

# DEPARTMENT OF SURGERY

## 2017 RESEARCH DAY & 23<sup>RD</sup> ANNUAL HELEN & JOHN SCHILLING LECTURE

UW TOWER AUDITORIUM  
4333 BROOKLYN AVE NE  
SEATTLE, WA 98105

FRIDAY, MARCH 3, 2017

UW Medicine



# AGENDA

7:00am	Breakfast & Registration	
7:30am	Welcome: <b>Douglas E. Wood, MD, FACS, FRCSEd</b> ( <i>ad hom</i> ) Introduction: <b>David R. Flum, MD, MPH</b>	
7:40am	<b>Andrew D. Ludwig, MD:</b> Radionuclide-Labelled Anti-Glypican-3 Antibody Reduces Hepatocellular Carcinoma Tumor Growth in Vivo	Page 8
7:55am	<b>Francys C. Verdial, MD:</b> Trends in Breast Cancer Incidence in the United States, 2000-2013	Page 9
8:10am	<b>Anne P. Ehlers, MD, MPH:</b> Achalasia Treatment, Outcomes, Utilization, & Costs: A Population-Based Study from the United States	Page 10
8:25am	<b>Lucas W. Thornblade, MD:</b> A Nationwide Rise in the Use of Stents to Manage Benign Esophageal Perforation	Page 11
8:40am	Faculty Presentation: <b>Kimberly J. Riehle, MD</b>	Page 7
8:55am	<b>Proceed to Poster Session 1</b>	
9:00am	<b>Andrew J. Riggle, MD:</b> Error Patterns in Unanticipated Trauma Deaths - Ten Years Later	Page 12
9:05am	<b>Christopher S. Crowe, MD:</b> Meta-Analysis of Phalloplasty Outcomes	Page 13
9:10am	<b>Harry V. Flaster, MD:</b> Comparison of the Society of Thoracic Surgeons, EuroSCORE I and EuroSCORE II in Israeli Patients Undergoing Cardiac Surgery: Progress Towards an International STS Database	Page 14
9:15am	<b>Joshua N. Wong, MD, MSc, FRCSC:</b> Feasibility, Safety, and Acceptability of an Interactive Computer-Based Physical Therapy Program in Burn Patients	Page 15
9:30am	<b>Barclay T. Stewart, MD, MscPH:</b> Exploring the Relationship Between Surgical Care Capacity and Output in Ghana: The Hidden Roles of Non-Material Structures and Processes	Page 16
9:45am	<b>Jay Zhu, MD:</b> Smooth Muscle Cell TGFBR2 Deletion in Mice Results in Aortic Hypercontractility and Impaired Relaxation	Page 17
10:00am	<b>Rebecca G. Maine, MD, MPH:</b> Impact of Prothrombin Complex Concentrate (PCC) on Time to Reversal of Coagulopathy and Use of Fresh Frozen Plasma in Patients with Traumatic Brain Injury	Page 18
10:15am	<b>Robert A. Tessler, MD:</b> State Alcohol Taxes and Firearm Fatality	Page 19
10:30am	<b>Stephen J. Kaplan, MD, MPH:</b> Paraspinous Muscle Sarcopenia Predicts One-Year Mortality in Older Adult Trauma Patients: Development and Validation of Prognostic Thresholds	Page 20
10:45am	<b>Proceed to Poster Session 2</b>	
10:50am	<b>Catherine E. Kling, MD, MPH:</b> Alcohol-Induced Hepatic Cirrhosis is Rising Among Young Adults	Page 21
10:55am	<b>Daniel Y. Cho, MD, PhD:</b> Penile Replantation: A Retrospective Analysis of Outcomes and Complications	Page 22



