
Mentor(s): Michael Hutchens, M.D., MA

Institution: **Oregon Health & Science University**

Project Topic: Neuronal Circuit Rearrangements following Brian Injury
Overview: Our research focuses on neuronal circuit rearrangements that result from brain injury. We combine translational models of injury with immunohistochemical and electrophysiologic assays of brain structure and function, and have been analyzing how anesthetic drugs alter hippocampal gene expression and neuronal circuit function.
Student Role: The student would assist in studies of the anesthetic modulation of adult neurogenesis and in the analysis of signaling pathways involved in neuronal circuit integration of new neurons.
Research Type: Basic Science
Mentor(s): Eric Schnell, M.D., Ph.D.

Institution: **Oregon Health & Science University**

Project Topic: Mechanisms underlying Thrombospondin-mediated Synapse Formation
Overview: This goal of this project is to elucidate the mechanisms through which thrombospondin proteins contribute to synapse formation and function in the central nervous system. The thrombospondin receptor is the primary target for the drug gabapentin, and we are hoping to use studies of synaptic structure and function to better understand how this drug works in the management of pain.
Student Role: The student will use heterologous cell culture techniques and confocal imaging of fixed brain tissue samples to assist with in vitro studies of thrombospondin-mediated signaling pathways. Students will be taught a range of basic science techniques and will perform bench research with the goal of contributing to a scientific manuscript describing thrombopondin signaling mechanisms.

Research Type: Basic Science
Mentor(s): Eric Schnell, M.D., Ph.D.

Institution: **Oregon Health & Science University**

Project Topic: Preoperative cognitive screening in older adults
Overview: This is a prospective analysis evaluating the accuracy of a brief cognitive screening tool administered to patients on the day of surgery
Student Role: The student will participate in administering a brief cognitive screening test to patients in Preoperative Medicine Clinic, and to patients in the preoperative area on the day of surgery. The student will be responsible for test administration, data entry, assisting with data analysis, abstract and manuscript preparation for submission to a peer-reviewed journal for publication.
Research Type: Clinical
Mentor(s): Katie Schenning, M.D., M.P.H.

Institution: **Oregon Health & Science University**

Project Topic: Emergence delirium in older adults
Overview: This is a prospective analysis evaluating whether emergence delirium in older adults is associated with negative outcomes
Student Role: The student will participate in assessing patients postoperatively to determine the presence of emergence delirium. The student will also participate in chart review/data abstraction and entry. The student will assist with data analysis as well as abstract and manuscript preparation for submission to a peer-reviewed journal for publication.
Research Type: Clinical
Mentor(s): Katie Schenning, M.D., M.P.H.

Institution: **Rutgers**

Project Topic: Epigenetic mechanism of sleep disturbance-induced prolongation of postoperative pain
Overview: Current treatment for chronic postoperative pain is limited. Understanding the mechanisms underlying this disorder may provide insight into novel prevention or treatment strategies. Most patients have normal pain perception before surgery, although they have to some extent perioperative sleep disturbance. Whether and how such sleep disturbance delays surgical pain recovery is elusive. We developed an animal model, in which short-term sleep disturbance did not affect basal pain, but prolonged postoperative pain. The present study will examine if this prolongation may be attributed to increasing methylation of opioid receptor genes and silencing their expression in pain-related regions.
Student Role: The student will be involved in partial phases of the project, including preclinical postsurgical pain model preparation, behavioral tests, tissue harvest, Western blot, data collection and analysis, and abstract/manuscript preparation.
Research Type: Basic Science
Mentor(s): Tao, M.D., Ph.D., professor at the department of anesthesiology

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Institution: **Stanford University School of Medicine**

Project Topic: The majority of children undergoing procedure in the hospital experience significant anxiety. Children may feel threatened by the loss of control, meeting new people, separation from their parents, scared of the surgery or anticipated pain. Peri-procedural anxiety is not only distressing for the child and the family, but is associated with increased post-operative pain, emergence agitation, sleep disturbances, and negative behavioral changes. Many interventions have been studied to decrease preoperative anxiety including: premedication, parental presence at induction, video games, cartoons, clowns, acupuncture, video glasses, hospital preparation programs, and hypnosis. Some are successful at decreasing anxiety, but still have many limitations including time, cost, and need for child/family cooperation. Even when these limitations are overcome, both pharmacologic and non-pharmacologic interventions still have significant failure rates, especially in our most anxious patients.

Overview: We have several projects that involve the use of technology to address anxiety in hospitalized patients undergoing procedures and diagnostic studies. Medical student researchers will have the opportunity to conduct a small case series applying either virtual reality, video projection, or interactive videogames to one of several proposed hospital settings in order to both understand the impact of the intervention as well as determine the most appropriate populations to target. Please see attached video for example of an ongoing project: http://www.npr.org/sections/health-shots/2016/06/29/483056065/doctors-get-creative-to-soothe-tech-savvy-kids-before-surgery. We will plan on having IRB approval prior to student arrival. With the help of a research assistant, the student will spend the first 4-6 weeks collecting data, and the last 2 weeks assisting in data analysis and abstract creation.
Student Role: Medical students will have the opportunity to work on an existing project or create their own. Their role will include data collection (direct observation, consenting families, and scoring videotaped interactions) as well as basic data analysis. Research students will have the opportunity to write up an abstract on a small case series focusing on novel technological interventions to address pediatric stress and anxiety. One example of a proposed project involves assessing the effectiveness of Virtual Reality in a variety of clinical settings. The student will have the opportunity to assist in data collection, as well as do basic data analysis and write up the results.
Research Type: Clinical
Mentor(s): PI: Samuel Rodriguez, M.D., Clinical Assistant Professor, Department of Anesthesia, Perioperative, and Pain Medicine
Co-Investigator(s): Laura Simons, Ph.D., Associate Professor, Department of Anesthesia, Perioperative, and Pain Medicine; Thomas Caruso, M.D., Med, Clinical Assistant Professor, Department of Anesthesia, Perioperative, and Pain Medicine

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Institution: **Stanford University School of Medicine**

Project Topic: Precision Medicine
Overview: Approximately 560 million people in the world have a genetic variant limiting the ability to break down reactive aldehydes and are commonly identified having a flushing response after alcohol consumption. However, these aldehydes are also 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 and cellular injury. We are studying, at the basic science level, how this genetic variant may affect outcomes to surgery and influence responses to pain and injury (see Gross ER, Science Translational Medicine and Ann. Rev. of Pharmacology and Toxicology). Our overall aim is to develop a precision anesthesia platform for those with this genetic variant, in order to allow for optimal recovery from surgery. This will help us to also understand in general how to improve surgical recovery for all patients we care for.
Student Role: Several portions of the project are reasonably accomplished in 8-weeks and is suitable in challenge and scope for a medical student, will consist of a variety of tasks who will meet with the mentor at least once a week to discuss progress, will have 6 hours per week of clinical exposure and be the only student assigned to the project. The student will learn how to perform an assay to measure reactive aldehyde metabolism to test whether a novel drug we identified in the laboratory, FN-2187, can increase reactive aldehyde metabolism in liver homogenates of rodents with the genetic variant versus rodents without the genetic variant. This is an introductory technique and our staff have trained several students with no research experience on this assay in the past. At the end of 8 weeks, the student will be able to determine how FN-2187 modifies reactive aldehyde metabolism for these rodents and provide pre-clinical data so this drug can be further moved towards testing in the clinic.
Research Type: Basic Science
Mentor(s): Eric R. Gross M.D., Ph.D.

Institution: **Stanford University School of Medicine**

Project Topic: Precision Medicine
Overview: Approximately 560 million people in the world have a genetic variant limiting the ability to break down reactive aldehydes and are commonly identified having a flushing response after alcohol consumption. However,

these aldehydes are also 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 and cellular injury. We are studying, at the basic science level, how this genetic variant may affect outcomes to surgery and influence responses to pain and injury (see Gross ER, Science Translational Medicine and Ann. Rev. of Pharmacology and Toxicology). Our overall aim is to develop a precision anesthesia platform for those with this genetic variant, in order to allow for optimal recovery from surgery. This will help us to also understand in general how to improve surgical recovery for all patients we care for.

Student Role: Through next generation cutting edge mass spectrometry (MS) technology, we will measure levels of reactive aldehydes in patients undergoing surgery. We will collect samples for patients during surgery and in turn use this technology to quantify the level of reactive aldehydes that are produced during a surgical procedure. The student will work with the mentor on enrolling patients, collecting samples, processing the samples, analyzing the data and interpreting the data. After 8 weeks, the student should be able to determine how the levels of aldehydes change during surgery in people and gain a better understanding of MS. Several portions of the project are reasonably accomplished in 8-weeks and is suitable in challenge and scope for a medical student, will consist of a variety of tasks who will meet with the mentor at least once a week to discuss progress, will have 6 hours per week of clinical exposure and be the only student assigned to the project.

Research Type: Clinical

Mentor(s): Eric R. Gross, M.D., Ph.D.

Institution: **Stanford University School of Medicine**

Project Topic: The contribution of central nervous system glia to the transition from acute to chronic pain

Overview: 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 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.

Research Type: Basic Science

Mentor(s): Vivianne Tawfik, M.D., Ph.D.

Institution: **Stanford University School of Medicine**

Project Topic: Comparing two ultrasound-based methods to assess diaphragm movement

Overview: With the introduction of ultrasound technology to the bedside, one can visualize the motion of the diaphragm and lungs in real time. This affords the ability to detect when the diaphragm is paralyzed or is not moving properly. We wish to compare two ultrasound-based methods of diaphragm analysis to determine which one is quicker and more user-friendly. The traditional method relies on identification and imaging the right and left diaphragms through the acoustic windows of the liver and spleen, respectively, and then record diaphragm movement in M-mode. A novel “ABCDE” method has recently described by the PI to rapidly identify the diaphragm in adults. We hypothesize that, due to the more obvious visibility of the structures involved, the second method will result in more accurate confirmation of diaphragm paralysis. We will scan both sides of the diaphragm of 100 pediatric patients using the two scanning methods and will record the length of time taken to obtain optimal images.

Student Role: The student’s primary roles in the project will be to recruit patients, obtain consent, collect data, and perform follow-up. The student will be able to develop their project management, problem-solving, and communication skills and gain valuable experience working in an acute-care clinical setting. The student will be

responsible for organizing and analyzing data and, if time permits, writing a manuscript describing the study and its results to be submitted to a peer-reviewed journal for publication. In addition, the student will gain not only significant clinical research experience but will have an opportunity to observe and learn ultrasound skills. This project can easily be accomplished within the eight-week time period. Since there is mounting evidence of point-of-care ultrasound in improving quality of care and patient safety, the educational opportunity in learning ultrasound will further enhance the student's overall medical education.

Research Type: Clinical

Mentor(s): Ban Tsui, M.Sc., M.D.

Institution: **Stanford University School of Medicine**

Project Topic: Obstetric Anesthesia: Cesarean Anesthesia and Labor Analgesia Clinical Studies

Overview: The research covers various aspects of cesarean anesthesia and labor analgesia with the aim of developing novel ways of improving post-cesarean and peripartum labor pain. The current area of research for cesarean delivery is to develop individualized treatment protocols and stratify treatment interventions to optimize postoperative pain management. Current labor epidural studies are focusing on optimizing epidural drug delivery methods, and developing labor and delivery pain measurement tools and analgesic consumption prediction models.

Student Role: Develop the optimal labor pain measurement tool to record labor pain before and after receiving parenteral, inhaled and epidural labor analgesia. Students will enroll patients, collect clinical data, and help with data analysis. Students will also have the opportunity to present their research results at national meetings, and can be involved in the journal publication of the study findings.

Research Type: Clinical

Mentor(s): Brendan Carvalho, M.D., Chief of Obstetric Anesthesia Division. Professor, Department of Anesthesia

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Institution: **Stanford University School of Medicine**

Project Topic: Obstetric Anesthesia: Clinical Outcome Improvement

Overview: The research covers various aspects of obstetric anesthesia outcomes with the aim to improve maternal and fetal outcomes and clinical care. The studies aim to examine the impact of enhanced recovery protocol and patient-centered care models as well as quality improvement interventions to optimize patient outcomes.

Student Role: Determine the opioid-sparing impact of the introduction of additional analgesics to the post-operative order-set, and examine how nursing instruction for opioid prescriptions can influence opioid use after cesarean delivery. Students will enroll patients, collect clinical data, and help with data analysis. Students will also have the opportunity to present their research results at national meetings, and can be involved in the journal publication of the study results.

Research Type: Clinical

Mentor(s): Brendan Carvalho, M.D., Chief of Obstetric Anesthesia Division. Professor, Department of Anesthesia

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Institution: **Stanford University School of Medicine**

Project Topic: Medical education has evolved slowly over the years to incorporate advances in technology and adapt to millennial learners. The Anesthesia Informatics and Media (AIM) Lab at Stanford University has created an online educational ecosystem to complement traditional resources in anesthesia residency. Our research has shown residents prefer this model and have improved performance on exams and clinically, and we want to extend this research to medical students. Our proposed research topic aims to discover how we can improve medical student education by complementing anesthesia rotations with technology and requires the unique knowledge and viewpoint of a medical student. The basic knowledge and skills that a student learns during an anesthesia rotation are invaluable beyond anesthesia and the proposed research will aim to help reinforce what medical students learn during their anesthesia rotation and increase the application of their knowledge as they progress through their careers.

Overview: Medical students have varying experiences during their anesthesia rotation depending on the mentors they encounter. We want to discover if the rotations meet their expectations and how to improve their educational experience. Through previous projects, the AIM Lab has a list of 10,000 residents and relationships with over 60 anesthesia residency programs. In preparation for the medical student's arrival, we will send out an IRB-approved survey to these programs to assess their learners' preferences and the data will be collected by the summer of 2018. This will allow the medical student to immediately start on both quantitative and qualitative data analysis, bringing their unique medical student perspective to the forefront of the analysis. The analysis of the data will inform the type of platform and online content that is developed to meets the students' needs to supplement education during a medical student anesthesia rotation.

Student Role: This is an exciting opportunity for a medical student to work with the survey results gathered to better understand the learning preferences and needs of medical students rotating through anesthesia. The student's unique and indispensable role to this project includes:

1. Identifying gaps between expectations and delivered outcomes in the content of the education curriculum in the anesthesiology rotation
2. Reading through qualitative survey comments and creating a summary and research analysis of comments that reflect the medical student perspective
3. Working as the research team lead with support from the post-doctoral fellow and Dr. Larry Chu, Director of the AIM Lab to synthesize results of the findings to start developing an online curriculum to address the gaps in the use of learning technologies for undergraduate anesthesiology education

In addition to the opportunities above, the student will also have opportunities in teaching and mentorship, both as a mentor and a mentee.

Research Type: Clinical

Mentor(s): Larry Chu, M.D.,M.S., Howard Ching, M.D.

Institution: **SUNY Downstate Medical Center**

Project Topic: A Comparison of Insulin Sensitivity and Management in Hyperglycemic Patients in the Perioperative Period: ESRD vs. non-ESRD

Overview: We propose to monitor the perioperative plasma glucose in hyperglycemic patients undergoing all surgical procedures, independent of anesthesia. We will evaluate the change in blood glucose following exogenous insulin administration to determine whether there is a significantly different response between ESRD and non-ESRD patients. We hypothesize that patients with ESRD and preoperative hyperglycemia will have heightened insulin sensitivity due to delayed renal clearance of insulin, and will demonstrate a more significant decrease in blood glucose following insulin administration compared to non-ESRD patients. For the purposes of this study hyperglycemia will be considered as blood sugar levels of 150mg/dL or higher and major surgical procedures will be considered to be arterio-venous access procedures, major abdominal, orthopedic and thoracic procedures.

Student Role: Assist with protocol implementation, patient recruitment, data collection and analysis.

Research Type: Clinical

Mentor(s): Ketan Shevde, M.D. - Professor of Clinical Anesthesiology, Vice-Chair for Research & Assistant Clinical Dean

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Institution: **SUNY Downstate Medical Center**

Project Topic: Complement Expression Profiles in Maternal Human Cord Blood

Overview: 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. The aim of this study is to quantify the profile of the initial molecules in three complement pathways in cord blood.

Student Role: Responsible for specimen collection and storage. Assist with protocol implementation, data collection, Elisa procedure, analysis and subject/ patient recruitment.
Research Type: Clinical
Mentor(s): Ming Zhang, M.D., Ph.D. - Assistant Professor, Department of Anesthesiology, MCB of Seminar Series in the Department of Molecular and Cellular Biology; Ivan Velickovic, M.D. - Clinical Professor of Anesthesiology, Director of Obstetric Anesthesiology

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Institution: **SUNY Downstate Medical Center**

Project Topic: Retrospective Chart Review of Preeclampsia and Preterm Birth
Overview: Preeclampsia is one of the most common pregnancy complications worldwide and is a prominent cause of preterm birth. Racial disparities exist in both preeclampsia and preterm birth. SUNY Downstate Medical Center and Kings County Hospital serve socioeconomically disadvantaged populations and deliver about 4000 babies annually. Over 90% of those infants are African American. By examining the information recorded in delivery logbooks, this study will evaluate whether racial disparities exist at SUNY Downstate Medical Center and Kings County Hospital as compared to those reported in the literature. Specifically, this study will investigate the relationship between preeclampsia and preterm birth for all deliveries among African American patients at SUNY Downstate Medical Center and Kings County Hospital between 2010 and 2016.
Student Role: Assist with chart review, data collection and analysis.
Research Type: Clinical
Mentor(s): Ming Zhang, M.D., Ph.D. - Assistant Professor, Department of Anesthesiology, MCB of Seminar Series in the Department of Molecular and Cellular Biology; Ivan Velickovic, M.D. - Clinical Professor of Anesthesiology, Director of Obstetric Anesthesiology

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Institution: **SUNY Downstate Medical Center**

Project Topic: Research Topic Comparing time to readiness for discharge after colonoscopy: propofol and dexmedetomidine vs propofol only sedation
Overview: In this randomized, double-blind study, we prospectively compare the recovery time as defined by the time of last administration of sedative medication to the time for the patient to attain MPADSS score of 9-10. We also compare: total propofol consumption (mg/kg)/duration of procedure in minutes and side effects:

a. lowest intraoperative % drop in MAP from baseline.
b. sustained bradycardic episode (HR less than 50 for at least 5 minutes) intraoperatively.
c. number of apneic episodes intraoperatively requiring positive pressure ventilation. Patients are randomly assigned to receive either intravenous Dexmedetomidine 0.3 ug/kg followed by propofol or propofol-only. Level of sedation is monitored with a Bispectral Index (BIS) Monitor and additional doses of propofol are given to maintain a BIS score below 60.

We hypothesize that there will be no difference in the time to discharge between the two treatment groups.
Student Role: Assist with protocol implementation, patient recruitment, data collection and analysis.
Research Type: Clinical
Mentor(s): Dennis Dimaculangan, M.D. - Clinical Assistant Professor of Anesthesiology, Clinical Director of Anesthesiology, Subspeciality Director of Regional Anesthesia

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Institution: **SUNY Downstate Medical Center**

Project Topic: The effect of volatile anesthetics on behavior, molecular signaling pathways and neuropathology in neonatal and adult mice.
Overview: Anesthetics when given during the neonatal period are thought to lead to persistent cognitive and behavioral dysfunction in humans and mice. It is critical to understand the mechanisms by which this dysfunction occurs in order to reduce it. We will use neonatal mice to examine the molecular, physiological and behavioral effects of anesthetics. The questions we are investigating are critical for the safe administration of anesthetics to these at risk populations.

