**Project Title:** Predicting Acute Kidney Injury after elevated risk non cardiac surgery.

**Problem Statement**:

Acute kidney injury (AKI), or a rapid decrease in renal function, is associated with prolonged hospitalization, cardiovascular disease, chronic kidney disease, and death. Retrospective data modeling has associated preoperative risk factors to the development of AKI, but no effective, clinically operational scoring system to predict post operative AKI has been successfully developed.1 Currently, as part of a Johns Hopkins School of medicine epic scholars funded project, we are modeling a population of 6000 elevated surgical risk patients with logistic regression to further identify associations with post operative AKI. However, we have access to significantly more data that would enable the application of machine learning. In particular we have access to all systolic and diastolic blood pressure values in the patient encounter. Also, we have every Creatinine measurement (the most common assessment of renal function) 1 month before surgery and 3 months after. These data should enable more complex analysis of trends over time. Ideally a real time prospective risk model could be generated that could give a daily assessment of a patient’s progression or risk score toward or away from kidney injury that could guide intervention.

**Project Team:** PI Lee Goeddel MD, MPH, co- investigators Thomas Metkus MD, Jeffrey Dodd-o MD, PhH, Derek Fine MD, MPH, Shaun Moeller, MD Mentor Nauder Faraday MD, MPH, (eg. Mentor, co-Investigator, research associate, etc.)

**Background**:

Acute kidney injury (AKI), or a rapid decrease in renal function is associated with prolonged hospitalization, cardiovascular disease, chronic kidney disease, and death. 30-40% of all AKI occurs after surgery.2 The incidence of perioperative AKI ranges from 18 to 47% depending on the observed population and has been strongly associated with increased 30 day mortality.3 Retrospective data modeling has associated preoperative risk factors to the development of AKI, but no effective, clinically operational scoring system to predict post operative AKI has been successfully developed.1Despite the significance of perioperative AKI, nothing is currently done to prevent it.

We have identified a retrospective cohort of 6000 elevated risk non cardiac surgery patients cared for at Johns Hopkins hospital. This local list was identified using a list of procedures identified in a recent retrospective analysis that used 2.5 million US surgical encounters from the Nationwide Inpatient Sample to identify surgical procedures alone with greater than 1% mortality.4 This list of surgeries is commonly performed and easy to screen as high risk. Current clinical care protocals would assess these patients to have high perioperative risk but have little further proactive intervention before, during, or directly after surgery to decrease the risk of postoperative kidney injury. The creatinine (serum test of renal function) trend is followed with urine output. AKI is determined using the KDIGO or RIFLE criteria, which correlates to decreases in urine output and increases from baseline creatinine. Intervention than follows, but may be too late after the injury has occurred.

The cost of acute kidney injury in hospitalized patients is profound and estimated at $7900 per hospital stay and an increase in LOS of 3.2 days.5 The increase is even more in the postoperative patient where the risk adjusted increase in cost of care for the hospital stay was $15,900.6 AKI is greater than the economic burden of myocardial infarction and Gastrointestinal bleeding and similar to the cost of stroke, pneumonia, and pancreatitis.5

Greater insight into postoperative AKI may also result in an ability to reduce other postoperative complications such as myocardial infarction, sepsis, and wound complications. Earlier identification of AKI may offer a window into the health of the other interconnected organ systems, and thereby enable significant benefit to improve other outcomes. Therefore, the potential benefit from the conceived scoring system with regard to improving AKI rates would be significant but may offer substantial further contribution.

**Potential Solution:**

Given that blood pressure and resulting renal perfusion are vital to kidney function, a more complex computational approach should be pursued. In particular we could calculate the time weighted average of the mean arterial pressure (TWA-MAP) and/or the generalized average real variability of the mean arterial pressure (ARV-MAP) as previously done but newly relate the output to the risk of renal injury.7 Additionally, the slope of systolic and diastolic blood pressure curves has been shown to correlate to physiologic vascular stiffness.8 A real time prospective risk model could be generated that could give a daily assessment of a patient’s progression or risk score toward or away from kidney injury that could guide intervention.

**Preliminary Data/Relevant Experience**:

We have recently received our data from the CCDA extraction team within the safe desktop environment at Johns Hopkins and have begun exploratory data analysis.

My relevant training to mentor the team has many components. First, I engage the BME program already serving as the faculty lead for the cardiac contractility frog lab as part of the core curriculum and am currently submitting an application to be considered for joint appointment in the Whiting School of Biomedical engineering.

In addition to my clinical training and practice as both a cardiac anesthesiologist, and critical care anesthesiologist I engage this patient population every working day. Furthermore, I am the program director of the Critical care fellowship and mentor 9 fellows yearly.

My research background began during my high school years and has continued through today conducting basic science research at the start and ultimately pursing additional training at the Bloomberg school of public health with a focus on biostatistics. I am comfortable with Stata for database management, manipulation, and statistical analysis. I have had the fortune to publish manuscripts throughout my career with a diverse collection of collaborators.

I would be able to commit to the requested weekly time commitment with the student group with advanced planning on the time of the meeting and would look forward to mentoring and collaborating with the group.

**Data Set Identification**:

Approximately 6500 patients  
  
Patient ID (will be de identified)  
Age  
Procedure description  
DRG   
All imaging procedures performed 3months before surgery and 3 months after  
Primary insurace  
Secondary insurance  
Weight  
Height  
Race  
Preop blood pressure  
Discharge disposition   
Cormorbidities  
Creatinine values within 1 month of surgery to 3 months beyond discharge  
Medications on admission  
Medications on discharge  
Problem List  
Surgery Start  
Surgery End

For the entire patient encounter (Over 900K values for the 6500 patients) we have:

Systolic BP  
Diastolic Blood Pressure  
Urine output

**Other Supporting Information**: Attached to the email

**References:**

1. Wilson T, Quan S, Cheema K, et al. Risk prediction models for acute kidney injury following major noncardiac surgery: systematic review. *Nephrology Dialysis Transplantation.* 2016;31(2):231-240.

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3. Bihorac A, Yavas S, Subbiah S, et al. Long-term risk of mortality and acute kidney injury during hospitalization after major surgery. *Ann Surg.* 2009;249(5):851-858.

4. Schwarze ML, Barnato AE, Rathouz PJ, et al. Development of a list of high-risk operations for patients 65 years and older. *JAMA Surg.* 2015;150(4):325-331.

5. Silver SA, Long J, Zheng Y, Chertow GM. Cost of Acute Kidney Injury in Hospitalized Patients. *Journal of hospital medicine.* 2017;12(2):70-76.

6. Hobson C, Ozrazgat-Baslanti T, Kuxhausen A, et al. Cost and Mortality Associated With Postoperative Acute Kidney Injury. *Ann Surg.* 2015;261(6):1207-1214.

7. Mascha EJ, Yang D, Weiss S, Sessler DI. Intraoperative Mean Arterial Pressure Variability and 30-day Mortality in Patients Having Noncardiac Surgery. *Anesthesiology.* 2015;123(1):79-91.

8. Obata Y, Barodka V, Berkowitz DE, Gottschalk A, Hogue CW, Steppan J. Relationship Between the Ambulatory Arterial Stiffness Index and the Lower Limit of Cerebral Autoregulation During Cardiac Surgery. *J Am Heart Assoc.* 2018;7(4).