11:00am	<b>Patrick C. Sanger, PhD on behalf of Cameron E. Gaskill, MD, MPH:</b> Use of Crowdsourcing to Triage Surgical Site Infections	Page 23
11:05am	<b>Kevin M. Sullivan, MD:</b> Robotic Transduodenal Resection of an Ampullary Neuroendocrine Tumor	Page 24
11:20am	Faculty presentation: <b>Grant E. O’Keefe, MD, MPH</b>	Page 7
11:35am	<b>Brinkley K. Sandvall, MD:</b> Severe Injuries from Fireworks: Injury Patterns, Treatment and Fireworks Types	Page 25
11:50am	<b>Brian J. Cook, MD:</b> Clinical Impact and Risk Factors of Portal Vein Thrombosis in the Waitlist for Liver Transplantation	Page 26
12:05pm	<b>Cordelie E. Witt, MD:</b> Transcranial Doppler Emboli Monitoring and Stroke Risk in Blunt Cerebrovascular Injury	Page 27
12:20pm	<b>Proceed to Poster Session 3 (Followed by Lunch)</b>	
12:25pm	<b>Matthew A. Bartek, MD, MPH:</b> Can We Crowdsourc Research Prioritization For Back Pain?	Page 28
12:30pm	<b>Mengyuan T. Liu, MD:</b> Predictors of Shape Maintenance Following Fronto-Orbital Advancement for Single Suture Synostosis	Page 29
12:35pm	<b>Sara K. Daniel, MD:</b> A Standardized Perioperative Care Pathway for Pancreaticoduodenectomy Patients Facilitates Safe Discharge on or Before Postoperative Day Five	Page 30
12:40pm	<b>Shane D. Morrison, MD, MS:</b> Training in Transgender Patient Care – A National Survey of Plastic Surgery and Urology Residents and Residency Directors	Page 31
12:45pm	<b>Thomas H. Shoultz, MD:</b> Provider Understanding and Perceptions of Frailty: Assessing Current Knowledge, Attitudes, and Beliefs in an Urban Trauma Center	Page 32
1:20pm	Faculty presentation: <b>Farhood Farjah, MD, MPH</b>	Page 7
1:35pm	<b>Lauren A. Jacobson on behalf of Brodie Parent, MD, MS:</b> Wound Morbidity in Anterior Component Separation and Transversus Abdominis Release	Page 33
1:50pm	<b>Mackenzie R. Cook, MD:</b> Reversible Respiratory Failure in Trauma: Not as Bad as We Thought	Page 34
2:05pm	<b>Theresa L. Chin, MD, MPH:</b> Burn Specific Health Scale–Brief Trends 10 Years after Burn Injury: A Burn Model System National Database Study	Page 35
2:20pm	<b>Y. David Seo, MD:</b> T-Cell Receptor Immunosequencing Reveals Novel Insights into the Immune Response to Human Pancreatic Cancer	Page 36
2:35pm	Closing: <b>David R. Flum, MD, MPH</b>	
3:15pm	<b>23<sup>rd</sup> Annual Schilling Lecture – Diana L. Farmer, MD:</b> “Seattle, Singapore, Senegal and Stem Cells”	

## INTRODUCTION



Douglas E. Wood, MD,  
FACS, FRCSEd  
*The Henry N. Harkins  
Professor and Chair*

Welcome to the 23<sup>rd</sup> Annual Department of Surgery Research Symposium and Schilling Lecture! This event was made possible by a generous gift from the late Helen Schilling in honor of her husband, Dr. John Schilling. The Schillings were deeply committed to teaching, scholarship and research and it is with enormous pride and gratitude that we are able to carry on their commitment through research-related events such as this.

This year we host Diana L. Farmer, MD, Chair of the Department of Surgery at UC Davis Health System, as our Schilling Lecturer. Dr. Farmer is an internationally renowned fetal and neonatal surgeon with a distinguished research career that has included innovative investigations into the safety and effectiveness of spina bifida treatments before birth. In today's Schilling Lecture, "Seattle, Singapore, Senegal and Stem Cells," Dr. Farmer will discuss the relationship between global surgery and scientific discovery, and update us on the latest approaches to fetal surgery for spina bifida.



David R. Flum, MD, MPH  
*Associate Chair for Research  
Professor of Surgery*

The Schilling Research Symposium is a forum for bringing together faculty, residents, fellows, students, and friends to share the innovative research happening in our Department. It is also an important learning opportunity for residents and fellows to refine their scientific presentation skills through oral and poster presentations, audience Q&A, and feedback from our panel of judges. We view this day as a celebration of the passion for research that exists within our Department. Each and every member of the Department plays a critical role in the success of our research mission and we are grateful for the hard work and dedication of our staff, faculty, and trainees who make events like this possible. This year's symposium format will again feature both podium and poster presentations, as well as assigned discussants for the plenary session. Tonight, we will honor Dr. Farmer and all participants and their faculty mentors, and present prizes to the top poster and oral presenters.