Student Role: Student will assist in anesthetizing the neonatal mice and carryout molecular, histological and behavioral experiments on neonatal and adult mice.
Research Type: Basic Science
Mentor(s): Daisy Lin, Ph.D., Department of Anesthesiology, Department of Physiology and Pharmacology; Ira S. Kass, Ph.D., Professor, Department of anesthesiology, Department of Physiology and Pharmacology; James E. Cottrell, M.D, Distinguished Professor & Chair Department of Anesthesiology

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Institution: **SUNY Downstate Medical Center**

Project Topic: Development of novel amnesic agents using a strategy of blocking PKM activity
Overview: Development of novel amnesic agents using a strategy of blocking Protein Kinase M-zeta (PKM-zeta) activity: PKM-zeta is a brain-specific, constitutively active isoform of PKC 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.
Student Role: Students 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 immunoblotting) and tissue staining (immunohistochemistry) would therefore be useful, but not necessary.
Research Type: Basic Science
Mentor(s): James E. Cottrell, M.D. Distinguished Professor & Chair Department of Anesthesiology
Panayiotis Tsokas, Ph.D. (Co-Mentor) Research Assistant Professor at State University of New York Downstate Medical Center

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Institution: **SUNY Downstate Medical Center**

Project Topic: The effect of volatile anesthetics on behavior, molecular signaling pathways and neuropathology in neonatal and adult mice. (same as project 5; Dr. Kass and Dr. Lin are co-investigators on this project)
Overview: Anesthetics when given during the neonatal period are thought to lead to persistent cognitive and behavioral dysfunction in humans and mice. It is critical to understand the mechanisms by which this dysfunction occurs in order to reduce it. We will use neonatal mice to examine the molecular, physiological and behavioral effects of anesthetics. The questions we are investigating are critical for the safe administration of anesthetics to these at risk populations.
Student Role: Student will assist in anesthetizing the neonatal mice and carryout molecular, histological and behavioral experiments on neonatal and adult mice.
Research Type: Basic Science
Mentor(s): Daisy Lin, Ph.D., Department of Anesthesiology, Department of Physiology and Pharmacology; Ira S. Kass, Ph.D., Professor, Department of anesthesiology, Department of Physiology and Pharmacology; James E. Cottrell, M.D, Distinguished Professor & Chair Department of Anesthesiology

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Institution: **SUNY Downstate Medical Center**

Project Topic: Development of novel amnesic agents using a strategy of blocking PKM activity (same as project 6) Related project: Mechanisms by which anesthetics alter behavior, learning and memory in normal and Alzheimer's prone mice.
Overview: Development of novel amnesic agents using a strategy of blocking Protein Kinase M-zeta (PKM-zeta) activity: PKM-zeta is a brain-specific, constitutively active isoform of PKC 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.
Student Role: Students 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 immunoblotting) and tissue staining (immunohistochemistry) would therefore be useful, but not necessary.
Research Type: Basic Science
Mentor(s): James E. Cottrell, M.D. Distinguished Professor & Chair Department of Anesthesiology;Panayiotis Tsokas, Ph.D. (Co-Mentor) Research Assistant Professor at State University of New York Downstate Medical Center

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Institution: **Texas A&M College of Medicine-Scott and White Medical Center (Temple) Program**

Project Topic: Comparison of dural puncture labor epidurals to regular labor epidurals
Overview: In June 2017, a practice change was introduced to the Scott & White Medical Center-Temple Department of Anesthesiology where providers were encouraged to employ the dural puncture epidural technique for labor epidurals. In a dural puncture epidural technique, the dura is punctured with a 25 gauge Pencan spinal needle, but no medication is administered. Ostensibly, the small dural puncture will facilitate spread of medication from the epidural space to the intrathecal space, improving labor epidural function. While some providers embraced this practice change, others did not. We would like to do a retrospective chart review to determine if there was a difference in outcomes between the two techniques.
Student Role: The student will collect data from electronic medical records and participate in data analysis and preparation of abstracts and manuscripts.
Research Type: Clinical
Mentor(s): Michael Hofkamp, M.D.

Institution: **Thomas Jefferson University**

Project Topic: The Artificial Pancreas Project: Glucose control and closed loop insulin delivery in type 1 diabetics
Overview: Development and testing of subcutaneous insulin delivery systems to improve insulin absorption in type 1 diabetics. Development and testing of an implantable long term glucose sensor for continuous glucose measurement using interstitial fluid and microfluidic technology.The projects require using various testing methods to assess flow, pressure, tissue histology and micro CT analyses. The devices are tested in large swine using the glucose clamp technique and analyses performed on PK/PD data.
Student Role: The students participate in weekly planning meetings and are trained to perform the testing and data collection when in the laboratory. In the animal lab, the students are taught how to handle the animals, administer sedation, general inhalation anesthesia, and glucose clamps. The students are also taught to prepare all infusions, perform serial blood draws and are responsible for data collection and preliminary analyses
Research Type: Basic Science
Mentor(s): Jeffrey I. Joseph, D.O.; Marc C. Torjman, Ph.D.

Institution: **University of Alabama at Birmingham**

Project Topic: Mechanisms of Nociception Induced by Innocuous Cold in Trigeminal System
Overview: Dr. Gu's laboratory studies sensory transduction, encoding and transmission in the somatosensory system with a focus on cellular and molecular mechanisms underlying inflammatory and neuropathic pain. The lab also explores new therapeutic targets for effectively treating pathological pain conditions in patients.

Project: This project studies the roles of ion channels including voltage-gated potassium channels in mediating pathological pain induced by cold temperatures. The long-term goal of this project is to develop therapeutic compounds targeting these channels for clinical treatment of cold pain in patients.

Student Role: As a summer student working in Dr. Gu's lab, you will perform behavioral tests to asses neuropathic and inflammatory pain using methods such as von Frey Test for mechanical sensitivity, 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.
Research Type: Basic Science
Mentor(s): Jianguo G. Gu, M.B. (equivalent to M.D.), Ph.D.

Institution: **University of Alabama at Birmingham**

Project Topic: "Effect of anesthetics on the activation of pro-cancerous genes" - Some studies have shown that anesthetics routinely used for surgical tumor removal can also alter cancer metastasis and progression. Other studies have reported that anesthetics can alter levels of the hypoxia-inducible transcription factors HIF-1 and HIF-2, a pro-cancerous transcription factor. Hypoxia-inducible transcription factors, HIF-1 and HIF-2 two closely related transcription factors that bind to the same consensus response element and regulate a more or less common set of genes, including glycolytic enzymes, vascular endothelial growth factor (VEGF), VEGF receptors and several cytokines. They promote cell growth, metastasis, invasion and angiogenesis. Purpose: (a) to identify anesthetics that do not alter HIFs or diminish HIF activity, so they can be safely used in cancer surgeries (b) identify anesthetic-induced angiogenic, survival, and inflammatory pathways.
Overview: These studies will initially be carried out using in vitro cell culture based assays. An HIF-reporter cell line will be used to screen for anesthetics. Additionally, anesthetics will be used to assess cell proliferation, migration and angiogenic potential of endothelial cells. Biopsies of tumors before and after the use of anesthetics will be obtained in collaboration with Dr. Mali Mathru. Initially, these samples will be assayed for downstream transcriptional targets of HIF-1 like VEGF, hexokinase-2 and phosphofructokinase using Realtime RTPCR. Subsequently, pro-angiogenic, pro-survival and inflammatory pathway genes will be assessed to identify the dysregulated pathways. We anticipate the work to be completed in a 6 - 7 week timeframe, allowing an additional week for data analysis and time to prepare a presentation for the ASA.
Student Role: The student will be trained to carry out studies using the HIF-reporter cell line. Genes of the angiogenic, survival and inflammatory pathways are routinely assessed in the laboratory using quantitative Realtime RTPCR and the student will be instructed in this procedure.
Research Type: Basic Science
Mentor(s): Aftab Ahmad, Ph.D.

Institution: **University of Alabama at Birmingham**

Project Topic: Mechanisms of Lung Immunosuppression after Traumatic Brain Injury
Overview: 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. Recent evidence suggests that TBI induces a systemic immunosuppressed state via a vagal response named the systemic cholinergic anti-inflammatory pathway that acts via the α7 nicotinic acetylcholine receptor (α7nAChR) expressed on macrophages in the spleen. 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.
Student Role: Students will be able to experiment with male and female alveolar macrophages to determine their immune response to Pseudomonas aeruginosa. Additionally, they will be able to test the effect of α7nAChR and estrogen receptor activators and inhibitors on this immune response. Furthermore, students will be able to observe animal experiments and potentially work with tissue derived from these experiments. Endpoints of these experiments will be measures of immune response by ELISA and Western blotting. Students will have an opportunity to be part of authorship of a manuscript and to present their results at a meeting.
Research Type: Basic Science
Mentor(s): Brant Wagener, M.D., Ph.D.

Institution: **University of Alabama at Birmingham**

Project Topic: Trauma Hemorrhage

Overview: Trauma is the leading cause of death and disability of patients between the age of 1-46 years, eclipsing ischemic heart disease, cerebrovascular disease and HIV/AIDS. Injury is responsible for 1 in 7 deaths worldwide, a figure expected to increase to 1 in 5 over the next 15 years despite advances in resuscitation, trauma surgery and critical care. Many experience severe blood loss and hemorrhagic shock requiring emergent treatment with large-volume "massive transfusions" (>10 units or 5 liters) of red blood cells (RBC). Trauma patients with hemorrhagic shock receive stored RBCs that are the oldest ("first-in, first-out" practice) and in the highest quantities compared to other patient populations. Results from retrospective studies with trauma patients and our preliminary data, suggest poorer therapeutic efficacy and adverse effects such as increased bacterial pneumonia associated with transfusion with longer stored RBCs, compared to RBCs stored for shorter periods.
Student Role: Students will experiment will various cell lines to determine whether stored blood has an effect on the immune response and greater likelihood of pneumonia. Furthermore, they will use knockout cells or inhibitors to help determine the mechanisms by which this takes place. An opportunity to observe animal experiments is also possible and students may, in some cases, have an opportunity to experiment with tissue from animals that have undergone trauma-hemorrhage.
Research Type: Basic Science
Mentor(s): Brant Wagener, M.D., Ph.D.

Institution: **University of Alabama at Birmingham**

Project Topic: "The roles of hyaluronan in mediating aspiration induced acute lung injury" - Pulmonary aspiration of gastric contents is a severe complication of anesthesia and a major direct cause of acute respiratory distress syndrome (ARDS) in ICU patients, causing hypoxia, bronchospasm and respiratory failure arising from inflammation, pulmonary edema and airway hyperresponsiveness (AHR). Current treatment is mainly supportive due to the lack of mechanism-based diagnosis and treatment. Preliminary studies indicate a novel role of low molecular weight hyaluronan (LMW-HA) in mediating the inflammation, pulmonary edema and AHR after acid aspiration via a neutrophil dependent, CD44-RhoA-ROCK2 mechanism.
Overview: We will test the hypothesis that LMW-HA plays a critical role in mediating pulmonary edema and AHR in aspiration induced acute lung injury. We further propose that high molecular weight hyaluronan (HMW-HA), which antagonizes the action of LMW-HA and is currently in clinical trials in Europe for the treatment of asthma, may serve as a novel therapeutic option for aspiration induced pulmonary injury. Using a mouse pulmonary aspiration model and TLR4-/- and/or CD44-/- knockout mice, we will determine the membrane pattern recognition receptor(s) for LMW-HA. We will measure intracellular Ca2+, activation of RhoA-ROCK, and phosphorylation of PLCε and MLC in human smooth muscle cells, as well as stress fiber formation in pulmonary epithelial and vascular endothelial cells in vitro after LMW-HA challenge. Finally, the effectiveness of HMW-HA in mitigating the pulmonary edema and AHR induced by acid aspiration will be tested using our in vivo model.
Student Role: The student will work closely with Dr. Matalon and Dr. Aggarwal, Assistant Professor of Anesthesiology and Perioperative Medicine, in all aspects of the study. First, he/she will be assigned a number of papers to read and present so he/she becomes familiar with the subject matter of the research. The student will receive the proper training (online) to become qualified to work with animals. The student will be taught to perform small animal surgery, bronchoalveolar lavages, as well as a variety of biochemical and physiological measurements (including assessment of cardiac hemodynamics using ultrasound. The student will also be responsible for organizing the results and delivering power point presentations during the weekly laboratory meetings. Dr. Riesenberg, Professor of Anesthesiology and Perioperative Medicine, will organize the clinical aspects of this project: specifically the student will shadow Dr. Brant Wagener in the operating room and critical care units to become more familiar with the diagnosis and treatment of acute lung injury. Finally, the student will submit an abstract to the ASA meeting and Dr. Matalon will supervise the preparation of the presentation.
Research Type: Basic Science
Mentor(s): Sadis Matalon, Ph.D.

Institution: **University of Alabama at Birmingham**

Project Topic: Cellular and Ion Channel Mechanisms Underlying the Sense of Light Touch in Mammal

Overview: Dr. Gu's laboratory studies sensory transduction, encoding and transmission in the somatosensory system. The lab focuses on cellular and molecular mechanisms underlying inflammatory and neuropathic pain. The lab also explores new therapeutic targets for effectively treating pathological pain conditions in patients.

Project: 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.

Student Role: As a summer student working in Dr. Gu's lab, you will perform behavioral tests to asses neuropathic and inflammatory pain using methods such as von Frey Test for mechanical sensitivity, 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.

Research Type: Basic Science

Mentor(s): Jianguo Gu, M.B. (equivalent to M.D.), Ph.D.

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

Project Topic: Intra-operative factors associated with hypoxemia in the PACU and associated outcomes.

Overview: The development of a data capture system to record oxygen saturation of PACU patients at one minute intervals demonstrated 68% of patients with values less than 95% and 25% of patients with saturations less than 90%. Standard EMR documentation does not capture this data as accurately. A Human Subjects Research Committee protocol has been developed to evaluate the clinical impact of a new monitor of tissue saturation on the incidence of arterial desaturation in the PACU. This project is focused on establishing intra-operative factors that correlate with PACU desaturaton and creating pathways to couple with post-operative complications.

Student Role: The student will assist in the development of systems to collate information from the operative records that will facilitate interpretation of the observations from the PACU, including the evaluation of potential confounding variables. They will establish links between the PACU data and post-operative outcome data and they will assist with the initial data analysis.

Research Type: Clinical

Mentor(s): Neal Fleming, M.D., Ph.D.

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

Project Topic: Assessment of Ventilator Induced Lung Injury in an Animal Model of Pulmonary Fibrosis

Overview: Ventilator-induced lung injury (VILI) is a known complication of mechanical ventilation. Patients with advanced interstitial lung diseases (pulmonary fibrosis (PF)) demonstrate decreased lung compliance and can be difficult to manage on mechanical ventilation. The standard approach to avoid VILI includes setting tidal volumes (VT) per kg of predicted body weight (PBW), to reduce harmful mechanical forces. This may not be optimal for patients with restrictive lung diseases. Our human data shows that pulmonary-focused metrics, specifically forced vital capacity are predictive of low compliance and can be used to calculate individualized VT. Patients with advanced interstitial lung disease tended to have lower lung compliance than other subgroups when exposed to VT based on PBW, suggesting patients with PF may be at risk for barotrauma from current lung-protective ventilatory strategies. We aim to examine the susceptibility of fibrotic lungs to VILI in an established animal model of PF.

Student Role: The student will have the opportunity to learn basic science research laboratory techniques in rats. There will be opportunities to learn tracheostomy, ventilation strategies, intraperitoneal and intra-tracheal injections in rats. Furthermore, there will be opportunities to learn histochemical techniques such as tissue fixation, cutting, staining and molecular biology techniques such as PCR.

Research Type: Basic Science

Mentor(s): Soban Umar, M.D., Ph.D.

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

Project Topic: This project focuses on the effects of general anesthetics on activity patterns in networks of cortical neurons in vivo.
Overview: Volatile anesthetics reliably induce reversible unconsciousness by changing neuronal activity patterns in the brain. Consistent with this, characteristic shifts in the electroencephalogram (EEG) occur as the depth of the anesthetic state changes. Notably, unconsciousness is produced at much lower levels of anesthetic than are required to produce electrical quiescence. This raises the question: how do volatile anesthetics disturb the cortical network at the population level to prevent consciousness? We are interested in determining whether general anesthetics have separable effects on subpopulations of interneurons in the cortex, and how the electrophysiologic signatures of anesthetic depth relate to changes in interneuron subpopulation activity during recovery from general anesthesia.
Student Role: The Medical Student Anesthesia Fellow would have the opportunity to participate in experiments that use cutting edge neuroscience optogenetic techniques to simultaneously record activity from a population of neurons in the intact cortex of a mouse at varying levels of anesthesia. Individual neuronal activity in somatostatin expressing inhibitory interneurons will be reported using the genetically encoded calcium indicator GCAMP-6 and recorded with a resonant scanning microscope while simultaneously recording EEG from implanted skull screws as the anesthetic depth is varied in a controlled fashion. The fellow will postprocess the imaging data and participate in first pass data analysis in MATLAB using existing code in the laboratory. I anticipate it will take approximately 2 weeks to orient the fellow to the literature and relevant experimental techniques. The fellow will then acquire and post-process data for 4 weeks, with the last 2 weeks spent characterizing the resulting responses.
Research Type: Basic Science
Mentor(s): Andrew Hudson, M.D., Ph.D.

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

Project Topic: Audiovisual Detection of Respiration, Heart Rate, and Oxygen Saturation
Overview: Purpose: The Audio-Visual Detection of Respiration, Heart Rate, and Oxygen Saturation (AVD-R) Project will develop a remote, non-invasive, non-contact, optical imaging system that will detect respiration, heart rate, oxygen saturation, and perfusion. Narcotic pain relief causes respiratory depression and may lead to apnea, respiratory and cardiac arrest, and death. At the present time, there is no monitor for continuous, non-contact, remote monitoring of respiration, heart rate, and saturation in hospitals. The AVD-R system has a video system that provides an RGB camera, an Infrared Camera, a Depth (3 D Vision) Camera, Acoustic Localization, Skeletal Tracking, Facial Tracking, and Speech Interpretation. The system can automatically monitor and measure respiration, heart rate, and likely oxygen saturation and cardiac perfusion remotely. Specific Aim: Develop and test a remote, non-contact, patient monitor to prevent respiratory and cardiac arrest in hospitalized patients.
Student Role: The student will work on algorithm development in LabView and clinical testing of the AVD-R system.
Research Type: Clinical
Mentor(s): Arthur Wallace, M.D., Ph.D.

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

Project Topic: Near Infrared Spectroscopy (NIRS) for Quantitative Assessment of Depression
Overview: Purpose: The Near Infrared Spectroscopy (NIRSIT) study is working to develop a quantitative, non-invasive measure of the severity of depression. Near Infrared Spectroscopy can measure changes in frontal lobe blood flow with sample rates of 30 samples/second. Frontal lobe activity will be measured while neurocognitive testing is performed. Correlation with standard scales of severity of depression will be tested. Patients will be monitored over time as they are treated with ECT, ketamine infusion therapy, and anti-depressant medications. Normal controls will also be tested.
Student Role: The student will work as a study coordinator testing patients with NIRSIT technology as well as conducting neurocognitive testing and analysis.
Research Type: Clinical
Mentor(s): Arthur Wallace, M.D, Ph.D.; Isabelle Fernandez, M.D.; Tobias Marton, M.D., Ph.D.