We are pleased that you are joining us today and hope that you find today's event both informative and engaging!

Sincerely,

A handwritten signature in black ink, appearing to read "Douglas E. Wood". The signature is fluid and cursive.

Douglas E. Wood, MD, FACS, FRCSEd (*ad hom*)  
*The Henry N. Harkins Professor and Chair*  
Department of Surgery  
University of Washington

A handwritten signature in black ink, appearing to read "David R. Flum". The signature is fluid and cursive.

David R. Flum, MD, MPH  
*Associate Chair for Research, Surgery*  
*Professor, Surgery, Health Services, and Pharmacy*  
Department of Surgery  
University of Washington



## DIANA L. FARMER, MD



**Diana L. Farmer, MD**  
Chair and Pearl Stamps  
Stewart Professor  
Department of Surgery  
University of California, Davis  
Surgeon-in-Chief  
UC Davis Children's Hospital

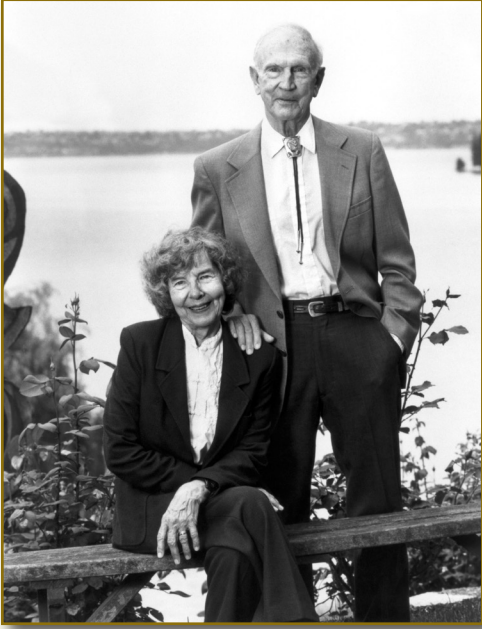
Dr. Diana L. Farmer holds the Pearl Stamps Stewart Endowed Chair, is Professor and Chair of the Department of Surgery at the University of California, Davis Health System, and is the Surgeon-in-Chief of the University of California, Davis Children's Hospital. Dr. Farmer is a native of Chicago, but spent the majority of her career in Seattle, WA and San Francisco, CA. After graduating from Wellesley College, she spent four years studying marine biology in Bermuda, at Stanford and at MIT/Woods Hole. She then got her MD degree from the University of Washington School of Medicine and remained here for two years of her general surgery residency. After a post-doctoral fellowship in surgical oncology at University of California, San Francisco, she stayed there to complete her general surgery training. She obtained her pediatric surgery training at the Children's Hospital of Michigan in Detroit, stayed as faculty for three years, and then returned to UCSF as an Associate Professor of Surgery. She was promoted to Professor of Surgery at UCSF four years later, and to Division Chief of Pediatric Surgery the following year. She subsequently assumed the role of Surgeon-in-Chief of the UCSF Children's Hospital and Vice-Chair of the UCSF Department of Surgery. She was recruited to be the Chair of the Department of Surgery at UC Davis in 2011.

Dr. Farmer has been honored with numerous awards throughout her career, including being a LUCE Scholar, a member of the Royal College of Surgeons of England, and a member of the esteemed National Academy of Sciences Institute of Medicine. She is currently the President of the American Pediatric Surgical Association, the Chair of the American College of Surgeons Board of Governors and Chair of the Society of Surgical Chairs. Dr. Farmer's laboratory made the seminal discovery that hindbrain herniation in spina bifida could be ameliorated by prenatal repair in the fetal sheep model. She is most well known for her role as Principal Investigator on the \$22 million NIH funded Management of Myelomeningocele Study (MOMS Trial), the results of which were published in the *New England Journal of Medicine*. Dr. Farmer has published over 150 manuscripts and 23 book chapters, has delivered 118 invited lectures as well as 57 international and national presentations, and has mentored over 30 MD and PhD students in her lab. Dr. Farmer resides in Sacramento, California with her husband, Dr. Charles Cauldwell, a pediatric anesthesiologist whom she met as a medical student at UW. She is an avid runner, and they are both avid bicyclists. She recently completed her first Half Ironman.