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

Project Topic: Innate Immunity in Sepsis and Acute Inflammation
Overview: General focus areas of my laboratory include the (1) effects of sepsis and inflammation on endothelial and leukocyte cell functions, (2) the role of innate immune pathways, including Toll-like receptor (TLR)-dependent signaling pathways in sepsis and inflammatory critical illness, and (3) the immunomodulatory effects of the endogenous cannabinoid system in inflammation and sepsis.
Student Role: The student will have the opportunity to participate in in vitro and in vivo studies focused on endothelial cell and leukocyte innate immune pathways in sepsis, including studies on the immune effects of activation of endocannabinoid and endovanilloid systems. The student will gain experience in basic methods, including, but not limited to tissue culture utilizing endothelial cells and leukocytes to assess innate immune pathways in vitro, mouse models for sepsis in vivo, and assays for assessing inflammation at the RNA and protein levels. The student will be responsible for performing in vitro experiments using human endothelial cells. They will treat cells with microbial toxins (such as LPS) and immune modulators, including cannabinoid receptor and vanilloid receptor agonists. They will then perform ELISA's to measure levels of inflammatory mediators, including cytokines and chemokines (IL-6 and IL-8 or CCL2). The student will also participate in the processing of samples from in vivo experiments in sepsis models. While they will not directly handle animals, they will participate in in vivo studies that the lab is performing to understand the role of cannabinoid and vanilloid receptors immune modulation in sepsis. For these experiments, they will be responsible for participating in discussions and planning at lab meeting, and for performing endpoint analyses, including measuring inflammatory mediators in mouse plasmas (ELISAs). They will be responsible for processing and performing statistical analyses on the data from their experiments. They will be expected to present the results of their experiments at our weekly lab meeting as well as in weekly one-on-one meetings between the student and the PI. They will also be responsible for providing a written synopsis of their work at the end of the summer, and to participate as a co-author on publications on their project.
Research Type: Basic Science
Mentor(s): Judith Hellman, M.D.

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

Project Topic: Adaptations of humans to high altitude environments: Effects of exercise on brain oxygenation at high altitude.
Overview: Our laboratory has a long history of investigating the basis for high-altitude adaptation and high altitude related illness, such as acute mountain sickness. This project builds on previous year's studies showing that exercise is a major risk factor for developing the symptoms of acute mountain sickness. This study will involve an expedition to the Barcroft Laboratory, run by the University of California, in August 2018.
Student Role: The student will be in charge of developing an exercise protocol for use at both sea level and altitude, and data collection with cerebral oximetry and collection of blood for RNAseq biomarker analysis.
Research Type: Basic Science
Mentor(s): Philip Bickler, M.D., Ph.D.

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

Project Topic: Preconditioning to improve cognitive performance in humans
Overview: The aim of this project is to demonstrate that cognitive performance in healthy humans during acute, profound hypoxia can be improved by preconditioning. This project involves cognitive tests on a laptop computer, administered during controlled hypoxia. Preconditioning is a mild stress, such as brief bouts of hypoxia or inflation of a blood pressure cuff on a leg, that leads to protection against the decline in cognitive performance that is otherwise associated with hypoxia. This project is recruiting subjects now, and has to date involved only preconditioning with hypoxia.
Student Role: The student's role on this project would be to continue the project with a new variation of preconditioning, based on a leg blood pressure cuff inflation.

Research Type: Basic Science
Mentor(s): Philip Bickler, M.D., Ph.D.

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

Project Topic: Effects of hypoxia on signaling pathways in human midbrain progenitor derived neuronal cultures.
Overview: This is a basic science project, with the goal of understanding how human neurons adapt to hypoxia in laboratory conditions. We are specifically examining the role of key proteins in the unfolded protein response pathway as the crucial components in hypoxia survival. The project involves neuronal culture, in vitro experiments with hypoxia, and protein analysis (Western blots, immunostaining and related biochemical techniques).
Student Role: The student's role will involve learning to successfully culture the progenitor cells and use the cultures in experiments assessing the activation of specific signaling pathways, including doing immunoblotting, fluorescence microscopy and cell survival assays.
Research Type: Basic Science
Mentor(s): Philip Bickler, M.D., Ph.D.

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

Project Topic: Predictors of hemorrhage and outcome in patients with cerebrovascular malformations
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.
Student Role: 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
6. racial/ethnic differences in outcomes.

Research Type: Clinical
Mentor(s): Helen Kim, M.P.H., Ph.D.

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

Project Topic: Developing innovative therapies for the treatment of brain arteriovenous malformation.
Overview: 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 FLT (sFLT1) binds to VEGF in the tissue, thus reducing its downstream signaling through membrane-bound VEGFRs. Soluble FLT1 in an AAV construct packaged in AAV serotype 2 capsid (AAV2) inhibited choroidal neovascularization in a non-human primate model. However, AAV2 does not cross the blood-brain barrier (BBB). We will test a non-invasive route, intravenous, using AAV serotype 9 (AAV9), because AAV9 enters the brain

parenchyma much more effectively. The goal of the project is to test if intravenous delivery of AAV9-sFLT will prevent progression of or reverse the AVM phenotype in our models.
Student Role: 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 the their activities during the fellowship period.
Research Type: Basic Science
Mentor(s): Hua Su, M.D.

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

Project Topic: Perioperative sleep changes in Obstructive Apnea Patients
Overview: This clinical research project is aimed to investigate changes in cognition associated with sleep patterns in patients with sleep apnea undergoing surgery.
Student Role: Student's role may include:

1. The student will be actively involved in the on-going project and learn how to conduct clinical research.
2. Learn how to use research equipment, sleep architecture and its interpretation and data analysis.
3. Learn various neurocognitive tests to assess brain function such as attention, memory.
4. Literature review and writing an abstract.

Research Type: Clinical
Mentor(s): Sakura Kinjo, M.D.

Institution: **University of Chicago**

Project Topic: Current investigation in our laboratory focuses on the mechanisms of common anesthetics with current emphasis on two main aims:

1. Pharmacological agents that are able to accelerate emergence from anesthesia
2. Changes in sensitivity to anesthetics after repeated exposure to anesthetics in rats. 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. We also examine the sensitivities (by measuring the wake up time) of these animals to anesthetics after these animals are exposed to anesthetics repeatedly. Concurrently, translational studies assessing the effects of these agents on emergence and recovery from anesthesia in healthy human volunteers will be ongoing.

Overview: Unlike the neurotoxic effects of recurrent anesthetics in the very young, the very old, and the critically ill, the potential changes in anesthetic sensitivity in healthy adults has not yet been studied. Children under 2 yr who have many surgeries with general anesthesia may be up to 3 times more likely than other children to suffer cognitive dysfunction. In the elderly, cognitive decline follows anesthesia; in vitro, anesthetics promote apoptosis and decrease neurogenesis. In healthy adults, the effects of anesthetics are considered reversible or short-lasting. Yet in our lab weekly exposure of adult rats to isoflurane changed anesthesia efficacy, suggesting long-term changes in CNS function. So far we have tested isoflurane and sevoflurane. Will there be changes with propofol or dexmedetomidine? This is an ongoing project in the lab. The study in humans to investigate the drugs, facilitating the emergence and the recovery of cognitive functions after anesthesia, is also ongoing.
Student Role: The student will be trained to work with rats and mice 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. Additionally, as the translational studies in anesthetized human volunteers will be ongoing, the student will be able to accompany the PI's to observe the conduct of these experiments. Additional clinical exposure will be provided to the student in the form of a mini clinical anesthesia rotation in which he/she will accompany one of the PI's into the OR or other anesthetizing locations. The student will have extensive exposure to the principal investigators that we anticipate will far exceed the minimum requirements of the program. The investigators will

work closely with the student to prepare an abstract for presentation at a national meeting, and we anticipate that the results of these investigations will contribute to publication in a peer-reviewed journal.
Research Type: Basic Science
Mentor(s): Zheng (Jimmy) Xie, M.D., Ph.D.; Robert Fong, M.D., Ph.D.

Institution: **University of Colorado Denver**

Project Topic: Risk factors for long-term opioid prescribing after surgery
Overview: Identifying risk factors for long-term opioid prescribing after surgery – a secondary data analysis of a 6000 patient cohort. This is a NIH NIDA funded sub-project of an active grant. Regulatory approval has already been obtained.
Student Role: Medical chart review, collaborating on statistical analysis, summarizing results, writing abstract and writing manuscript.
Research Type: Clinical
Mentor(s): Karsten Bartels, M.D., MS

Institution: **University of Colorado Denver**

Project Topic: Monitoring of minute ventilation in patients during sedation.
Overview: The goal of this study is to prospectively evaluate the correlation between the degree of sedation and hypoventilation in patients during sedation. We will analyze the correlation between values of electroencephalogram (SedLine) and non-invasive minute ventilation (ExSpiron) monitoring at key time points during the perioperative care of patients receiving sedation.
Student Role: The student will participate in the study protocol implementation as well as collection, analysis and interpretation of data.
Research Type: Clinical
Mentor(s): Ana Fernandez-Bustamante, M.D., Ph.D.

Institution: **University of Colorado Denver**

Project Topic: Reducing postoperative hypoventilation in surgical patients after general anesthesia.
Overview: This prospective study aims to reduce the incidence of hypoventilation in the post-anesthesia care unit (PACU) and implement preventive measures with the goal of decreasing hypoventilation episodes in the immediate postoperative period. Specific aims of this study include: first, assessing the incidence and risk factors of postoperative hypoventilation and hypoxemic events in surgical patients during usual care (observational phase, ~2 weeks), then testing the implementation of a new protocol of care using the noninvasive minute ventilation monitor ExSpiron to trigger encouraged deep breathing exercises and incentive spirometry in response to hypoventilation episodes (interventional phase, ¬~6 weeks). We will evaluate the incidence of hypoventilation and hypoxemic events, oxygen therapy duration, PACU and hospital length of stay, respiratory complications during the hospital stay and also protocol implementation compliance and barriers.
Student Role: The student will participate in the study protocol implementation as well as collection, analysis and interpretation of data.
Research Type: Clinical
Mentor(s): Ana Fernandez-Bustamante, M.D., Ph.D.

Institution: **University of Colorado Denver**

Project Topic: Light at the interface of circadian proteins and acute lung injury
Overview: The main goal of this research proposal is to study light elicited mechanisms as a novel anti-inflammatory and lung-protective strategy to prevent or treat acute lung injury (ALI). A large-scale screen for over 1000 proteins in human plasma samples exposed to intense light (>10,000 LUX) pointed us towards using light as an anti-inflammatory strategy for lung protection. As light is the hallmark of circadian rhythm protein regulation, we next addressed the possibility that the light-elicited protein PER2 could function to attenuate lung injury. Functional studies in Per2-/- mice or in mice with a tissue specific deletion of Per2 in ATII cells exposed to ALI

found significantly decreased percent survival. Based on these studies, we hypothesize that light elicited PER2 stabilization in the lung attenuates ALI.
Student Role: The student will assist with the intratracheal application of LPS to induce lung injury and expose mice to intense light thereafter. The student will also help harvest lung tissue and draw blood samples for analysis using EISA.
Research Type: Basic Science
Mentor(s): Tobias Eckle, M.D., Ph.D.

Institution: **University of Colorado Denver**

Project Topic: Light elicited Per2 in cardio protection
Overview: 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. 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.
Student Role: The student will expose mice to intense light and draw blood samples from mice or harvest heart tissue for analysis using ELISA. The student will also help with light exposure of human volunteers and assist with blood draws from humans and analysis of human blood samples using ELISA.
Research Type: Basic Science
Mentor(s): Tobias Eckle, M.D., Ph.D.

Institution: **University of Colorado Denver**

Project Topic: The role of different isoforms of T-type calcium channels in painful diabetic neuropathy
Overview: T-type voltage-gated calcium channels are ubiquitously expressed in nervous system and are critical determinants of neuronal excitability. These channels exist in three isoforms based on the structure of pore-forming alpha1 subunit: Cav3.1, Cav3.2 and Cav3.3. Our recent studies documented supportive role of Cav3.2 isoform of T-type calcium channels in different animal models of 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 streptazocin-induced model of type 1 diabetes in mice to investigate the roles of Cav3.1 and Cav3.3 isoforms of T-channels in painful diabetic neuropathy. We will study cohorts of wild-type mice and age-matched, as well as gender-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.
Student Role: Learning how to perform mechanical and thermal pain testing in mice, learning how to inject drugs intraperitoneally and measure blood glucose in mice. Learning how to analyze the data and present graphics.
Research Type: Basic Science
Mentor(s): Slobodan M. Todorovic, M.D., Ph.D.

Institution: **University of Colorado Denver**

Project Topic: Neurobiology of Stroke
Overview: Interrogate mechanisms of neuronal cell death and synaptic plasticity deficits following cerebellar ischemia. Our laboratory utilizes mouse models of global and focal cerebral ischemia. Student will utilize protein expression analysis from post-ischemic brain tissue. Specifically they will investigate intracellular signaling that is engaged through activation of TRPM2 ion channels subsequent to cardiac arrest. We hypothesize that calcium/calmodulin-dependent protein kinase II (CAMKII) and death associated protein kinase (DAPK) are activated by calcium influx through TRPM2. To test this hypothesis the student will perform western blots on brain tissue from mice subjected to cardiac arrest with pharmacological or genetic knock-down of TRPM2 function. Immunohistochemistry will also be used to examine CAMKII and DAPK expression and localization.
Student Role: The student will learn to isolate protein, perform electrophoresis and western plot protocols. For immunohistochemistry the students will learn to how to perform staining protocols and trained on microscopy to

acquire images. Student will also be trained in appropriate statistical analysis of their data and to interpret their findings in the context of other data available within the laboratory and published literature.
Research Type: Basic Science
Mentor(s): Nidia Quillinan, Ph.D.

Institution: **University of Florida**

Project Topic: Developmental effects of neonatal anesthesia.
Overview: Human retrospective epidemiological studies along with the laboratory studies strongly support the possibility that general anesthesia affects brain development. We study the mechanisms of these developmental effects of general anesthetics using a variety of techniques from animal behavior to synaptic electrophysiology and molecular biology.
Student Role: The student will have opportunity to conduct the study by learning these techniques. Specifically, he/she will be involved in analysis of the electroencephalographic and behavioral effects of general anesthetics and steroid agents administered to rat pups during early postnatal period, writing a draft of the manuscript as well as writing a brief literature review on the developmental effects of general anesthetics.
Research Type: Basic Science
Mentor(s): Anatoly Martynyuk, Ph.D., D.Sc., Professor

Institution: **University of Florida**

Project Topic: Retrospective study investigating potential predictive factors affecting SAH clinical outcomes.
Overview: Medical Students are invited to take part in current research projects in the Department of Anesthesiology at University Of Florida. The aim of this research project is to chart the clinical outcomes of severely debilitated patients admitted in ICU struck by a catastrophic subarachnoid hemorrhage (SAH) with high mortality and morbidity using standardized tests. Current project is believed to have the potential to make ground breaking changes in the field of clinical practice. We also want to learn about how potential changes in the current guidelines could affect the outcomes.
Student Role: Our goal is to in sculpt organizing skills in medical students which have long term impact in their career as independent researchers. Each medical student will be actively involved in possibly all steps of retrospective clinical study with tasks that range from development/modification of IRB proposal to analysis of clinical data which will challenge them continuously and eventually help them develop a research acumen. Thus we expect the student at the end of program will be able to clinically judge the severity of the clinical scenario of the illness. We hope that about half of the project can be completed in reasonable time of eight week period.
Research Type: Clinical
Mentor(s): Sylvain Doré Ph.D., FAHA, Professor

Institution: **University of Florida**

Project Topic: How do common medications affect clinical neurocritical care outcomes
Overview: Medical Students are invited to take part in current research projects in the Department of Anesthesiology at University of Florida. The aim of this project is to establish evidence as to “how the use of commonly used medications on a regular long term basis can have beneficial effects on various health states of population”. Current project is expected to revolutionize the pattern of taking medications.
Student Role: Our goal is to in sculpt organizing skills in medical students which have long term impact in their career as independent researchers. Each medical student will be actively involved in possibly all steps of retrospective clinical study with tasks that range from development/modification of IRB proposal to analysis of clinical data and writing a manuscript which will challenge them continuously and eventually help them develop a research acumen. Thus we expect the student will be able to have a broad perspective of clinical research which will lead to the origin of new discoveries.
Research Type: Clinical
Mentor(s): Sylvain Doré Ph.D., FAHA, Professor

Institution: **University of Florida**

Project Topic: Effect of particular biomarkers on the outcomes of ischemic stroke, intracerebral hemorrhage, subarachnoid hemorrhage, and traumatic brain injury.
Overview: Stroke and traumatic brain injury (TBI) are highly debilitating diseases that are accompanied by high death rates and poor recovery. When considered separately from other cerebrovascular diseases, stroke ranks number five among all causes of death; heart disease, cancer, chronic lower respiratory disease, and unintentional injuries are ranked ahead. As such, our aim is to investigate whether particular biomarkers that are present can confer protection for various stroke subtypes—ischemic stroke (IS) intracerebral haemorrhage (ICH), and aneurysmal subarachnoid haemorrhage (aSAH) — and TBI in an adult patient population. In addition, we intend to collect data on other factors—including sociodemographic information—in order to develop a more comprehensive understanding of these putative protective effects. From this, we hope to elucidate the potential role of particular biomarkers for stroke and TBI outcomes.
Student Role: The student will build an Excel Data sheet with all IS, ICH, SAH, and TBI data. Then multi-variate analyses will be performed to determine if certain biomarkers improve outcomes in the aforementioned pathological diseases.
Research Type: Clinical
Mentor(s): Sylvain Doré Ph.D., FAHA, Professor

Institution: **University of Florida**

Project Topic: Effect of sleep and the glymphatic system on experimental TBI
Overview: Sleep function in regards to its beneficial & potential detrimental effects remains controversial. Sleep has been documented to have significant effect on memory consolidation & effectiveness. Physiological sleep can replenish brain energy; though, recently, its effect on clearance of brain by-products has attracted a lot of attention. Sleep would stimulate the glymphatic flow & help in the detoxification in the brain in order to maintain homeostasis. While there is no single measure of sleep, several features can be investigated to define quality of sleep and arousal. Electrophysiological parameters can help to address some of these measurements. Thus, the goal would be to perform TBI in mouse model followed by sleep disturbance and monitor EEG, EMG, and duration of slow wave sleep. Then animals will be assessed for functional outcomes followed by euthanasia to assess neuropathology. Abnormal sleep/wake physiology is likely to affect the functional & pathological outcomes after TBI.
Student Role: The student will learn some of the functional monitoring and assessments. The student will also analyze EEG and EMG data. Student will also perform histology and immunohistochemistry and perform quantification.
Research Type: Basic Science
Mentor(s): Abdullah Ahmad Ph.D., Assistant Professor

Institution: **University of Illinois College of Medicine at Chicago**

Project Topic: Lung vascular mechanotransduction: a novel mechanism for pulmonary edema during acute heart failure
Overview: Dr. Dull studies how acute changes pulmonary capillary pressure and flow alter endothelial permeability. His laboratory discovered that heparan sulfate proteoglycans on the cell surface sense pressure and flow and respond to these mechanical forces by activating pathways that adversely affect barrier function. His research focuses on studying lung vascular mechanotransduction, acute heart failure and glycoprotein-mediated mechanism(s) of vascular signaling. These studies utilize cells, isolated lungs and whole animal studies. Dr. Dull is interested in novel mechanism(s) regulating vascular permeability and the susceptibility of the lung to mechanical forces. This work challenges the long held Starling principle for understanding edema development and identifies novel targets for therapeutic intervention.
Student Role: Students will learn and participate in the uses cell culture models, the isolated perfused lung preparation, use of knock-out mice and whole animal models of acute heart failure and pulmonary edema.