Team work—Dr. Farmer and her NP rounding at Shriners Hospital

## ABOUT HELEN & JOHN SCHILLING



Helen & John Schilling

The Helen and John Schilling Endowed Lectureship was established by the late Helen Schilling to bring distinguished scholars to the Department of Surgery at the University of Washington, and to enhance the Department's commitment to the highest standards of patient care, teaching, research and scholarship. It was Mrs. Schilling's wish that the lectureship be in honor of her husband, John.

Dr. Schilling devoted his life to academic medicine in a career spanning 50 years. He was born and raised just outside Kansas City, Missouri, and at the age of 15 entered Dartmouth College. After graduating from Dartmouth in 1937, he attended Harvard Medical School as a member of the class of 1941, the last class to graduate before World War II. In the six months before the start of his internship and residency at the Roosevelt Hospital in New York City, he signed on as a ship's doctor on the schooner Effie M. Morrissey for a scientific expedition to the Arctic sponsored by the U.S. Bureau of Standards. After a number of perilous adventures along the Greenland coast and in the Hudson Straits, he returned to New York and started his training in general surgery. He joined the surgical staff at the University of Rochester in

1945 where he began his life long work on wound healing. His career at Rochester was interrupted for several months by a stint in the central Pacific (Eniwetok) to participate in the study of flash burns as part of the atom bomb tests and the Manhattan Project. Subsequently he joined the Air Force as a volunteer and set up a surgical department at the new School of Aviation Medicine in San Antonio.

In 1956 Dr. Schilling was invited to be the chief of the first full-time department of surgery in the new medical school at the University of Oklahoma. He was successful in recruiting a number of outstanding junior faculty, many of whom have gone on to become chairmen. In addition to his administrative responsibilities, he maintained an extensive research program in wound healing in collaboration with Dr. Betty White. At the end of 18 years Dr. Schilling and his faculty had trained 75 surgeons from Oklahoma and adjoining states and had established a department known for its academic accomplishments.

Dr. Schilling came to the University of Washington in 1974 as a senior investigator and, upon the sudden resignation of the chairman, was asked to take over the management of the Department of Surgery. Thus began his third chairmanship which lasted eight years until his retirement. His first responsibility was to recruit faculty to fill the many vacancies, a task he achieved after several stormy years. Upon his retirement in 1983, he had recruited 41 new faculty members and graduated a total of 40 chief residents.

His career in academic surgery was marked by a devotion to patient care and teaching, as well as research. But, despite his commitment to the profession, Dr. Schilling still found time to engage in other activities. From his early childhood, he enjoyed the outdoors and had become an expert tennis player, skier, and fly fisherman; he always believed that one's life work should be punctuated by intervals of travel and recreation.

Helen Schilling shared with her husband both the non-academic as well as the academic side of his life. They first worked together in Rochester and continued their association through the years in Oklahoma and Washington. They were married in 1979. She had a career in newspaper work and administration after graduating from Oberlin College. This dual background enabled her to be his close associate and administrative assistant for 40 years.



# JUDGES

## Special Guest Judge



**Diana L. Farmer, MD**  
Chair and Pearl Stamps Stewart Professor  
Department of Surgery  
University of California, Davis  
Surgeon-in-Chief  
UC Davis Children's Hospital

## Department of Surgery Research Leadership



**Douglas E. Wood, MD, FACS, FRCSEd** (*ad hom*)  
*The Henry N. Harkins Professor and Chair*



**David R. Flum, MD, MPH**  
Associate Chair for Research, Professor of Surgery

## Research Leadership Committee



**Saman Arbabi, MD, MPH**  
Professor



**Eileen Bulger, MD**  
Professor



**Joseph Cuschieri, MD**  
Professor



**Farhood Farjah, MD, MPH**  
Assistant Professor



**Nicole Gibran, MD**  
Professor



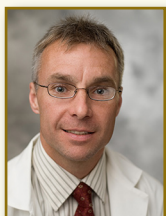
**Danielle Lavallee, PharmD, PhD**  
Research Assistant Professor