Research Type: Basic Science
Mentor(s): Randal Dull, M.D. Ph.D., Professor and Vice Chair for Research.

Institution: **University of Illinois College of Medicine at Chicago**

Project Topic:

1.Neuronal ischemic tolerance
2. Epidemiology of perioperative visual loss

Overview: Dr. Roth's lab works on neuronal ischemic tolerance, and uses in vivo and in vitro models in retina. At present there are two main studies in the lab. One is on the mechanisms of ischemic post conditioning, a very interesting phenomenon the lab described, where transient ischemic stimulus after ischemic insult attenuates the injury. Also, there is a large collaborative project involving other investigators at UIC and other universities where we are studying exosomes in ischemic injury. On the clinical side, we are studying the risk factors and epidemiology of perioperative visual loss using analysis of large clinical databases. For any of the projects, students could be involved in a doable piece of the project during the 8 weeks of the FAER program.
Student Role: Student will learn basics of mammalian cell culture, exosome isolation and characterization, basic protein assays, and use of isolated exosomes to treat and prevent ocular injury following ischemia reperfusion. Students will learn how to design a basic science study, identify confounders, control for those confounders and perform basic data analysis. Students may also participate in an ongoing clinically-related research project that involves using big-data and data mining strategies to identify patient centered risk factors that lead to incidence of peri-operative ischemic ocular injury.
Research Type: Basic Science
Mentor(s): Steven Roth, M.D., Michael Reese Professor of Anesthesiology.

Institution: **University of Illinois College of Medicine at Chicago**

Project Topic: Effects of sevoflurane on macrophage efferocytosis and resolution of acute lung inflammation in a model of endotoxin sepsis.
Overview: Acute lung inflammation is characterized by polymorphonuclear neutrophil (PMN) infiltration. Successful resolution of inflammation occurs by clearance of inflammatory cells and restoration of alveolar function. Efferocytosis, phagocytosis of apoptotic cells by macrophages and other phagocytic cells, is a multi-step process of engulfment of dying cells that helps in resolving inflammation. Sevoflurane has been reported to inhibit the pro-inflammatory cytokine release from alveolar macrophages and monocytes following lipopolysaccharide challenge; the effect(s) of sevoflurane on the resolution of lung inflammation remains unknown. Our recent study indicated that isoflurane promoted macrophage efferocytosis and resolution of lung inflammation. In the proposed study, we will examine the potential effects of sevoflurane on macrophage efferocytosis and subsequent resolution of lung inflammation in a model of sepsis with endotoxin.
Student Role: Student will learn and participate in the isolation and characterization of neutrophils, conduct assays of phagocytosis and efferocytosis, learn about sepsis models in mice, and test the effects of anesthetic gases on lung inflammation. Students will learn how to conduct cytokines assays, protein assays, basic histology for fluorescence microscopy, statistics and data analysis.
Research Type: Basic Science
Mentor(s): Guochang Hu, M.D., Ph.D., Assoc. Professor of Anesthesiology and Pharmacology.

Institution: **University of Illinois College of Medicine at Chicago**

Project Topic:

1. Effect of Propofol on vWF secretion in vitro and in vivo
2. Effect of Lidocaine on Metabolic Switch in Breast Cancer Cells
3. Effect of Lidocaine on Diabetic Skin Wound Healing in Mice

Overview:

Project 1: The anesthetic propofol has important influence on the release of VWF from vascular endothelial cells that contributes to pro-coagulant activity. Dr. Minshall discovered a peptide that interferes with VWF

release and it is being developed as a novel anti-coagulant. Understanding the role of propofol on VWF secretion has important implications for pro-coagulant issues during surgery.
Project 2: The local anesthetic lidocaine is well known to have anti-inflammatory activities and reduces cancer metastasis during surgery. Characterizing the mechanisms of local anesthetics on cancer cell metabolism has the potential to revolutionize oncological surgery and provide novel therapies to reduces metastatic risk during surgery.
Project 3: Local anesthetics have been shown to enhance chronic wound healing in diabetic subjects. This project will characterize the molecular mechanism(s) of how local anesthetics affect endothelial cells to promote enhanced wound healing.

Student Role: Student will learn and participate in the isolation and characterization of neutrophils, conduct assays of phagocytosis and efferocytosis, learn about sepsis models in mice, and test the effects of anesthetic gases on lung inflammation. Students will learn how to conduct cytokines assays, protein assays, basic histology for fluorescence microscopy, statistics and data analysis.
Research Type: Basic Science
Mentor(s): Richard Minshall, Ph.D., Professor.

Institution: **University of Illinois College of Medicine at Chicago**

Project Topic: Using social media as a platform for peer parenting support
Overview: Cavities is the most prevalent chronic disease of childhood, worldwide. Often, due to a combination of disease severity, need for extensive treatment, and developmentally appropriate behavioral issues, treating severe cavities in young children requires general anesthesia. Unfortunately, this intervention is ineffective, as the majority of patients have recurrent disease within one year of surgery. The etiology of disease is influenced by oral health behaviors, which is rooted in the parents' habits and parenting styles. I would like to test the efficacy of peer parenting support on the outcomes of efficacy, knowledge, and oral health habits. Other ongoing projects require working experience with STATA and large data sets.
Student Role: Students will directly participate in designing, developing and implementing strategies utilizing social media and apps to assist parents with education, planning and follow up of dental care.
Research Type: Clinical
Mentor(s): Helen H. Lee, M.D., M.P.H. , Assistant Professor of Anesthesiology, Public Health.

Institution: **University of Illinois College of Medicine at Chicago**

Project Topic: Preventing entero-hepatic recirculation of toxins
Overview: In many cases, drug toxicity can be associated with biological half-life; longer half-lives allowing for sustained tissue damage. Drugs which undergo enterohepatic recirculation (EHR) can therefore induce sustained pathology in addition to any acute effects. To circumvent EHR, non-absorbable compounds can be administered which form strong complexes with toxins allowing them to bypass EHR and be directed eliminated. In this project we will use in vitro methods to screen a panel of absorbents for their ability to bind to anti-depressants (amitriptyline, buproprion); and rodenticides (warfarin, brodifacoum). Selected absorbent(s) will then be assessed for in vivo efficacy.
Student Role: Students will learn how to perform toxicology studies and how to use absorbents to scavenge toxic compounds. Students will learn the basics of mammalian cell culture, experimental design, assays for cell injury and cell death, microscopic examination of cells, use of common laboratory equipment, data analysis and basic statistic.
Research Type: Basic Science
Mentor(s): Douglas Feinstein, Ph.D., Research Professor.

Institution: **University of Iowa**

Project Topic: Effect of developmental exposure to inhalational anesthetics on structure and function of the adult nervous system: a fruit fly model. A number of studies using animal models suggest that inhalational anesthetics have some adverse effects on the developing nervous system. However, the molecular mechanisms and

functional significance of such effect remain largely elusive. We will take advantage of versatile experimental tools available for a genetic model organism the fruit fly Drosophila melanogaster to determine how adult sleep behavior and relevant neuronal circuits are affected by exposure to desflurane or sevoflurane during development. The outcome of this study is expected to provide fundamental insights into the effect of inhalational anesthetics on structures and function of the adult brain neurons, given that the basic biological processes are highly conserved between flies and humans.

Overview: The wild-type flies will be exposed to either desflurane or sevoflurane during development. Adult flies will be examined for their sleep behavior and various sleep parameters (e.g., total sleep amount, sleep- or wake-bout length, locomotor activity, etc.) will be compared between experimental and control flies. In addition, brain neurons that are implicated in regulation of sleep (particular dopaminergic, GABAergic, and peptidergic neurons) will be visualized using genetically coded reporters and the effects of anesthetics on their detailed structures will be studied using confocal microscopy.

Student Role: Under the PI's supervision, the student will maintain fly stocks, expose them to anesthetics during the pupal stage, and measure adult sleep parameters under controlled environmental conditions. For neuroanatomical studies, the student will first receive formal training at the Central Microscope Research Facility and then analyze the structure of certain brain neurons using genetically encoded fluorescent reporters. He/she will analyze data and apply statistics to interpret the experimental results. Experimental designs and results will be discussed with other lab members at weekly lab meetings and at joint-lab meetings with collaborators' groups.

Research Type: Basic Science

Mentor(s): Toshihiro Kitamoto, Ph.D.

Institution: **University of Iowa**

Project Topic: Comparison of Retrograde and Antegrade Peripheral Intravenous Cannulation on the Ability to Aspirate Blood Samples in the Operating Room.

Overview: The ability to draw blood samples is an important facet of clinical care of patients throughout the inpatient hospital setting. Sometimes an antegrade intravenous (IV) catheter can be used to aspirate blood samples, frequently with the use of a proximal tourniquet to increase venous pressure at the catheter site. However, the failure rate of antegrade IV catheters in their ability to draw blood is high. There is a paucity of data on the use of retrograde IV catheters in the clinical setting to draw blood, but there are many reports of its use in human research studies. We propose a double-blinded prospective randomized control study comparing success rate of antegrade and retrograde IV catheters in their ability to facilitate blood draws 3 hours after placement. Our hypothesis is that retrograde IV catheters will have a significantly increased success rate both with and without use of tourniquet.

Student Role: We have already initiated study design and plan to complete IRB proposal by January 2018. The study will be partially underway by the start of summer 2018, so the FAER student scholar will be involved mainly with data collection, but will also take part in analysis and manuscript preparation. Specifically, the student will help to recruit potential subjects in the preoperative area on the day of surgery and consent for the study. After randomization, they will assist in placement of IV catheters and instruct the anesthesia provider on proper data acquisition. They will gather and log the data once it has been completely acquired by the intraoperative anesthesia team. The student will also be involved with the interim and final analysis of study data and manuscript preparation once target study subject recruitment has been achieved.

Research Type: Clinical

Mentor(s): Andrew Feider, M.D.

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

Project Topic: Study of the rate of relapse to opioids and the related factors in the perioperative period in patients with addiction-in-remission

Overview: Opioid use disorder is a primary, chronic, and relapsing disease. The risky behaviors during the periods of relapse expose patients to increased risk of trauma, illnesses, overdose, and death.

The peri-operative period may predispose recovering patients to relapse. The medications that are used to treat opioid use disorders (such as buprenorphine) are often discontinued preoperatively. Patients are then re-introduced to opioids. Stress of surgery and lingering sedation will impair their coping mechanisms. Patients are sent home with an abundant supply of opioid medications. If pain is not well controlled, recovering patients may self-medicate and relapse- a potentially deadly consequence. We therefore, hypothesize that the patients with history of opioid use disorders are at increased risk of relapse to opioids in the postoperative period. We aim to test this hypothesis in a retrospective study on Veterans with OUDs who have been enrolled in the opioid agonist treatment program.

Student Role: The student will be exposed to the peri-operative management of the patients with substance use disorder (addiction). The student will analyze the perioperative database to explore the risk of relapse during the perioperative period in the recovering patients. The student will be involved in analyzing the data with the statistician and in preparing the manuscript

Research Type: Clinical

Mentor(s): Khodadad Namiranian, M.D., Ph.D., Assistant professor of Anesthesiology

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

Project Topic: Development of a meaningful peer-review tool for anesthesiology

Overview: Peer-review is commonly conducted for quality assurance, assessment of liability potential, identification of patient safety concerns, and identification of sub-par clinician performance. The processes and forms used by reviewers and committees vary widely between medical practices, even within a single medical specialty. Standardized processes for reviewing cases allow leaders to maintain transparency, fairness, and accountability. Using a standard tool (case review form) can bring consistency to the process but may not be used easily by reviewers or contain information that is meaningful to leaders. Project keywords: quality improvement, peer review, practice management, just culture, survey design

Student Role: The student will develop an evaluation method, using best practices for survey design and semi-structured interviewing, to assess peer view tool(s) in use and development by the Department of Anesthesiology's Peer Review Committee. The student will collect and analyze data on the tools' ease of use and ability to provide meaningful data. No prior experience is required, though the student role can be tailored for those with pre-existing skill sets.

Research Type: Health Services

Mentor(s): Megan Graybill Anders, M.D., MS, Assistant Professor of Anesthesiology, Associate Chair for Safety and Quality

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

Project Topic: Role of extracellular miRNAs in innate immune response during traumatic injury

Overview: 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.

Student Role: 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-1b, IL-6, TNFa, 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.

Research Type: Basic Science

Mentor(s): Lin Zou, M.D., Ph.D., Assistant Professor; Wei Chao, M.D., Ph.D., FAHA, Professor of Anesthesiology, Vice Chair for Translational Research

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

Project Topic: Effects of Aeromedical Evacuation-Relevant Hypobaria on Survival and Neurologic Outcome Using a Rat Polytrauma Model of Traumatic Brain Injury plus Hemorrhagic Shock
Overview: Ongoing research indicates that exposure of rats within a few days after traumatic brain injury (TBI) to hypobaria equivalent to a normal airplane cruising cabin pressure equivalent to 8000 ft worsens neurologic outcomes. This study tests the hypothesis that exposure to hypobaria also worsens neurologic injury and increases mortality in a rat polytrauma model. The study also tests the hypothesis that treatment of rats with sulforaphane, a compound that increases expression of genes coding for antioxidant enzymes, will mitigate the deleterious effects of hypobaria.
Student Role: The student will learn to process brain tissue for immunohistochemistry and will use stereologic techniques with light microscopy to quantify extent of neuronal death, protein nitration, DNA/RNA oxidation, and cellular inflammatory reactions. The student will also become familiar with animal physiology and with critical care for hemorrhagic shock.
Research Type: Basic Science
Mentor(s): Gary Fiskum, Ph.D., Professor of Anesthesiology

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

Project Topic: Intraoperative temperature range and risk of surgical site infection
Overview: Perioperative hypothermia is associated with surgical site infections. Most studies evaluating this association focus on the temperature at the conclusion of the case or in the post-anesthesia care unit, parameters which likely underestimate the proportion of patients who experience hypothermia during surgery. This observational database study will use retrospective and epidemiologic techniques to evaluate physiologic data (temperature), investigate a hypothermia "index", and evaluate the association with postoperative complications (surgical site infections). Project keywords: patient safety, surgical site infection, hypothermia, database research, data research, observational study, outcomes, quality improvement
Student Role: Data validation and analysis. No background experience in data science or analysis is required, though the student role can be tailored for a pre-existing skill set. The student may participate in developing quality improvement interventions if desired.
Research Type: Health Services
Mentor(s): Megan Graybill Anders, M.D., MS, Assistant Professor of Anesthesiology, Associate Chair for Safety and Quality

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Institution: **University of Michigan Health System**

Project Topic: Reducing Postoperative Pain with Caffeine . The central hypothesis is that reducing postoperative pain with caffeine will improve postoperative pain and cognitive function in patients undergoing major surgery.
Overview: Pain and cognitive dysfunction remain common and distressing complications after surgery. For example, approximately 75% of patients report moderate/severe pain after surgery, and cognitive dysfunction can persist for months after non-cardiac surgery. Furthermore, these outcomes are interrelated, as pain itself may worsen cognitive function, leading to further overall neurologic impairment. Although opioids remain a mainstay therapy for managing postoperative pain, opioids can induce cognitive dysfunction, sleep disruption, and persistent postoperative use. Preliminary data from our laboratory research group demonstrate that caffeine, a non-selective adenosine receptor antagonist, demonstrates both acute anti-nociceptive properties and protection against postoperative pain in both sleep-deprived and non-sleep-deprived rat models. Caffeine also promotes arousal, and it has been shown to improve cognitive function in a variety of settings.
Student Role: The student will have the following responsibilities:

1. Learn the principles of ethical and responsible conduct of research
2. Participate in the screening and recruitment of eligible surgical patients at the University of Michigan Health System
3. Learn the basic principles of postoperative pain evaluation and data collection

4. Learn basic principles of electroencephalogram data acquisition and analysis
5. Develop skills and knowledge related to research database management

The student will also be expected to prepare and submit an abstract to the Society for Neuroscience in Anesthesiology and Critical Care Annual Meeting based on the project.

Research Type: Clinical

Mentor(s): Phillip E. Vlisides, M.D.

Institution: **University of Michigan Health System**

Project Topic: The number of opioid prescriptions dispensed to U.S. youth more than doubled over a decade. Over the same period serious opioid-related adverse drug events soared to include thousands of hospital admissions and hundreds of accidental overdose deaths annually. Furthermore, recent estimates suggest that on an average day 2500 adolescents in the U.S. will misuse an opioid for the first time. The staggering number of ADEs and widespread misuse among youth reflects, in large part, a lack of knowledge about the potential dangers of opioids. The goal of this research is to improve opioid analgesic safety and efficacy by optimizing opioid risk understanding, informed decision-making, and disposal behaviors among parents of youth who are prescribed these agents after surgery.

Overview: This longitudinal, randomized controlled study will include parents whose children aged 5-18 years are prescribed opioids for acute, short-lived pain after ambulatory, orthopedic surgery. Parents will be randomly assigned to receive our interventions or a routine provider informational interaction at the time of opioid prescribing. We will follow parents for up to 30 days to assess their knowledge, risk perceptions, analgesic-decisions and use, the child's pain outcomes, and drug storage and disposal behaviors. These comprehensive data will allow us to compare the intervention and control groups to identify the most effective and efficient means to optimize parents' opioid-related risk reduction decisions and behaviors while enhancing their ability to manage their children's pain.

Student Role: The summer student will be intimately involved in recruiting parent/child dyads to take part in this longitudinal study; they will work with other research staff to ensure that each follow-up survey is sent and completed; students will review medical records to record perioperative data and pain outcome data. Students will help to enter data, ensure data integrity. Learning will include ethical recruitment of adults and children; data integrity; conduct of randomized controlled trial in clinical setting; preliminary data analysis and data safety monitoring. Clinically, students will learn about safe opioid prescribing in children and trends toward improving safe handling of opioids in the homes of children. Perioperative pain management will also be included as a learning experience.

Research Type: Clinical

Mentor(s): Terri D. Voepel-Lewis, RN, MS, Ph.D.

Institution: **University of Pennsylvania**

Project Topic: Ligand interactions with mu opioid receptor

Overview: The mu opioid receptor (MOR) is a G-protein coupled receptor (GPCR). MOR agonism results in analgesia, sedation, and respiratory depression, among other effects. MOR agonists and antagonists are critical tools in the practice of anesthesiology. The prototypical MOR agonist is morphine, but there are a variety of natural and engineered drugs, many in clinical use, that can also bind to MOR. Different drugs have different side effect profiles, which may be related to structural effects of their binding with MOR. Relatively recently, crystal structures of both active and inactive MOR have become available. This allows for direct computational studies of structural aspects of ligand-MOR binding.

Student Role: This research experience will serve as an introduction to computational methods in structural biology as well as to the molecular aspects of drugs used in anesthesia. The student will use computational tools such as docking and molecular dynamics to conduct the research. This involves learning about the theory behind these methods and directly setting up and running calculations. The goals of this project are to 1) determine and refine binding poses for different ligands in MOR and 2) conduct molecular dynamics simulations of the putative complexes to elucidate any structural differences in MuOR as a function of the ligand.

Research Type: Basic Science
Mentor(s): Thomas T. Joseph, M.D., Ph.D.

Institution: **University of Pennsylvania**

Project Topic: Translational Neuroscience Initiative (TNI): Understanding the Neurobehavioral Correlate of Conscious Perception and Sensory Integration
Overview: The TNI clinical science project uses a novel approach to understand the mechanisms of unconsciousness in human subjects. Rather than analyzing ad hoc features of EEG and evoked potentials to evaluate consciousness, the project focuses on using visual and auditory sensory stimulation with high temporal resolution to identify features of multisensory event related potentials most relevant to conscious perception. This sensory stimulation will take place in healthy subjects undergoing intravenous infusions of propofol and ketamine with the goal of understanding how the brain integrates information. High density EEG will be recorded and synchronized with sensory stimulus presentation and behavioral response. We hypothesize that anesthetics cause a disruption of ongoing brain activity to make it impossible for incoming information to be incorporated into conscious awareness.
Student Role: Over the 8 week summer FAER project, the medical student will help carry out this translational clinical project that can be tailored to the student's interest. The student can interact with subjects, collect data in real time during drug infusions, work closely with attending anesthesiologists on sensory stimuli paradigm development and potentially help build features into the visual/auditory sensory system. Ideally, students would also help with data analysis and learn more advanced topics of neurophysiologic data processing during their time on this project. Specifically, helping quantify the nature of stimulus perturbations of the ongoing brain dynamics using phase synchronization and independent component analysis. Students will have exposure to clinical research settings and a team of physicians, scientists, study coordinators, engineers and data analysts to understand anesthesiology research and develop ideas of their own under mentorship of a multidisciplinary team.
Research Type: Clinical
Mentor(s): C. William Carspecken, Clinical Instructor, M.D., MS, MBA; Max B. Kelz, Associate Professor, M.D., Ph.D.; Alex Proekt, Assistant Professor M.D., Ph.D.

Institution: **University of Pennsylvania**

Project Topic: Handoffs and Transitions in Critical Care (HATRICC)
Overview: This ongoing quality improvement research project aims to understand barriers and facilitators of clinician communication at times of patient handoff from the operating room (OR) to intensive care unit (ICU). Our group and others have shown that standardized OR to ICU handoff interventions improve information exchange, teamwork, and communication. However, less is known about how to sustain, adapt, and spread successful quality improvement interventions. Currently, the HATRICC project is focused on facilitating the spread of a standardized OR to ICU handoff within two Penn hospitals as well as developing ways to feedback handoff performance to clinicians. More project information is available at the study website: http://www.hatricc.com
Student Role: The medical student scholar would join a team of interdisciplinary researchers collecting and analyzing data about the operating room to intensive care unit handoff process. Data collection involves in-person and remote observations of clinician behavior, while data analysis includes systematic coding of qualitative data. The student will also participate in weekly research team meetings and journal clubs. By the end of the summer, the student will have developed familiarity with research involving mixed methods (qualitative and quantitative approaches), as well as principles underpinning research in quality, safety, and implementation science.
Research Type: Health Services
Mentor(s): Meghan Lane-Fall, M.D., MSHP, Assistant Professor of Anesthesiology and Critical Care at the Perelman School of Medicine, Co-Director, Center for Perioperative Outcomes Research and Transformation, Senior Fellow, Leonard Davis Institute of Health Economics

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Institution: **University of Pennsylvania**

Project Topic: Regional Anesthesia Postoperative Pain Management

Overview: An increasing number of total shoulder arthroplasty (TSAs) are being performed for degenerative shoulder disease after failing conservative tehrapy. Despite the overall success of shoulder arthroplasty, certain patients experience less than optimal hospital experience because of inadequate pain management after surgery.. This may also lead to delay in hospital discharge and pose a strain on the available hospital resources. Shoulder Arthroplasty enhanced Recovery Protocol (ShARP) was developed and implemented since July 2016. This proposal aims to improve patients' experience and health care resource utilization at Penn Presbyterian Medical Center (PPMC). The main elements of the protocol include use of multimodal analgesia and regional anesthesia.
Student Role: Students will work on a case control study design where we will be comparing 50 consecutive cases undergoing TSA under ShARP versus controls from the year prior. Endpoints to be measured will include: LOS, hospital direct costs and charges, and Pain scores and opioid use during hospital stay. Functional outcomes will be assessed using the PENN shoulder questionnaire. The questionnaire is administered as part of routine office visit in the shoulder and elbow service.
Research Type: Clinical
Mentor(s): Nabil Elkassabany, M.D.

Institution: **University of Pennsylvania**

Project Topic: General anesthetics affect cancer cell survival via regulation of autophagy
Overview: Our recent studies suggested that general anesthetics (propofol vs. isoflurane) affect cell survival and death by regulation of autophagy via activation of ryanodine receptors. Autophagy play important roles in cancer cell survival/death and metastasis. Our preliminary data suggested that propofol dose-dependently affect breast cancer survival and proliferation via regulation of autophagy. We will continue this study and illustrate the detailed mechanisms of effects of general anesthetics on cancer cell survival/proliferation and metastasis, with the focus on effects of general anesthetics on regulation of autophagy and intracellular calcium homeostasis.
Student Role: The student will join the ongoing research project and study the effects of general anesthetics (propofol vs. sevoflurane) on cancel cell survival/death, proliferation and metastasis via their effects to regulate autophagy through activation of ryanodine receptors, using tissue cultures of various types of cancer cells.
Research Type: Basic Science
Mentor(s): Huafeng Wei, M.D., Ph.D.. Associate Professor

Institution: **University of Pennsylvania**

Project Topic: Anesthetic neuro-biology and hysteresis characterization in mice
Overview: The goal of the animal experiments is to investigate the cellular basis for anesthetic-induced disruption of consciousness and determine if mice lose and regain consciousness at the same dose of volatile anesthesia. In mice, we will validate the electrographic signature of disruption of multisensory integration and loss of consciousness. In murine experiments, single cell recordings can be simultaneously performed from various brain areas during a simple behavioral task in the absence or presence of precisely titrated levels of general anesthetics.
Student Role: The student will work with mice (hands on animal work) with anesthesiologists and basic science researchers evaluating the neurobehavioral signatures of loss and regain of consciousness. This project will involve developing a sophisticated understanding of pharmacology and experimental design with animals. The student will be mentored and trained in basic science animal handling techniques and will assist a variety of researchers with the goal to establish a fundamental neurobiologic phenomenon. Data analysis of murine experiments will be part of this project.
Research Type: Basic Science
Mentor(s): Max B. Kelz, Associate Professor, M.D., Ph.D.; Andrew McKinstry Wu, M.D.

Institution: **University of Pennsylvania**

Project Topic: Perioperative Neurotoxicity in Mice and Cellular Models
Overview: We hypothesize that elements of the perioperative period (anesthetics, surgery,

inflammation, pain) interact with the neuropathology of neurodegenerative diseases (like Alzheimer's) to accelerate the onset of cognitive symptoms. Under NIH support, we use protein assays, cell culture, transgenic animals, behavioral assays and other approaches to determine the magnitude of each influence in order to assist the design and interpretation of future and ongoing patient-oriented studies.
Student Role: The student will identify areas of particular interest, and be assigned a task or tasks in support of the ongoing work. Every attempt is made to give students "ownership" of their particular project. The students will be expected to collect and analyze their own data, understand the context of their experiments to the entire project, and summarize their work in a presentation to the entire group at the conclusion of their summer work.
Research Type: Basic Science
Mentor(s): Maryellen Eckenhoff, Ph.D.; Roderic G Eckenhoff, M.D.

Institution: **University of Pittsburgh**

Project Topic: The Role of RTK Signaling in Opioid Tolerance
Overview: We recently discovered that growth factor inhibition completely eliminates opioid tolerance. We also discovered an important reason why opioids are ineffective against neuropathic pain, and demonstrated a mechanistic link between pain and tolerance. We will begin clinical trials guided by these concepts soon. However, we still do not completely understand the mechanisms underlying these effects.
Student Role: Students will receive training in Drosophila and mouse genetics, signal transduction assays, cutting-edge proteomic approaches, as well as advanced behavioral and neuroanatomical techniques. Students will also have the opportunity to interact with stimulating collaborators in the high caliber research environment of the Pittsburgh Center for Pain Research.
Research Type: Basic Science
Mentor(s): Howard Gutstein, M.D.

Institution: **University of Pittsburgh**

Project Topic: Epigenetic Effects of Ethanol
Overview: Recent research in the lab suggests that an individual's ethanol phenotype is dictated in part by his father's history of ethanol exposure prior to conceiving that individual. Remarkably, these transgenerational effects of ethanol appear to only affect male offspring. These exciting observations suggest that ethanol is an epimutagen (ie, alters the epigenetic program) that impacts germ cells in an enduring fashion. To further investigate the hypothesis that an individual's drinking and neurobiological sensitivity to ethanol are due in part to preconception ethanol exposure, we will 1) characterize the model in greater detail, 2) undertake studies to reveal the mechanism(s) that mediate these effects, and 3) examine if these effects represent true transgenerational epigenetic inheritance.
Student Role: Students will actively participate in experiments involving exposure of mice to alcohol, breeding mice, testing the behavioral phenotype of mice (e.g., alcohol drinking, alcohol sensitivity, etc), and/or molecular characterization of the effects of alcohol on the brain (e.g., RT-PCR, ChIP assay, RNAseq, etc). Students will be expected to participate in data collection and data analysis, and ultimately contribute to manuscript preparation. This type of student project should ultimately result in co-authorship on a peer reviewed publication.
Research Type: Basic Science
Mentor(s): Gregg Homanics, Ph.D.

Institution: **University of Pittsburgh**

Project Topic: Identification of an Imaging-based Biomarker for Pain
Overview: An objective measure for pain would not only enhance our understanding of pain, but also further our ability to develop successful pain treatments. Using functional connectivity magnetic resonance imaging (fcMRI), we have developed a preliminary analysis framework with an acute model of neuropathic pain that can detect pain with 90% sensitivity. We propose that fcMRI is able to integrate the physiological phenomenon of nociception (the perception of a painful stimulus) with the psychological processing of pain. Therefore, fcMRI

data analyzed with our algorithm is uniquely suited to objectively measure the experience of pain. The goal of this project is to test the effectiveness of our technique in chronic pain patients.
Student Role: The student will have the opportunity to work on this project in multiple ways, depending on their experience and skill set. Project aspects include: digital image processing, functional image analysis, integration of physiologic and psychologic factors with fMRI data. It is expected that the student will participate in the data collection, analysis, and manuscript generation steps, culminating in a contribution worthy of recognition as an author.
Research Type: Clinical
Mentor(s): James Ibinson, M.D., Ph.D.

Institution: **University of Pittsburgh**

Project Topic: Determination of the Neural Correlates of Post-Operative Cognitive Dysfunction
Overview: The perioperative period presents a unique ability to research multiple cognitive issues. One of these is Postoperative Cognitive Dysfunction (POCD). Recently, non-invasive brain imaging using functional connectivity magnetic resonance imaging (fcMRI) has shown that hippocampal and somatosensory cortex fcMRI changes occurred and resolved in parallel with POCD symptoms in a rat model, suggesting that fcMRI could have utility in studying POCD and elucidating any links between POCD and AD. The objective in this protocol is to gather functional imaging data pre- and post-operative, allowing investigation of the above. Surveys reflecting cognitive function will be collected for correlation with the imaging data.
Student Role: Students will assist with enrolling patients and obtaining consent, performing cognitive testing, gathering and analyzing functional imaging, and integrating physiologic data with the imaging results. It is expected that the student will participate in the data collection, analysis, and manuscript generation steps, culminating in a contribution worthy of recognition as an author.
Research Type: Clinical
Mentor(s): James Ibinson, M.D., Ph.D.

Institution: **University of Pittsburgh**

Project Topic: The Interaction of Sustained Inflammation and Insulin Signaling Pathways in a Drosophila Model of Sepsis
Overview: Sustained inflammation following recovery from sepsis is a major factor for increased morbidity (dementia, neuro-muscular dysfunction, accelerated atherosclerosis) and mortality in critically ill patients. Our laboratory developed a Drosophila model of surviving sepsis, where we infect flies with S. aureus and treat in a delayed fashion with linezolid. Despite survival advantage, the antibiotic treated survivors had sustained inflammation as shown by NF-kB expression compared to sham controls. The survivors also had decreased glucose/glycogen storage. We are exploring the Insulin Receptor pathways to modify the sustained inflammation.
Student Role: The student will focus on the role of metformin-induced lifespan and health span changes in Drosophila. This project is designed to train students to ask scientific questions as they explore biology; student responsibilities will encompass a diversity of opportunities including maintenance of Drosophila colonies, infection of Drosophila, preparation of food vials for Drosophila experiments, data collection including survival analysis, activity level of sepsis surviving flies, and help with the total protein measurement, Western blotting, and NF-kB activity assays. 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.
Research Type: Basic Science
Mentor(s): Murat Kaynar, M.D., M.P.H.

Institution: **University of Pittsburgh**

Project Topic: Role of Acute Postpartum Pain in Clinically Diagnosed Postpartum Depression
Overview: Recent research suggests that pain during labor and the postpartum period may be predictive of risk for postpartum depression. Although studies have used validated depression screening tools as the primary

endpoint, they lack a clinical diagnosis of depression by Structured Clinical Interview for DSM-IV diagnoses (SCID), the gold standard for psychiatric diagnoses in clinical trials. To address these limitations, we will do secondary analysis of data collected by our psychiatry collaborators in the LEAP study (Relationship of Loss of Control Eating to Excessive Gestational Weight Gain), in which SCID for depression was performed at six months postpartum. Using this highrisk cohort, we will collect pain score data from the first postpartum days after childbirth. We will:

1. characterize the relationship between acute postpartum pain & depression detected by SCID; and
2. examine the relative impact of acute pain compared to other factors known to influence risk for postpartum depression.

Student Role: The student may learn skills in: pain score modeling; data abstraction; clinical research using health existing health record information; abstract and manuscript development and submission.
Research Type: Clinical
Mentor(s): Grace Lim, M.D., MS

Institution: **University of Pittsburgh**

Project Topic: Motor-sparing MultiModal PeriNeural Analgesia (MS-MMPNA)
Overview: Our group reported in vitro and in vivo safety of a 4-drug MS-MMPNA drug combination comprised of preservative-free midazolam, clonidine, buprenorphine, and dexamethasone (MDZ-CBD). We also reported a limited case series of patients receiving this drug combo as femoral nerve block for analgesia after knee arthroscopy. To better characterize its motor-sparing potential, we are completing a retrospective review of patients who received MDZ-CBD for indications other than knee arthroscopy. We will prospectively follow patients undergoing hip/knee replacement when the surgeon is seeking same-day physical therapy (PT) after joint replacement surgery with a motor-sparing block. Data to be collected and analyzed include descriptive statistics addressing analgesic duration, rebound pain, and various PT parameters. The mentor possesses investigational new drug approval from the FDA for a different 4-drug nerve block mixture, which will serve as a training/template tool for this project.
Student Role: The student will accompany the mentor on clinical activities in observing the MS-MMPNA blocks that are being used for all prospective cases, and will observe the physical therapy processes for these patients after surgery (including joint replacement patients on the same day as surgery). The student will be responsible for prospective data collection and collation and mentored analysis of all data. It is expected that the student's participation in the data collection, analysis, and manuscript generation steps will include an abstract/poster presentation and will culminate in a contribution worthy of recognition as an author.
Research Type: Clinical
Mentor(s): Brian A. Williams, M.D., MBA

Institution: **University of Rochester**

Project Topic: Effects of local anesthetics on autophagy in neurons. Autophagy is essential for the maintenance of neuronal proteostasis. Selective autophagy involves a surveillance system to identify damaged or misfolded proteins, targeting the cargo to the autophagic machinery and finally effective sequestration and degradation of the client proteins. Any disruptions in these processes can negatively impact neuronal health. Intriguingly, one of the primary substrates of neuronal autophagy is tau. Tau is a normal neuronal protein, but in many neurodegenerative conditions, with Alzheimer's disease being the most prominent example, tau becomes abnormally modified, accumulates and contributes to the pathogenic processes.
Overview: Given the importance of autophagy to neuronal health it is important to understand how specific anesthetics affect autophagy and the clearance of tau. There have been some studies suggesting that depending on the model system local anesthetics (eg. lidocaine or bupivacaine) can both increase and decrease autophagy. Further there is no clear consensus of how local anesthetics specifically affect tau turnover. Therefore the focus of this project would be to treat primary neurons with specific local anesthetics, collect the neurons at time points after treatment and determine the expression level of tau and phosphotau, as well as indicators of the extent of autophagy. In other experiments neurons will be grown on coverslips and transfected with a RFP/GFP-LC3 construct prior to treatment with vehicle only or a local anesthetic. The number of autophagic vacuoles and

whether they are autophagosomes or autolysosomes will be determined by fluorescence microscopy and analysis using ImageJ.

Student Role: The student will learn:

1. how to use aseptic techniques and treat neurons with specific local anesthetics
2. how to properly collect neurons, prepare lysates, determine protein concentrations and prepare samples SDS-polyacrylamide gel electrophoresis (SDS-PAGE)
3. do SDS-PAGE, transfer proteins to nitrocellulose, immunoblot and develop
4. quantitate the immunoblots using ImageJ or another similar program
5. how to prepare coverslips for plating of neurons, watch the process of preparing neurons on coverslips
6. how to transfect neurons
7. how to do fluorescence imaging, capture the data and quantitate.

Research Type: Basic Science

Mentor(s): Gail V.W. Johnson, Ph.D.

Institution: **University of Rochester**

Project Topic: 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.

Overview: 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.

Student Role: The student will 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.

Research Type: Basic Science

Mentor(s): Andrew P. Wojtovich, Ph.D.

Institution: **University of Rochester**

Project Topic: Optimal inhibition of coagulation and inflammatory systems during cardiopulmonary bypass. Cardiopulmonary bypass has been used since the 1950's to facilitate the performance of cardiac surgery. Exposure of blood to the artificial surfaces of the pump oxygenator would lead to catastrophic activation of the coagulation system with thrombosis of the entire pump. To prevent this, heparin has been administered prior to bypass to provide high level suppression of thrombin activation. While this enables clinical bypass to proceed, there are a number of problems with heparin anticoagulation: Heparin is antigenic and there is a low but significant incidence of severe reactions; despite "full" anticoagulation with heparin, low-level activation of thrombin continues during bypass, producing a consumptive coagulopathy associated with post-surgical bleeding; interactions with coagulation and inflammatory systems produce an inflammatory state that can cause adverse outcomes in cardiac surgery.