**Ronald Maier, MD**  
Professor, Division Chief



**Michael Mulligan, MD**  
Professor



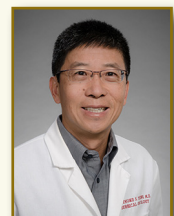
**Grant O'Keefe, MD, MPH**  
Professor



**Kimberly Riehle, MD**  
Assistant Professor



**Robert Sawin, MD**  
Professor, Division Chief



**Raymond Yeung, MD**  
Professor

## FEATURED DEPARTMENT OF SURGERY FACULTY



### **Farhood Farjah, MD, MPH**

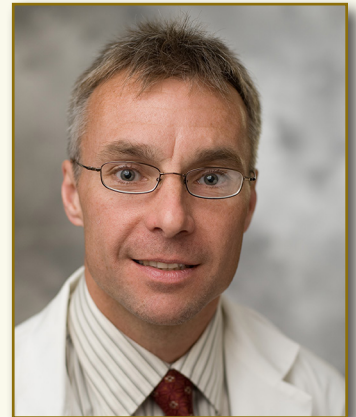
*Assistant Professor, Division of Cardiothoracic Surgery*

Dr. Farjah's research focuses on quality improvement, comparative-effectiveness, and value optimization. He completed a National Cancer Institute (NCI)-funded post-doctoral fellowship in epidemiology and biostatistics through the Surgical Outcome Research Center (SORCE) under the mentorship of Drs. David Flum and Doug Wood. Shortly after joining the faculty at UW, Dr. Farjah pursued mentored early career development as a Cancer Research Network Scholar under the mentorship of Dr. Diana Buist. Although a majority of his work has focused on lung cancer, he has investigated care and outcomes associated with other conditions including incidentally detected pulmonary nodules, esophageal cancer, benign esophageal perforation, and achalasia. Dr. Farjah's work has been supported by the NCI, CHEST Foundation, and the Fred Hutch/UW Cancer Consortium.

### **Grant O'Keefe, MD, MPH**

*Professor, Division of Trauma, Burn & Critical Care Surgery*

Dr. O'Keefe is a Professor of Surgery and Adjunct Professor of Neurological Surgery, Orthopedics and Sports Medicine and is based at Harborview Medical Center. He received his MD in 1988 at the University of Alberta. His MPH was obtained from the University of Washington in 1994. He is a fellow of the American College of Surgeons and board certified in surgery and surgical critical care. Dr. O'Keefe's research spans three general areas and aims to understand the biology of critical illness and apply new knowledge to patient care. First, his research program has aimed to study the role of genetic variation in determining human inflammatory responses to infection. This work has been supported by the National Institutes of Health and the Department of Defense. Second, he has led and collaborated on studies aimed at understanding how the body responds to more severe infection and injury. These studies indicate that a systemic suppression of inflammation is an advantageous response, but one that, if excessive, may lead to compromise of immune functions needed to limit bacterial invasion. Dr. O'Keefe's third area of investigation builds upon a clinical interest in artificial nutritional support. He applies system-wide approaches to understanding the metabolic response to injury and towards the future of personalized nutritional support in critically ill patients.

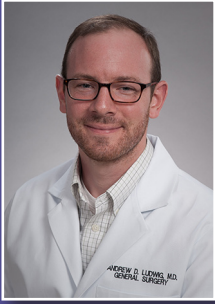


### **Kimberly Riehle, MD**

*Assistant Professor, Division of Pediatric General Surgery*

Dr. Riehle's primary research focuses are the molecular pathways driving liver regeneration after injury or resection and the pathogenesis of liver cancer. These interests developed during her general surgical residency, when she spent two years as a research fellow in the laboratory of Dr. Nelson Fausto, who was Chairman of the Department of Pathology at the time. Since returning to the UW as a faculty member, her work has been supported by the Herbert S. Coe Foundation, the Department of Surgery Research Reinvestment Fund, the American College of Surgeons Louis C. Argenta Faculty Research Fellowship, the American Surgical Association Foundation Fellowship, a Fred Hutchinson Cancer Consortium New Investigator Award, and the UW Royalty Research Fund. Dr. Riehle is Principal Investigator on a project titled "Neurotensin in Fibrolamellar Hepatocellular Carcinoma," which was recently funded by the National Cancer Institute. She is currently collaborating with multiple faculty members in Surgery, Pathology, and Pharmacology to develop new therapies for patients with fibrolamellar liver cancer.





Andrew D. Ludwig, MD

Research Resident

Hometown: Gaithersburg, MD

Medical School: University of Texas Health Science Center, San Antonio

Research Interests: Basic and translational cancer research, liver and colorectal cancer

Faculty Mentor

James O. Park, MD

## RADIONUCLIDE-LABELLED ANTI-GLYPICAN-3 ANTIBODY REDUCES HEPATOCELLULAR CARCINOMA TUMOR GROWTH IN VIVO

Ludwig AD, Seo D, Hamlin DK, Nguyen HM, Yeh MM, Yeung RS, Wilbur DS, Park JO

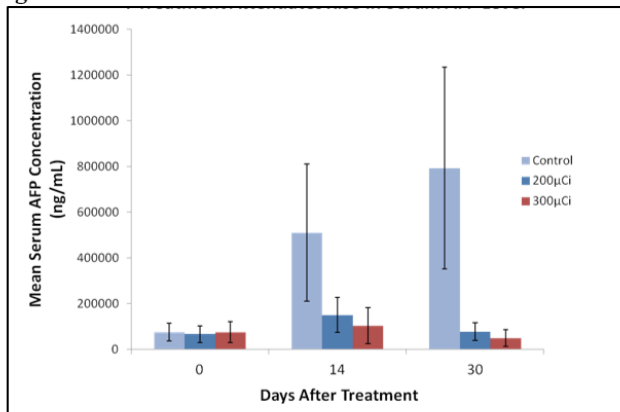
**Background:** Hepatocellular carcinoma (HCC) is an increasingly lethal malignancy with few systemic treatment options. Glypican-3 (GPC3) is a proteoglycan cell surface receptor overexpressed in most HCCs and provides a unique target for molecular therapies. We have previously demonstrated that immuno-PET using  $^{89}\text{Zr}$ -conjugated  $\alpha$ -GPC3 can be used to image small tumors in an orthotopic xenograft mouse model of HCC and that serum AFP levels are highly correlated with tumor size in this model. In the present study, we conjugated  $^{90}\text{Y}$ , a  $\beta$ -particle-emitting radionuclide, to our  $\alpha$ -GPC3 antibody to develop a novel antibody-directed radiotherapeutic approach for HCC.

**Methods:** Luciferase-expressing HepG2 human hepatoblastoma cells were injected into the left lobe of the liver in athymic nude mice (Nu/J). At 6 weeks after implantation, tumor establishment was verified by IVIS imaging and serum AFP levels from tumor-bearing animals were drawn. Yttrium-90 was conjugated to a monoclonal  $\alpha$ -GPC3 antibody using the chelating agent DOTA (1,4,7,10-tetraazacyclododecane-1,4,7,10-tetraacetic acid) and injected via tail vein into the experimental mice at a dose of  $200\mu\text{Ci}/\text{mouse}$  ( $n=9$ ) or  $300\mu\text{Ci}/\text{mouse}$  of  $^{90}\text{Y}$  ( $n=9$ ). Control mice received DOTA-labeled antibody without radionuclide ( $n=7$ ). Serum AFP levels were drawn at 14 and 30 days after treatment. The animals were then sacrificed and the livers were removed en bloc, weighed, and preserved for immunohistochemistry.