Overview: We are investigating the applicability of novel anticoagulant drugs alone and in combination, with effects on specific elements in the coagulation system. Effects are measured using viscoelastographic tests, platelet function testing, conventional coagulation test, and in simple in vitro models of cardiopulmonary bypass.

Student Role: The student will learn the use of viscoelastographic equipment (TEG, ROTEM), Multiplate platelet analysis, activated clotting time with multiple analyzers, point-of-care prothrombin times, and ELISA testing. He/she will learn to run Chandler loop simulations of cardiopulmonary bypass, and simulations using a full bypass circuit with oxygenator and an A-V loop. The student will be expected to keep accurate lab records and may present at lab meetings, and will write up experimental results for presentation at a national meeting.
Research Type: Clinical
Mentor(s): Michael P. Eaton, M.D.

Institution: **University of Texas M D Anderson Cancer Center**

Project Topic: Mechanisms of Chemotherapy Induced Neuropathic Pain
Overview: Dr. Dougherty's research interest focuses on determining the mechanism of chemotherapy- induced peripheral neuropathy. This project is composed of parallel studies conducted in human patients and in animals. In the human studies he and his team are conducting psychophysical studies to define the sensory fibers that are involved in this pain condition. The animal studies are being conducted to define the central neurophysiological mechanisms that are altered following chemotherapy and to determine agents that may provide a neuroprotective role. The current emphasis in each of these studies is to determine the role that immune-derived cytokines play in this pathogenesis.
Student Role: The clinical project involves psychophysical testing in patients who are undergoing or have undergone chemotherapy with Cisplatin, Taxol, Vincristine, or Bortezomib. A student participating in this project will assist in the psychophysical testing and sample collections from patients who are undergoing or have undergone cancer chemotherapy.The basic science project is geared toward modeling chemotherapy neuropathy in rodents. Rats develop hypersensitivity to mechanical stimulation following 5 to 10 days of treatment with vincristine, taxol or cisplatin. Neurophysiological, immunocytochemical, and biochemical studies are used to define the underlying mechanisms. A student participating in this project will learn how to conduct behavioral analysis of pain sensation in rats, surgical preparation of rats for neurophysiological recording, and the basics of neurophysiological analysis of spinal dorsal horn neurons.
Research Type: Basic Science
Mentor(s): Patrick M. Dougherty, Ph.D.

Institution: **University of Texas M D Anderson Cancer Center**

Project Topic: Dorsal Horn Mechanisms of Somatosensory and Pain Encoding
Overview: Hundreds of thousands of patients each year develop chronic pain and hyperalgesia that cannot be adequately managed due to our limited understanding of functional organization in the spinal dorsal horn. This project is composed of a series of interrelated intracellular neurophysiological studies in intact animals and in reduced spinal cord-dorsal root-dorsal root ganglion-preparations with follow-up immunohistochemical analysis of the subject tissues as a means to advance our understanding of spinal mechanisms of somatosensory and pain encoding.
Student Role: Students participating in this project will assist in conducting whole-cell patch clamp neurophysiological studies of dorsal horn neurons from either intact anesthetized adult rats or using in vitro isolated spinal cord preparations from neonatal or young adult rats.
Research Type: Basic Science
Mentor(s): Patrick M. Dougherty, Ph.D.

Institution: **University of Texas M D Anderson Cancer Center**

Project Topic: Preoxygenation with Optiflow™, a high flow nasal cannula (HFNC), is superior to preoxygenation with facemask in morbidly obese patients undergoing general anesthesia
Overview: Dr. Hagberg's research interest focuses on outcomes related to difficult airway management. This project is composed of a prospective, controlled, single blinded, randomized clinical trial to determine the apnea time before a patient desaturates to 94% SpO2 after preoxygenation with Optiflow™ vs conventional facemask in the morbidly obese patient. In this clinical investigation Dr. Hagberg and her team will determine the safe apnea

time before a patient desaturates to 94% SpO2 after preoxygenation with the study device when compared to standard facemask, monitor the effects of Optiflow™ high flow nasal cannula (HFNC) on arterial PaCO2 using transcutaneous CO2 or as measured in arterial blood gas samples. The current emphasis of this study is to determine the efficiency of the Optiflow™ as a modality for pre-oxygenation in patients with BMI > 40 kg/m2, is superior to pre-oxygenation with standard facemask and prolongs safe apnea time in patients undergoing general anesthesia.

Student Role: The clinical project involves using high flow nasal oxygenation in airway management for preoxygenation, as well as maintenance of oxygenation in airway procedures. Optiflow™, a humidified high flow nasal cannula (HFNC), may provide an opportunity to be useful in preventing desaturation during intubation in addition to, prolonging safe apnea time in the morbidly obese patient population. If demonstrated to be efficacious, this could provide a safer environment for intubation in this particular patient population. All time recordings in the operating room will be recorded using a stopwatch by the student who will be present during the procedure. The student will record BMI, age, gender, comorbidities, indication for procedure, positioning needs of the patient, dosing of induction medications. The student will assist with collecting blood gas samples for PaO2 and PaCO2 immediately after placement of the endotracheal tube and will transport to the central lab.

Research Type: Clinical

Mentor(s): Carin A. Hagberg, M.D., FASA

Institution: **University of Texas M D Anderson Cancer Center**

Project Topic: SuperNO2VA™ and General Anesthesia Postoperative Care

Overview: Patients with morbid obesity or Obstructive Sleep Apnea (OSA) are at an increased risk of cardiopulmonary complications compared to the general population, likely as a result of upper airway obstruction during anesthesia and emergence/recovery of anesthesia. Nasal continuous positive airway pressure (nCPAP) has been shown to effectively relieve upper airway obstruction as it creates a pneumatic stent in the hypopharynx that reduces obstruction and allows for continuous oxygenation.

The SuperNO2VA™ is a new commercially available nasal mask that provides both intra-operative and post-operative nasal positive pressure ventilation and nasal mask ventilation. The objective of this study is to compare the incidence, duration, and severity of respiratory complications (of patients that are at risk for postoperative pulmonary complications) when using the SuperNO2VA™ nasal mask versus a standard oxygen facemask or nasal cannula, postoperatively during the recovery phase of anesthesia.

Student Role: For each anesthetic case, a preoperative history and physical and intraoperative record will be documented by the students, which includes Age, Gender, Height, Weight, BMI, ASA classification, Neck circumference, Mallampati classification, Thyromental distance, STOP-BANG Score, Type of Surgery, Patient Co-morbidities. Immediately post extubation, the student will also record the incidence of airway interventions, number of airway interventions, and respiratory and cardiac complications in each group provided by anesthesia providers during transport to and in recovery room, until anesthesia end-time. In the recovery room the student will also record the incidence and duration of respiratory and cardiac complications, along with the incidence of post-operative nausea and vomiting, headache, facial discomfort, skin ulceration or breakdown, corneal abrasions, amount of pain medication administered, nurses satisfaction, and total length of stay in recovery.

Research Type: Clinical

Mentor(s): Carin A. Hagberg, M.D., FASA

Institution: **University of Texas M D Anderson Cancer Center**

Project Topic: Mechanisms of opioid-induced tumorigenesis and metastasis in head and neck cancer cells

Overview: Dr. Cata's research interest focuses on determining the mechanisms linked to opioid-induced cell proliferation, migration and invasion in head and neck cancer cells. He has demonstrated that the use of opioids is associated with poor prognosis in patients with laryngeal and oral cancers. This project is composed in vitro and in vivo studies. In the in vitro studies he and his team are conducting experiments to identify intracellular pathways that impacted after mu-opioid receptor activation. The animal studies are being conducted to define the whether

opioid-induced tumorigenesis and metastasis can be prevented by different pharmacological interventions including mu-opioid receptor antagonists, Src inhibitors and immunotherapies.

Student Role:

1. The laboratory project involves the experimental testing of mu-opioid agonists, antagonists and Src inhibitors in different head and neck cancer cells. Using MTT assays, wound closure assays, matrix invasion experiments and clonogenic assays the student will assess the functional cellular changes induced by those agents.
2. The animal project is geared toward modeling the impact of opioids in tumorigenesis and metastasis using a nude mouse orthotopic xenograft model of oral tongue cancer. A student participating in this project will learn how to conduct surgical preparation of mice for tumor inoculation, tumor and lymph nodes harvesting and the basics of immunohistochemistry.

Research Type: Clinical

Mentor(s): Juan Cata, M.D.

Institution: **University of Texas M D Anderson Cancer Center**

Project Topic: Mechanisms related surgical recovery after surgery

Overview: Thousands of patients each year undergo major cancer surgery either to treat the primary tumor or the metastatic disease. The biological mechanisms of postoperative recovery after oncologic surgery are ill defined. We have recently demonstrated that specialized molecules of resolution of inflammation measured in plasma follow an opposite directions to that of inflammatory biomarkers. This project is composed of a series animal and human studies geared to understand the role of lipoxin A, resolvins and protectins in postoperative surgical recovery.

Student Role: Students participating in this project will assist in conducting animal and human studies. Specifically, she or he will learn how to perform laparotomy in rats and behavioral assays to assess postoperative recovery. The student will also learn how to measure plasma concentrations of lipoxin A, resolvins and protectins in animals and humans who have had surgery.

Research Type: Clinical

Mentor(s): Juan Cata, M.D.

Institution: **University of Texas M D Anderson Cancer Center**

Project Topic: Neuroimmune mechanisms of pain in a model of Gulf War Illness

Overview: Musculoskeletal pain is a principal symptom of Gulf War Illness (GWI), and affects up to 17% of Gulf War veterans. This project uses a rat model to investigate the neurobiological basis of pain in GWI and to test putative neuroimmune pharmacotherapies. Animal studies are being undertaken to determine how pain arises in a model of GWI, and whether drugs that target neuroimmune pathways can be used to treat such pain.

Student Role: This basic science project is geared toward modeling GWI pain in rodents. Rats develop hypersensitivity to mechanical stimulation following treatment with corticosterone and organophosphates. Biochemical studies are used to define the underlying mechanisms, and pharmacological techniques are used to target these mechanisms and resolve the pain. A student participating in this project will learn how to conduct behavioral analysis of pain sensation in rats, and the basics of biochemical techniques such as Western blotting and ELISA.

Research Type: Basic Science

Mentor(s): Peter Grace, Ph.D.

Institution: **University of Texas M D Anderson Cancer Center**

Project Topic: Antibody signaling in neuropathic pain.

Overview: Millions of Americans suffer from chronic pain that cannot be adequately managed due to our limited understanding of the underlying mechanisms. This project is composed of a series of interrelated in vitro and in vivo studies to understand how activation of astrocytes—specialized support cells in the spinal cord—by

antibodies can promote hyperexcitability of neurons in pain pathways. These studies are aimed at identifying new therapeutic targets for chronic pain.
Student Role: Students participating in this project will assist in isolating primary rat astrocytes, in vitro treatments to identify new signaling pathways, as well as several imaging and biochemical techniques. These include immunostaining and microscopy, live cell calcium imaging, RT-PCR, Western blotting, and ELISA.
Research Type: Basic Science
Mentor(s): Peter Grace, Ph.D.

Institution: **University of Texas M D Anderson Cancer Center**

Project Topic: Hypothalamic Neuronal Plasticity in Chronic Stress
Overview: The ongoing projects in Dr. Li's lab focuses on understanding the neuronal plasticity in the PVN underlying the HPA hyperactivity during chronic stress. This project is to decipher the cellular and molecular mechanisms involved in HPA hyperactivity and ultimately to design effective therapeutics.
Student Role: The students will perform both in vivo and in vitro experiments. Also, she/he will help with surgical preparation, animal stress model, the immunocytochemistry staining, real-time RT-PCR, and Western blot analysis, and preparation of lentivirus-shRNA, and performing microinjections.
Research Type: Basic Science
Mentor(s): De-Pei Li, Ph.D.

Institution: **University of Texas M D Anderson Cancer Center**

Project Topic: Mechanisms of Opioid Analgesia and Chronic Pain
Overview: Dr. Pan's research focuses on the functions and interactions of opioid receptors, and the neural mechanisms underlying acute and chronic opioid-induced effects, including opioid analgesia and interactions of chronic pain and opioid addictions. His research uses multiple approaches, including molecular biology, cellular physiology, and systems behavior techniques, to gain insight into how opioid drugs act and how to improve opioid treatment of cancer pain and minimize associated side effects such as drug dependence. Dr. Pan's research has been published in several high-impact journals. He is currently an active member of Graduate Faculty in the Neuroscience Program of the Graduate School of Biomedical Sciences at the University of Texas-Houston.
Student Role: Students participating in this program will conceptually gain frontier knowledge on analgesic functions of different types of opioid receptors and the underlying molecular and cellular mechanisms in acute and chronic pain conditions. Technically, those students will learn small animal surgeries, creation of small animal models of chronic pain, opioid reward and selfadministration, basic molecular methods for real-time RT-PCR and Western blotting, basics of whole-cell patch-clamp recording in vitro and various behavioral pain and reward tests for assessment of opioid analgesia and drug addiction in the animal models. Short-term research projects are available to investigate the analgesic efficacy and functional interactions of laboratory and clinical opioid or non-opioid compounds with differential pharmacological profiles for opioid receptors.
Research Type: Basic Science
Mentor(s): Zhizhong Pan, Ph.D.

Institution: **University of Utah**

Project Topic: Managing postoperative pain in patients that chronically consume opioids is a challenge. In the presence of similar painful stimuli (i.e. same surgical procedure), post-operative pain is often more intense in this group than in opioid naïve patients and their response to conventional pain management techniques is often inadequate. It is as if they are wired up different! The use of opioids for the treatment of chronic pain has escalated in recent years; they are one of the most commonly prescribed medications in the United States. One implication of this escalation is that patients on high doses of long-term opioid pharmacotherapy suffer exaggerated acute pain after surgery and often require escalating doses in chronic opioid therapy. The aim of this study is to explore differences between opioid consuming and opioid naïve patients in the expression of mRNA that code for selected protein receptors that play a role in transmitting pain.

Overview: We will measure perioperative changes in mRNA expression of mu3, metabolite-detecting, adrenergic, and immune gene receptors on white blood cells between chronic opioid consuming and opioid naïve patients undergoing elective surgery. The expression of mRNA in white blood cells is a surrogate of what is expressed at neural junctions that transmit pain.
Student Role: The student will identify prospective patients from the surgery schedule, participate in the consent process, and visit the OR when studies are performed by anesthesiology faculty.
The student may also contribute to other aspects, including: literature updates, preparation of and assay for mRNA expression, data analysis, interpretation, manuscript preparation, and presentation.
Research Type: Clinical
Mentor(s): Ken B. Johnson, M.D.

Institution: **University of Utah**

Project Topic: Development of a monitor to detect opioid-induced progressive hypoventilation in hospital patients and prompt for self-rescue.
Overview: The National Institutes of Health has identified the need for a device to monitor ventilation in patients receiving neuraxial opioids in the post-operative period. Although pulse oximetry will monitor oxygenation, it has reduced sensitivity as a monitor of hypoventilation, when supplemental oxygen is given. Nurses' periodic assessment of respiration is inadequate. New monitoring technology is needed to detect progressive hypoventilation in hospital patients. We will use monitored data acquired from 40 patients during their hospital stay after surgery to test a new detection and patient self-rescue prompting system.
Student Role: The medical student will assist in data collection from patients after surgery. The student will also assess how effective the prompting system was for promoting breathing after surgery. The student will prepare the results in abstract and/or journal format for publication.
Research Type: Clinical
Mentor(s): Lara Brewer, Ph.D.; Joe Orr, Ph.D..

Institution: **University of Utah**

Project Topic: Development of an Advanced Heart Sounds Monitor.
Overview: Heart sounds can be obtained noninvasively and carry substantial information about the mechanical performance of the heart, incl. strong correlations to cardiac contractility. A large number of detailed studies of phonocardiography were done in the 1950s and 1960s, but the field was mostly abandoned in the 1970s, when more attractive monitoring devices, such as echocardiography were developed. Modern instrumentation and advanced signal processing should allow us to build upon those early findings and build a heart sound based monitor of cardiac function. We will update a literature review of this field, which was done in the late 1990s and build the first prototype of a heart sound monitor.
Student Role: The medical student will be responsible for updating the literature review. The student will with supervision, validate and verify a simple heart sound monitor, consisting of a patient interface (microphone) and a data collection, signal processing, and display system. The student will be involved in initial clinical data collection efforts.
Research Type: Clinical
Mentor(s): Kai Kuck, Ph.D.

Institution: **University of Utah**

Project Topic: Development of a method and/or device to improve the estimate of blood loss during surgery based on an evaluation of suctioned fluid that is collected during the surgery.
Overview: The goal is to develop a model to improve estimates of surgical blood loss through analysis of suction fluid. The model is complicated by mixture of blood, irrigation fluid, and ascites, urine, and other fluids in the suction canister. Accurate determination is essential for accurate volume replacement. Simple first order estimates based on hematocrit of suction fluid are limited by factors such as: not all blood lost by the patient has the same hematocrit. Therefore, we will pursue a multi-compartment modeling strategy. The end product will be

a method by which we can use measurements of the composition of suction fluid together with patient data (preoperative hematocrit, etc.) and the volume of IV fluids to estimate the cumulative blood loss at any point during the surgery.
Student Role: The medical student will work with biomedical engineers to analyze data obtained in the operating room from a fluid canister evaluation system. Data from the fluid canister evaluation system will include hemoglobin concentration and canister volume. The student will interact with biomedical engineers and to use the measured contents of the canister to estimate blood lost by the patient. A background in data analysis with Excel will be essential for success in this project.
Research Type: Clinical
Mentor(s): Lara Brewer, Ph.D.

Institution: **University of Utah**

Project Topic: Muscle pain and muscle fatigue are symptoms in many chronic diseases including Fibromyalgia, Chronic Fatigue Syndrome, Myofacial Pain, Chronic Tension Headache, and Temporomandibular Disorder. Many more patients have degraded quality of life because of short term myalgia and fatigue that sometimes remits with treatment, or for unknown reasons, becomes chronic.
Overview: Here we propose to create a transgenic mouse that will make it possible, for the first time, to image the activity of sensory neurons that signal pain and fatigue inside functioning skeletal muscle. This will allow us to establish muscle structures that are innervated in skeletal muscle as well as the molecular and cellular mechanisms the sensory neurons use to signal pathways cognitive sensations of muscle pain and muscle fatigue.
Student Role: The medical student may participate in all phases of experimentation including: literature updates, participation in laboratory protocol development and group meetings, cell collection, cultures, 2-photon imaging in tissue and live mice, interpretation, manuscript preparation and presentation.
Research Type: Basic Science
Mentor(s): Alan R. Light, Ph.D..

Institution: **University of Utah**

Project Topic: Clinical validation of models to predict oxygen desaturation
Overview: We have built models that predict how fast people desaturate once apneic following induction of anesthesia. As you may know, some people desaturate really quickly while others can go for a long time. We've used physiologic models and pharmacologic models to predict how long patients won't breath following induction and whether or not they will desaturate. We'd like to validate these models in real patients. This is a collaboration with our bioengineering department. They have considerable expertise in modeling pulmonary physiology and anesthetic drug behavior.
Student Role: Conduct a sensitivity analysis of the pulmonary models used to predict desaturation to identify high impact parameters on model predictions. Assist in conducting a clinical observation study to evaluate model predictions.
Research Type: Clinical
Mentor(s): Lara Brewer, Ph.D.; Ken Johnson, M.D.