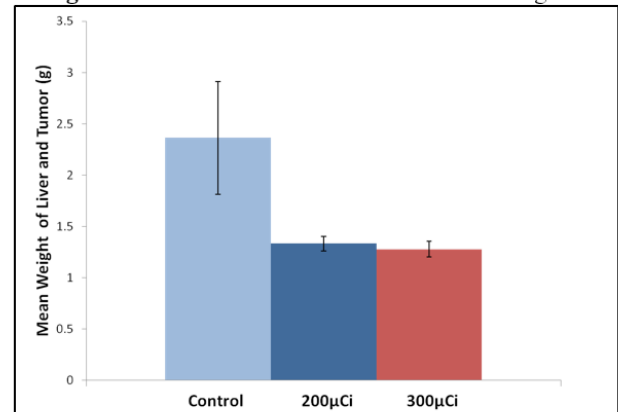
**Results:** Before treatment there was no statistical difference between serum AFP levels or tumor size by IVIS imaging among any of the three groups. While mean serum AFP levels in control animals increased by 663% over the course of the experiment, animals treated with  $200\mu\text{Ci}$   $^{90}\text{Y}$  experienced only a 28% increase in mean AFP levels and animals treated with  $300\mu\text{Ci}$   $^{90}\text{Y}$  had an overall reduction in mean serum AFP levels by 42% ( $p=0.03$  and  $0.02$ , respectively) [Fig. 1]. At 30 days after treatment, mean tumor-bearing liver weight in control animals reached 2.36g compared to 1.33g in animals that received  $200\mu\text{Ci}$   $^{90}\text{Y}$  and 1.28g in animals that received  $300\mu\text{Ci}$   $^{90}\text{Y}$  ( $p=0.05$  and  $0.04$ , respectively) [Fig. 2].

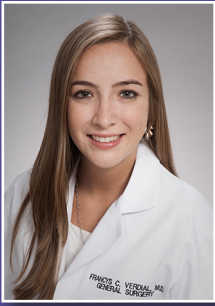
**Conclusions:** The results of this small-scale experiment demonstrate that GPC3, a cell-surface proteoglycan overexpressed in most HCC, can be used as a target for radioimmunotherapy in a mouse model of HCC. The ability to simultaneously image tumors with  $^{89}\text{Zr}$ -conjugated  $\alpha$ -GPC3 and treat with  $^{90}\text{Y}$ -conjugated  $\alpha$ -GPC3 indicates that GPC3 may be useful in clinical theranostics (combined, targeted diagnostic and therapeutic modalities) for HCC patients.

**Figure 1.** Treatment with  $^{90}\text{Y}$  attenuates rise in serum AFP levels



**Figure 2.** Treatment with  $^{90}\text{Y}$  reduces tumor weight





**Francys C. Verdial, MD**  
Research Resident

Hometown: San Pedro Sula, Honduras  
Medical School: Vanderbilt University  
Research Interests: Surgical outcomes

**Faculty Mentor**  
Benjamin O. Anderson, MD

## TRENDS IN BREAST CANCER INCIDENCE IN THE UNITED STATES, 2000–2013

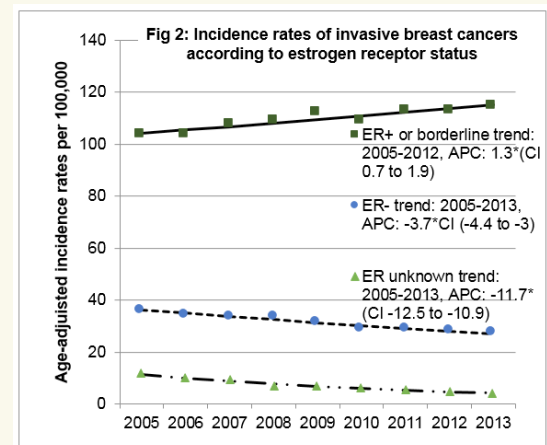
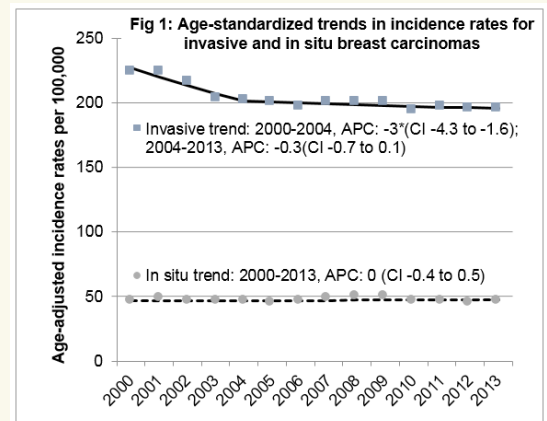
Verdial FC, Flanagan MR, Chen L, Li CI, Anderson BO

**Background:** There was a significant decline in breast cancer incidence between 1999 and 2004 in the United States. This trend has been largely attributed to decreases in combined estrogen and progestin hormone replacement therapy (CHT) following Women’s Health Initiative study results in 2002, which demonstrated an association between CHT and increased breast cancer risk. However, questions remain about the biological plausibility of this explanation given the rapid decrease in breast cancer incidence within months of the WHI publication. If these declines in breast cancer incidence were primarily due to a decrease in CHT use, we would anticipate sustained decreases in breast cancer incidence with steadily decreasing CHT use as well as more significant declines in incidence among subgroups most likely to be affected by CHT use (post-menopausal women with ER+ tumors). We hypothesize that patterns in breast cancer incidence do not support the idea that declines in breast cancer in the early part of the 21st century were principally associated with CHT use.