Institution: **University of Utah**

Project Topic: Development of a clinical data mining visualization and navigation tool.
Overview: The department has high resolution data and information (incl. clinical notes, intraoperative physiological measurements, beginning and end of surgical and anesthesia process steps, etc.) from more than hundred thousand surgical cases in its database. The database architecture is designed for easy scaling to the national MPOG database, which has well over three million cases. Accessing this database requires substantial affinity and familiarity with database tools to program advanced SQL queries etc. For many clinicians this represents a formidable barrier, preventing them from using this data to answer important clinical research questions. We will be developing a tool, which allows an initial visualization and navigation through the data, to detect patterns and do preliminary analyses. The software development will be undertaken by engineering and

computer science graduate students. However, the design of this tool will need to incorporate the clinical perspective

Student Role: The medical student, in collaboration with an engineering or computer science graduate student, will be developing the first one or two iterations of the visualization and navigation tool. This will involve familiarization with the database and its potential to answer clinical research questions, working with clinicians to understand how to design the visualization tool to support them best. In that collaborative team, the medical student will focus on contributing to the aspects that require applied physiological know-how, that involve clinical aspects, and on working with clinicians. Publication opportunities include publishing the chosen approach of eliciting expertise from and designing for domain experts (clinicians), and initial results of discovering relationships in the data. A successfully designed and implemented tool might give rise to opportunities to be listed as co-authors of clinical researchers who use the tool in their research work.

Research Type: Clinical

Mentor(s): Kai Kuck, Ph.D.

Institution: **University of Utah**

Project Topic: Correlation of tricuspid annular measurements between awake transthoracic echocardiograms (TTE) and anesthetized transesophageal echocardiograms (TEE).

Overview: There is increasing recognition that tricuspid regurgitation and annular dilation identified at the time of left heart surgery (particularly mitral valve repair) is associated with subsequent development of right heart failure. Surgery for this late complication is associated with significant perioperative mortality and therefore appropriate measures should be undertaken to avoid development of postoperative ricuspid regurgitation. A preoperative TTE measurement of tricuspid annular dimension of 4.0 cm or above is an indication for tricuspid annuloplasty. The recommendation is specifically not to use intraoperative TEE measurements to make these important decisions. This is because no study has addressed the association between these two measurements.

Student Role: The student will identify prospective patients from the surgery schedule, participate in the consent process, and visit the OR when studies are performed by anesthesiology faculty. The student will participate in the measurement of preoperative and intraoperative tricuspid annular dimensions and the identification of the correlation between the values. The student will be responsible, with supervision, for collecting data, data entry and analysis, and manuscript preparation.

Research Type: Clinical

Mentor(s): Joshua Zimmerman, M.D., FASE

Institution: **University of Utah**

Project Topic: Myalgic encephalomyelitis/Chronic fatigue syndrome (ME/CFS) and Fibromyalgia syndrome (FM) are chronic multi-symptom disorders, which are frequently comorbid.

Overview: The primary goal of this study is to identify unique genetic mutations seen in ME/CFS and/or FM but not in depression or other functional disorders like migraine
Both ME/CFS and FM have been proposed to involve mitochondrial dysfunction. Recently, we employed RNA-Seq to examine mutations in leukocytes (not whole blood) for the full human transcriptome. In a pilot sample, 94% of the 17 ME/CFS patients had High or Moderate Impact variants in mitochondrial genes affecting NADH dehdrogenase 4, and the 17th had mitochondrial variants affecting cytochrome B. Both are proteins in the respiratory chain complexes that have critical roles in production of ATP, the cell's major energy source. Known mitochondrial disorders are associated with other mutations affecting these same complexes.

Student Role: The medical student may participate in all phases of experimentation including: literature updates, participation in laboratory protocol development and group meetings, obtaining and processing blood samples, RNAseq, interpretation, manuscript preparation and presentation.

Research Type: Basic Science

Mentor(s): Alan R. Light, Ph.D..; Kathleen C. Light, Ph.D.

Institution: **University of Utah**

Project Topic: Does isoflurane anesthesia have an antidepressant effect equivalent to that of electroconvulsive therapy (ECT)? Do other anesthetics (e.g. ketamine, propofol) have similar effects? If so by what mechanisms and how can such therapy be optimized?
Overview: Preliminary clinical studies suggest that isoflurane has an antidepressant effect at least as effective as ECT without associated cognitive decline. Nevertheless the mechanism is little understood as are optimal dosing and treatment strategies. This ongoing clinical project is evaluating the role of "burst-suppression" as a potential acute antidepressant therapy.
Student Role: This is an ongoing clinical trial. The isoflurane study has moved to a randomized, blinded phase and the propofol arm is in the pilot phase. The student can be involved in team meetings and thus study design, present for patient enrollment, treatment planning and treatment with data collection and analysis. Ultimately, significant work meriting acknowledgement or authorship would be awarded accordingly.
Research Type: Clinical
Mentor(s): Scott Tadler, M.D.; Alan Light, Ph.D.; Kathleen Light, Ph.D.

Institution: **University of Vermont Medical Center**

Project Topic: Self-Determination Theory (SDT) and Development of Anesthesiology Resident Autonomy: A Comparison of Resident and Faculty Perceptions
Overview: 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 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.
Student Role: 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.
Research Type: Health Services
Mentor(s): Melissa Davidson, M.D.

Institution: **University of Vermont Medical Center**

Project Topic: Prospective randomized study of IV toradol vs. placebo for the management of post-operative ureteral stent symptoms
Overview: Placement and removal of ureteral stents are a commonly performed procedure, and patients report high levels of pain and discomfort following these surgeries. This study will examine whether the addition of intravenous toradol at the end of endoscopic urologic intervention with ureteral stent placement improves a) post-surgery pain control and b) allows for patients to be discharged without opioid medications. The project will be a prospective randomized double-blind trial, with patients randomized to receive either IV toradol or placebo.
Student Role: The student will assist the principal investigator and research staff with all aspects of clinical data collection: Recruitment of subjects, obtaining informed consent from subjects, randomization of subjects,

administering patient questionnaires, abstraction of data from patient records, and ensuring that good clinical practice is followed, including required human subjects research practices.
Research Type: Clinical
Mentor(s): Borzoo Farhang, D.O.

Institution: **University of Vermont Medical Center**

Project Topic: Avoiding cough through precise delivery of remifentanil in otolaryngological or ophthalmological cases.
Overview: Coughing at extubation is common in patients at the end of procedures with general anesthesia, and is not dangerous. In certain surgeries, the avoidance of cough is important to ensure a good surgical outcome, specifically during certain operations in the eye and in the neck, where coughing can cause bleeding into the site of surgery, which may cause harm to the patient and may potentially require a new surgery.
Many methods have been proposed to avoid coughing during extubation with variable success rates. The most promising method involves using remifentanil, an ultra-short acting opioid, with an advanced medication delivery system that is not available in the U.S. We have developed a method to replicate this system using a standard medication pump and an algorithm that can be run on a spreadsheet or mobile app. The purpose of this trial is to determine whether using remifentanil with our algorithm can in fact decrease or prevent coughing around the time of extubation.
Student Role: The student will work with the principal investigator and research staff on all aspects of conducting a clinical trial on patients in the operating room, including recruitment of subjects, obtaining informed consent, randomization, collection of data in the operating room, and ensuring adherence to the protocol during surgery.
Research Type: Clinical
Mentor(s): Donald Mathews M.D.; Elie Sarraf M.D.C.M

Institution: **University of Vermont Medical Center**

Project Topic: Applying Pareto Optimization to Operating Room Management
Overview: 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 service occurs along a Pareto front. 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.
Student Role: The student will complete an 8-week health care management capstone project examining and implementing change in perioperative processes using a systems-based multidisciplinary approach. 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 direct observation in anesthesia settings. Data will be abstracted from WiseOR and EPIC, and analyzed and presented with Microsoft Excel.
Research Type: Health Services
Mentor(s): Mitchell Tsai, M.D., M.M.M.

Institution: **University of Vermont Medical Center**

Project Topic: Performance assessment of a novel processed-EEG monitoring index during surgery: A four-arm, randomized, prospective trial.
Overview: Anesthetics cause predictable and reproducible changes in a patient’s electroencephalogram (EEG). These changes led to the development of processed-EEG monitors for use in surgery. While these monitors

display one component of the anesthetic state (the "hypnotic depth"), they do not show the patient's ability to respond to external stimuli, such as intubation and incision. Those responses imply patient movement, which could interfere with the surgery, and are often seen as a sign of pain. Predicting the ability of a patient to respond would inhibit those movements as well as contribute to patient comfort.
A new monitor calculates and displays two indices. One displays the depth of the hypnotic state; the second shows data about patient responsiveness. With both indices, we can tailor the anesthetic to a patient's specific needs. This four-arm randomized trial will be used to provide evidence of clinical performance of the monitor in order to obtain FDA clearance.
Student Role: The student will participate in all aspects of conducting a clinical trial of a medical device in a hospital setting, and will assist the principal investigator and research team in identification and recruitment of subjects, setup and operation of the devices in the operating room, collection of data, and general conduct of the study and adherence to the protocol and good clinical practice.
Research Type: Clinical
Mentor(s): Catherine Christenson M.D.; Donald Mathews M.D.

Institution: **University of Vermont Medical Center**

Project Topic: Changes in transpulmonary pressures during varying surgical conditions
Overview: For specific patient populations, intraoperative lung-protective ventilation (LPV) strategies have been linked to a reduced postoperative complication rate. We believe that patients undergoing laparoscopic surgery would benefit from a ventilation strategy tailored to their transpulmonary pressure (TPP), due to the unique condition of their perioperative pulmonary physiology and positioning compared with that of the standard surgical population. This study aims to answer two questions:

1. Does patient positioning effect TPP?
2. Is the magnitude of the change in TPP associated with BMI?

We believe that by better establishing the change in TPP as a patient is positioned for laparoscopic surgery, we will begin to uncover the relationship between TPP and lung injury. This would put us firmly on a path toward generating a significant contribution to the fields of perioperative management and lung injury prevention.
Student Role: The student will assist the principal investigator and co-investigators in the conduct of this single-arm, prospective, proof-of-concept study. The student will act as a member of the research team, including identifying and recruiting patients, assisting the anesthesia provider assigned to the patient to deploy the esophageal manometry system in the OR, gathering data, and ensuring the smooth functioning of the system during surgery.
Research Type: Clinical
Mentor(s): S. Patrick Bender M.D.; W. Gabriel Tharp M.D., Ph.D.

Institution: **UT Southwestern Medical Center**

Project Topic: Monitoring for Spinal Cord Ischemia
Overview: Spinal cord injury due to ischemia impacts patients after aortic and spine surgery, as well as after traumatic injury. Currently no good technology exists to allow for the direct monitoring for spinal cord ischemia, handicapping surgeons and critical care physicians in the management of these patients and likely resulting in less that optimal outcomes for patients. With a group that includes physicists and engineers, we are developing a device that can directly monitor spinal cord blood flow and oxygenation and we are testing this device in a large animal model.
Student Role: A student participating in this project will be challenged to develop an understanding of the relevant literature and scope of the clinical problem at hand. The student will also assist in the surgical procedures on the animals, to include spines surgery, cannulation of the heart, and placement of monitoring catheters. Following each experiment the student will assist in the analysis and presentation of the data acquired.
Research Type: Basic Science
Mentor(s): Thomas F, Floyd, M.D.

Institution: **UT Southwestern Medical Center**

Project Topic: Association between Acute Kidney Injury after Cardiac Surgery and Quality of Life Up to One Year after Surgery

Overview: Cardiac surgery-associated acute kidney injury (CSA-AKI) is a leading cause of AKI, and it is associated with postoperative mortality and with elevated risk of chronic kidney disease. Approximately 20% of cardiac surgical patients develop CSA-AKI. Little work has been done to assess the association between CSA-AKI and decline in postoperative health related quality of life. This pilot study will assess the association between serum creatinine defined AKI and quality of life assessed one year after surgery.

The central hypothesis of this study is that development of CSA-AKI as assessed by the KDIGO criteria will associate with significantly reduced health related quality of life (assessed with SF-12 and Seattle Angina Questionnaires) administered to patients 6 months and 1 year after surgery. This pilot study will assess n=~200 undergoing cardiac surgery at a single center.

Student Role: The student will review subjects' medical records and enter data on primary hospitalizations as needed. The student will also enter data as needed regarding patient responses to 6 month and 1 year postoperative quality of life questionnaires. The student will work with the research team to help obtain follow-up on patients who have not responded to questionnaires by re-contacting with reminders by mail and telephone. The student will be involved with data analysis of quality of life data, and the student will help author a scientific abstract of study findings to be presented at the Medical Student FAER Scientific Abstract Session at the 2018 Annual Meeting of the American Society of Anesthesiologists. The student will learn about cardiac surgery, biomarkers, acute kidney injury, databases for clinical research, and statistical analyses for outcome studies.

Research Type: Clinical

Mentor(s): Amanda A. Fox, M.D., M.P.H.

Institution: **UT Southwestern Medical Center**

Project Topic: Patient Blood Management – Impact of Transfusion Algorithm and Point-of-Care Testing on Blood Product Utilization and Outcomes in Cardiac Surgery.

Overview: Although transfusions are often considered lifesaving measures, increasing evidence has shown that blood transfusions are an independent risk factor for many adverse clinical outcomes including increased mortality, stroke, major adverse cardiac events (MACE), renal failure, and infection. This project will use data collected from a Blood Conservation and Hemostasis in Cardiac Surgery survey distributed to the members of the Society of Cardiovascular Anesthesiologists (SCA) to determine if the use of transfusion algorithms supported by point-of-care (POC) testing has a significant impact on blood utilization. Institutions that utilize transfusion algorithms with POC testing will be compared to those utilizing only one or none of these best practice interventions. The Society of Thoracic Surgery (STS) database will be used to examine the impact of these two best practices on blood transfusion and risk-adjusted clinical outcomes.

Student Role: The student will be involved in the collection, organization, and storage of data from the Society of Cardiovascular Anesthesiologists blood management survey. In addition, the student will collect, organize, and store data from the STS database inquiry and searches. The student will also be involved in data analysis and presentation on preliminary results, possibly an abstract. He/She will meet routinely with Drs. Joshi and Greilich, attend organizational meetings, collaborative research meetings, departmental grand rounds, and will be directed to online research resources.

Research Type: Clinical

Mentor(s): Philip E. Greilich, M.D., FASE; Ravi V. Joshi, M.D., FASE

Institution: **UT Southwestern Medical Center**

Project Topic: Ultrasonographic Changes in Facial Soft Tissue Thickness During Robotic-Assisted Pelvic Laparoscopic Surgery: A Pilot Study.

Overview: During pelvic robotic-assisted laparoscopic surgery patients are exposed to insufflation of the peritoneal cavity and steep Trendelenburg positioning. As a result, the compliance of the respiratory system is

decreased and high positive pressures are required for mechanical ventilation. Concurrently, significant shifts of fluids from the lower to the upper body and impaired venous return and lymphatic drainage from the head and neck occur. The effect of all these changes is often clinically observed as facial conjunctival edema. Ultrasonography has been reliably used to assess the thickness of soft tissues in several anatomic locations. A few studies have also demonstrated that ultrasound imaging can be used to assess changes in the content of fluid of the skin and soft tissues. The proposed project is a pilot study to assess ultrasonography as a tool to quantify changes in thickness of the soft tissues of the face during robotic-assisted pelvic surgery.

Student Role: The medical student participating in this project will:

- Participate in the enrollment and consent process of patients interested in the study.
- Participate in Ultrasonographic acquisition of images of the soft tissues of the face (at specific anatomic locations) before induction of anesthesia and immediately after the surgery.
- Collect baseline patient data.
- Collect data regarding intraoperative variables, including total amount of fluids administered, surgical bed tilting, ventilatory parameters, duration of procedure, etc.
- Participate in the off-line measurements and analysis of the Ultrasonographic images.
- Participate in the statistical analysis of data
- Participate in writing an abstract with the results of the study.
- Will present the results of the study at a local student research session at our institution.
- In addition, the student will have the opportunity to have exposure to anesthetic procedures for laparoscopic pelvic surgery at our institution.

Research Type: Clinical

Mentor(s): Eric Rosero, M.D., M.Sc

Institution: **Vanderbilt University Medical Center Program**

Project Topic: Understanding the Relationship between Patient Satisfaction and Formal Measurements of Care Quality

Overview: Anesthesiologist performance is being increasingly measured by government agencies, hospitals and at a departmental level, using a variety of sources of information. While the importance of patient satisfaction in health care is clear, and the necessity of developing care quality metrics is apparent, little work has been done to evaluate the relationship between patient satisfaction and care quality metrics in anesthesia. We hypothesize that patients who rank their satisfaction with anesthetic care highly also have correspondingly high objective measurements of care quality.

Student Role: The student will be responsible for formulating a data analysis plan, identifying target variables to ascertain which covariates need to be adjusted for and selecting the formal measurements of care quality. After understanding these elements, the student will perform an analysis to determine how and if patient satisfaction is related to objective measures of care quality, as currently defined. No programming or computer skills are required as we have a highly functional engineering team which can provide ready access to electronic patient data. Statistical support is available through our team biostatistician should this be required.

Research Type: Health Services

Mentor(s): Jonathan P. Wanderer, M.D., M.P.H.; Jesse M. Ehrenfeld, M.D., M.P.H.

Institution: **Vanderbilt University Medical Center Program**

Project Topic: Practice Patterns: National Survey On Pre-Operative Clinic Evaluation Practice

Overview: Currently there appears to be wide national variation in which patients are assessed in a preoperative anesthesia clinic prior to surgery. Additionally there are multiple reimbursement models that have been implemented in preoperative anesthesia clinics, but the success of those models has never been quantified. Furthermore, with the advent of bundled care payment methodologies, it is unclear how preoperative clinics can best operate and provide value to patients, departments, and the healthcare system in the future. We plan to

perform a survey of U.S. preoperative anesthesia clinics to determine their characteristics, approach to reimbursement, and plans for adapting to new models of care.
Student Role: The student will be responsible for developing the survey instrument, validating the questions and methodology, enrolling preoperative clinics, and participating / performing the statistical analysis. We have an online survey tool available for use, and no computer skills are required. Statistical support is available through our team biostatistician should this be required.
Research Type: Health Services
Mentor(s): Jonathan P. Wanderer, M.D., M.P.H.;Jesse M. Ehrenfeld, M.D., M.P.H.

Institution: **Vanderbilt University Medical Center Program**

Project Topic: Use of copolymer-based cell membrane stabilizers to provide neuronal protection after traumatic brain injury
Overview: Each year, 2.5 million people sustain a traumatic brain injury (TBI), with >50,000 deaths and >280,000 suffering permanent disability. TBIs can be focal (confined to one area) or diffuse (involving many areas), and can range from mild (e.g., a concussion) to severe (e.g., extended periods of unconsciousness, memory loss). TBI kills brain cells and causes numerous biochemical reactions. These can lead to cellular and mitochondrial dysfunctions, and further cell death. Current therapies are limited, and dependent on only a few surgical / pharmacological interventions. We have shown that copolymer-based cell membrane stabilizers (CCMS) improve in-vitro cellular viability when given at the start of reoxygenation following hypoxia, and improve recovery from ischemia/reperfusion injury in the in-vivo brain and heart when given upon reperfusion. CCMS may represent an innovative therapy that can break the chain of deleterious cellular and molecular events set in motion by TBI.
Student Role: The student will actively participate in research studies to test the hypothesis that CCMS will improve neuronal viability and attenuate cytotoxicity using cultured neurons and in-vitro models of TBI (e.g., compression, metabolic stress, stretch injury, transection). On a daily basis, the student will work with team members such as research assistants, graduate students, fellows, and/or junior faculty. The student will acquire all the necessary technical skills for the summer project, and will be mentored on data collection and analysis, as well as scientific writing. Subsequent local and/or national poster presentations are encouraged. This focused basic science research experience will be complemented by frequent opportunities to shadow anesthesiologists in different clinical environments and simulations.
Research Type: Basic Science
Mentor(s): Matthias L. Riess, M.D., Ph.D.; Professor of Anesthesiology and Pharmacology

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Institution: **Vanderbilt University Medical Center Program**

Project Topic: Modulation of Innate and Adaptive Immunity to Improve Resistance to Infection: From Bench to Bedside
Overview: Infection, especially with antibiotic resistant pathogens, is a common and important problem in perioperative and critically ill patients. This project will examine the ability of immunomodulatory strategies to improve host resistance to infection with common pathogens that exhibit a high incidence of antibiotic resistance (Pseudomonas, Acinetobacter, Staphylococcus). Specific strategies include modulation of innate immune function using toll like receptor ligands and adaptive immunity using checkpoint inhibitors (anti-PD-1/PDL1, anti-CTLA-4). Specific endpoints will include resistance to systemic infection and mechanistic readouts such as cellular metabolism, antimicrobial functions and cell signaling. Further studies will define the specific alterations in metabolic substrate utilization that lead to induction of the antimicrobial phenotype and the downstream signaling pathways and transcription factors involved.
Student Role: Students will have the opportunity to gain a variety of skills based on their desires and experience. Their specific project assignment will be determined through discussion with the student. After development of the project, students will either work directly with lab personnel to learn experimental techniques. It is expected that students will gain independence and run their own experiments. However, we are committed to providing strong mentorship and teaching to assure a meaningful learning experience. We are open to working with students with all levels of experience as we are an enthusiastic team of investigators with a strong desire to teach.

Students will have the opportunity to gain experience with a variety of in vitro and in vivo experimental techniques including mouse models of bacterial infection, tissue and blood harvesting, bacterial culture/microbiology, assessment of leukocyte glycolysis and aerobic metabolism using a Seahorse XFe96 metabolic analyzer, qPCR, Western blotting and protein measurements using ELISA and Bio-plex techniques, cell culture and flow cytometry. In regard to models of bacterial infection, students will have the opportunity to culture and quantify bacteria and perform intravenous, intraperitoneal and/or subcutaneous injections. Students may also participate in intravenous or intraperitoneal injection of experimental agents (TLR agonists/checkpoint inhibitors). Blood and tissue will be harvested to quantify bacterial burden using serial dilution and quantitative culture techniques. Leukocyte recruitment to sites of infection will be determined using flow cytometry and cytokine production will be measured by ELISA. Mechanisms of drug action will focus evaluation of cellular metabolism, intracellular signaling and gene expression primarily using harvested peritoneal macrophages. Cellular metabolism will be analyzed using the Seahorse XFe96 metabolic analyzer, gene expression by RNAseq and qPCR and cell signaling using Western blotting with a focus on the mTOR signaling pathway. Students will be closely involved in experimental design, data acquisition and data analysis. They will be required to present experimental plans and results at our weekly lab meeting and have a good understanding of the literature related to their project. Students will be required to present their work to the lab group by oral presentation at the end of their rotation. An overview of background literature, methods, results and a discussion of conclusions is expected. Based on their performance and contributions, students will have the opportunity to serve as co-author on peer-reviewed publications, a goal that several previous summer students have attained.

Research Type: Basic Science

Mentor(s): Edward Sherwood M.D., Ph.D.; Julia Bohannon, Ph.D. ; Antonio Hernandez, M.D., M.Sc.I

Institution: **Wake Forest University School of Medicine Program**

Project Topic: Nerve block duration comparing multimodal nerve block solution mixture vs indwelling catheter infusion of local anesthetic.

Overview: Non-inferiority study to determine efficacy of a single injection nerve block using a 4 component mixture versus a continuous infusion of local anesthetic alone in patients recovering from total knee arthroplasty.

Student Role: Assist with enrollment, data collection, patient interviews and data analysis for patients who are participating in the study.

Research Type: Clinical

Mentor(s): J. Douglas Jaffe, D.O.; James D. Turner, M.D.

Institution: **Wake Forest University School of Medicine Program**

Project Topic: Pharmacokinetics of bupivacaine used in the performance of Pectoralis Nerve Blocks under ultrasound guidance for breast surgery.

Overview: Blood sample acquisition for use in laboratory analysis of plasma levels of bupivacaine. Cohorts include two populations, unilateral PK data and bilateral PK data.

Student Role: The student will perform blood sample acquisition, assist with enrolment of patients and transport samples to laboratory storage areas. Once data collection is complete, data will be interpreted and results will be published.

Research Type: Clinical

Mentor(s): J. Douglas Jaffe, D.O.; James D. Turner, M.D.

Institution: **Wake Forest University School of Medicine Program**

Project Topic: Comparison of psoas compartment blockade to quadratus lumborum blockade for anterior total hip arthroplasty.

Overview: Randomized, double blind, active comparator trial investigating analgesic non-inferiority comparing two nerve block procedures and the resultant analgesia, patient satisfaction, and side effect incidence for anterior approach total hip arthroplasty.

Student Role: Patient interviews, enrollment into the study, blood sample collection, and data management.

Research Type: Clinical
Mentor(s): Christopher Edwards, M.D.; J. Douglas Jaffe, D.O.; James D. Turner, M.D.

Institution: **Washington University**

Project Topic: The Palanca lab focuses on markers of reversible neurological impairments associated with the perioperative period and procedural medicine. These neurophysiologic and imaging markers may allow a greater understanding of the neural mechanisms underlying these disorders, suggest avenues for diagnosis and intervention, and elucidate the underpinnings of normal cognitive function.
Overview:

1. Electroencephalgraphic (EEG) markers of delirium following surgical procedures.
2. Functional magnetic resonance imaging markers of susceptibility and recovery of delirium in the postoperative period.
3. The relationship of neural markers and cognitive task performance during the recovery from electroconvulsive therapy.

Student Role: Assist in data acquisition and analysis. Technical or mathematical background is ideal. Students will have the opportunity to shadow in the cardiac operating room and present their work at the end of the summer.
Research Type: Clinical
Mentor(s): Ben Palanca, M.D., Ph.D., M.Sc., Assistant Professor of Anesthesiology

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Institution: **Washington University**

Project Topic: Persistent post-surgical pain (PPSP) affects 5-40% of patients undergoing surgery, and causes a substantial impairment in quality of life. Numerous studies have proposed patient-specific risk factors for the development of PPSP, such as patient age, sex, psychological and cognitive factors, and the existence of pre-surgical pain, as well as factors related to the surgical technique, choice of anesthesia and others. However, the topic has not been systematically reviewed, and currently no strategy exists to identify high-risk patients. As most perioperative interventions demonstrate only modest effect sizes in preventing or mitigating PPSP, it would be imperative to develop appropriate risk-stratification approaches to allow targeted, personalized PPSP prevention in high-risk patients.
Overview: The project is a systematic literature review and meta-analysis to determine overall and surgery-specific risk factors for the development of PPSP after nine types of surgery.
Student Role: The methodology for the systematic review has been set, and the literature up to 2014 has been reviewed, extracted and analyzed. The student's role, under the PIs mentorship, will be:

- To perform an updated systematic literature search
- To extract data on risk factors from the relevant 2015-2018 papers on 9 types of surgery (Thoracic/Chest, Breast, Abdominal, Total hip/knee arthroplasty, Iliac crest bone harvest, Inguinal hernia repairs, donor nephrectomy, hysterectomy, and radical prostatectomy)
- To perform data analyses
- To complete writing the manuscript and submit it for publication

Research Type: Clinical
Mentor(s): Simon Haroutounian, Ph.D., M.Sc., Assistant Professor of Anesthesiology, Division of Clinical and Translational Research

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Institution: **Washington University**

Project Topic: Sepsis.
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.

Overview: 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.
Student Role: The student involved in this project would help screen the patient censuses of the medical and surgical ICUs to identify appropriate patients for inclusion and would approach patients and families to obtain consent for participation. The student would also assist with data collection from the electronic medical record and enter data into an online data management system. The student would also have the opportunity to observe and/or participate in performing cytokine secretion assays in the research laboratory.
Research Type: Clinical
Mentor(s): Anne M. Drewry, M.D., Assistant Professor of Anesthesiology

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Institution: **Washington University**

Project Topic: Simulation and Performance Assessment Research at Washington University in St Louis
Overview: Our primary research interest is to develop and disseminate simulation-based educational methods that accelerate the acquisition and retention of skills relevant to clinical practice. The research occurs at the simulation centers at WUSM www.simulation.wustl.edu. Our main simulation center is the Howard & Joyce Wood Simulation Center directed by the main mentor, David Murray. Students also have an opportunity to participate in education programs at the Saigh Pediatric Simulation Center in St Louis Children's Hospital and the Anesthesia Simulation Center in Barnes Hospital. Our simulation centers work collaboratively on many educational research projects. We have a range of educational research projects that include medical students, interdisciplinary research teams and practicing physicians. Our centers research projects are directed primarily to developing and defining a standard for performance in cognitive and psychomotor skills that are essential to clinical practice.
Student Role: The student will select from one of the ongoing projects at the Wood Simulation Center. The summer months are busy at the centers as we provide numerous training programs for medical students, interns, residents, fellows and practicing physicians. Students will be involved in our ongoing curriculum for 3rd year students in airway, resuscitation and trauma as well as our specialized simulation curriculum that prepare graduating medical students for internship, orient new interns to ultrasound-guided central line placement, as well as provide training for anesthesia, medical and surgical residents. Research responsibilities primarily revolve around learning how to score current and previously recorded individual and team simulated performances from digital recordings. The student's data entry responsibilities are primarily via use of excel/SASS spreadsheets. Students provide preliminary analysis mainly via descriptive statistics and conducting assessments of the scores reliability and validity. The primary analysis is conducted by a consultant psychometrician. Students participate in publication and presentations of the simulation research at conferences and meetings.
Research Type: Clinical
Mentor(s): David J Murray, M.D. Professor of Anesthesiology Carol B.;Jerome T. Loeb Professor, Director, Howard & Joyce Wood Simulation Center, Washington University School of Medicine

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Institution: **Washington University**

Project Topic: Identification of sites to which anesthetics bind to produce their effects, with the particular focus on the protein chemistry of GABA-A receptors to identify and characterize drug binding sites.
Overview: The Evers lab studies the protein chemistry of GABA-A receptors to identify and characterize drug binding sites, sequence variants and post-translational modifications. The focus is on anesthetic neurosteroids and propofol, using analogue photolabeling reagents coupled with mass spectrometry, to identify anesthetic binding sites on membrane proteins. The lab has pioneered mass spectrometric methods to sequence the transmembrane segments of integral membrane proteins such as the GABA-A receptor. Current directions include: Using top-down mass spectrometry to identify the stoichiometry of anesthetic binding to GABA-A

receptors and; Identifying cholesterol binding sites on GABA-A receptors and their relationship to anesthetic binding sites using photolabeling and mass spectrometry.
Student Role: Feasibility: The student will perform cell harvesting, membrane purification and protein purification using established methods in the lab.
Responsibility: The student will work closely with a senior lab member to label a protein with an anesthetic photolabeling reagent for identification of drug binding sites. The student will analyze purifications by Western blots. Mass spectrometric analysis of samples will be performed and analyzed by senior lab member with student observation/assistance.
Accomplishment: Student will have opportunity to participate in a publication of results.
Opportunity: Student will learn modern protein chemistry methods including affinity purification, FPLC and will gain some understanding of protein mass spectrometry. There will be opportunity for student to observe in the OR and ICU.
Research Type: Basic Science
Mentor(s): Alex S. Evers, M.D. is Henry Mallinckrodt Professor and Head of Anesthesiology, Professor of Medicine, Professor of Developmental Biology, and a DBBS faculty member in the Computational/Molecular Biophysics and Neurosciences Programs. Evers is also a member of the Institute of Medicine of the National Academy of Sciences.

Institution: **Washington University**

Project Topic: The Bruchas lab focuses on the genetic, pharmacological, and behavioral dissection of G-protein coupled receptor signal transduction in pain and neuropsychiatric disorders
Overview:

1. Neuropeptide and monoamines in anxiety, depression, and drug seeking
2. GPCR functional selectivity and signal transduction in pain, stress, and motivated behavior
3. Neural circuits in the modulation of reward and aversion
4. Developing, computation, and engineering novel tools to dissect neural circuits in affective behaviors and pain

Student Role: Participate in translational or basic research projects ; lead a small project that can be accomplished during the summer.
Research Type: Basic Science
Mentor(s): Michael Bruchas, Ph.D., Henry E. Mallinckrodt Professor of Anesthesiology

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Institution: **Washington University**

Project Topic: Outcomes research focused on perioperative care, including intraoperative awareness, long term psychological consequences of intraoperative awareness and of surgery, postoperative delirium and cognitive alteration, and postoperative medium-term outcomes of surgery.
Overview: His research group completed two large, randomized clinical trials evaluating interventions including targeted education, structured protocols and automated intraoperative alerts. The studies advanced patient care by demonstrating effective interventions to decrease intraoperative awareness and identify risk factors for awareness and perioperative factors associated with adverse postoperative outcomes. In collaboration with colleagues in the Alzheimer's Disease Research Center at Washington University, his research group found that surgery did not appear to be associated with accelerated cognitive decline or increased incident dementia. He led in international multi-center trial, investigating the potential of low dose ketamine to reduce postoperative delirium and acute pain. He is currently conducting a large clinical trial called ENGAGES to determine whether electroencephalogram guidance of anesthesia decreases postoperative delirium.
Student Role: Participate in outcomes-focused clinical research projects; lead a small project that can be accomplished during the summer.
Research Type: Clinical

Mentor(s): Michael Avidan, M.D., MBBCh, Professor of Anesthesiology, Professor of Cardiothoracic Surgery, Chief Division of the Division of Clinical and Translational Research, and Director of the Institute of Quality Improvement, Research, and Informatics (INQUIRI).

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

Project Topic: Vascular Regenerative in vitro
Overview: 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.
Student Role: 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.
Research Type: Basic Science
Mentor(s): Laura E. Niklason, M.D., Ph.D.

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

Project Topic: Integrating perioperative care into the treatment of hypertension
Overview: Essential hypertension is common, treatable, and deadly. While comprehensive guidelines assist physicians in the diagnosis and management of hypertension, numerous studies show that patients consistently suffer from ongoing and widespread hypertension diagnostic failures. We propose to use the ambulatory surgical encounter as a pathway for identifying and addressing these failures.
Student Role: Students will obtain training on accessing the Veterans Administration database in order to gain access to diagnostic histories of patients involved in Dr. Schonberger's clinical studies. Students will learn longitudinal evaluation of patient diagnostic and therapeutic histories, in order to pinpoint timing of diagnosis of hypertension, and consequent therapeutic efficacy. Overall project is based upon the fact that Schonberger's studies have shown that a high fraction of patients diagnosed with hypertension prior to the pre-operative encounter are, in fact, under-treated for their disease.
Research Type: Clinical
Mentor(s): Robert Brian Schonberger, M.D., M.H.S.

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

Project Topic: Noninvasive Monitoring of Cardiovascular Waveforms
Overview: 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.
Student Role: 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 effected 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.
Research Type: Clinical
Mentor(s): Kirk Shelley, M.D., Ph.D.

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

Project Topic: Assessment of Pain Mechanisms

Overview: Peripheral nerve sensation of pain is complex, with multi-factorial influences such as co-stimuli, inflammation, and learning all impacting pain outcome. Our laboratory focuses on the basic mechanisms of pain signaling in peripheral and dorsal root ganglion neurons, to increase our understanding of acute and chronic pain syndromes.
Student Role: Participate in laboratory assessments of pain mechanisms in animals and humans, and study means of pain modulation. Specifically, our laboratory studies pain mechanisms in the dorsal root ganglion in a rat model of acute pain. Students will learn analysis of electrophysiological signals and will compare those arising from naïve animals to those arising from animals undergoing various interventions to modulate neural response to painful stimuli.
Research Type: Basic Science
Mentor(s): Robert LaMotte, Ph.D.

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

Project Topic: Assessment of Mechanisms of Cutaneous Itch
Overview: Cutaneous itch is an under-studied phenomenon that is associated with substantial discomfort and morbidity in some cases. Our laboratory is working as part of a consortium of investigators to tease out basic events that occur in the sensation and transduction of cutaneous itch.
Student Role: Participate in human and basic biochemical studies of the mechanisms of sensation of itch, and in the modulation of pathologies resulting in chronic sensation of itch. Studies of cutaneous itch are performed in normal human volunteers, using targeted pruritic stimuli. Students will learn analysis of electrophysiological signals to pruritic stimuli, and will compare those arising from naïve individuals to those arising from subjects undergoing various interventions to modulate neural response to pruritic stimuli.
Research Type: Basic Science
Mentor(s): Robert LaMotte, Ph.D.

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

Project Topic: Evaluation of safety and efficacy of antithrombin for preventing thrombosis in VAD patients
Overview: Antithrombin III is a natural anti-coagulant that works by activating endogenous heparin moieties to prevent the progression of the coagulation cascade. When complex with heparin, antithrombin III binds and inactivates both thrombin and factor Xa. This study will look at the efficacy of antithrombin III administration in the prevention of thrombosis in patients receiving ventricular assist devices (VADs). Antithrombin III is administered peri-operatively to patients enrolled in the study, and thrombotic events intra-operatively and post-operatively are tallied. Safety and effectiveness of the drug will be studied.
Student Role: Students will participate in various aspects of the clinical research, including patient recruitment and consent, and evaluation of medical records. In addition, students will assist in data collection and collation, as well as analysis in collaboration with statistical experts. Data to be collected and analyzed will include hemodynamic data, quantification of transfusion volumes, measurements of PT, PTT, platelet count, and ACT. Comparison of coagulation parameters in patients receiving Antithrombin III, with those patients not receiving the drug, will be undertaken by students in collaboration with our statistician.
Research Type: Clinical
Mentor(s): Manuel Lopes Fontes, M.D.

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

Project Topic: Peer-review model of quality of care in Anesthesia.
Overview: Measurement of performance and quality outcomes in Anesthesia is difficult and has not been implemented in most academic medical centers across the US. By quantifying quality of care and outcomes, we can provide guidance on how to improve physician care, and we can measure improvements over time and across centers.
Student Role: Medical students participating in this project will work with Dr. Lagasse on implementing a structured peer review model for subspecialty care in the Department of Anesthesiology, measure performance

through statistical process control of adverse outcomes, analyze causal factors of adverse events, coordinate performance improvement through systematic changes, and quantify the effects of those system changes through continuous monitoring.

Research Type: Clinical

Mentor(s): Robert LaGasse, M.D.