**Methods:** In order to inform reasons behind incidence rate changes, we queried the National Cancer Institute’s Surveillance Epidemiology and End Results (SEER) Database for all cases of women  $\geq 30$  years of age with a first invasive or in situ breast cancer between 2000 and 2013. Incidence rates according to malignant potential, stage, and estrogen receptor (ER) status were evaluated for all ages, and were also stratified by age at diagnosis. Statistically significant changes in incidence rates over this time period were evaluated using the National Cancer Institute’s Joinpoint Regression Program.

**Results:** Among all women in 18 SEER registries, incidence rates of invasive breast cancer decreased 3.0% (95% confidence interval [CI], -4.3 to -1.6) per year between 2000 and 2004, but were relatively stable between 2004 and 2013 (-0.3% per year; CI, -0.7 - +0.1) (Fig1). This pattern was most pronounced among women over the age of 50 (age 50-64: 2000-2004, -4 [CI-5.8,-2.1]; 2004-2013, -1 [CI -1.5,-0.4]. Age  $\geq 65$ : 2000-2004, -3.4 [CI -5.1,-1.7]; 2004-2012, 0.1[CI -0.5,0.5]). The incidence of ER+ breast cancer significantly increased by 1.3% per year (95% CI +0.7 to +1.9) throughout the study, compared to a decrease in the incidence of ER- breast cancer decreased among all women (-3.7% per year; CI -4.4 to -3) (Fig2). Larger increases in ER+ tumors were seen among women aged 30-49 years (+1.8% per year; CI, +1.3 to +2.2) compared to women aged 50-64 years (+0.9% per year; CI, +0.5 to +1.3).

**Conclusions:** Our data demonstrates that changes in breast cancer incidence rates cannot be solely explained by decrease in CHT use. In light of ongoing declines in CHT use over the past decade without concurrent declines in breast cancer incidence among postmenopausal women and increase in ER+ breast cancers, our study supports a more complicated interplay of risk factors contributing to overall breast cancer incidence trends.



APC: Annual Percent Change, ER: Estrogen Receptor, CI: 95% confidence interval, \*p<0.05\*





**Anne P. Ehlers, MD, MPH**

*General Surgery, R4*

Hometown: Seattle, WA

Medical School: University of Washington

Research Interests: Comparative effectiveness research, surgical outcomes

**Faculty Mentor**

Farhood Farjah, MD, MPH

## **ACHALASIA TREATMENT, OUTCOMES, UTILIZATION, & COSTS: A POPULATION-BASED STUDY FROM THE UNITED STATES**

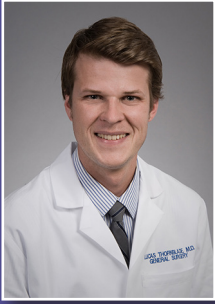
Ehlers AP, Oelschlager BK, Pellegrini CA, Wright AS, Saunders MD, Flum DR, He H, Farjah F

**Background:** Randomized trials show that pneumatic dilatation  $\geq 30$ mm (PD) and laparoscopic myotomy (LM) provide equivalent symptom relief and disease-related quality of life for patients with achalasia. However, there remain questions about the safety, burden, and costs of treatment options.

**Methods:** We performed a retrospective cohort study of achalasia patients initially treated with PD or LM (2009–2014) using the MarketScan® Commercial Claims Database. All patients had one year of follow-up after initial treatment. We compared safety, healthcare utilization, and total and out-of-pocket costs using generalized linear models.

**Results:** Among 1,061 patients, 82% were treated with LM. LM patients were younger (median age 49 vs. 52 years,  $p < 0.01$ ) but were similar in terms of sex ( $p = 0.80$ ) and prevalence of comorbid conditions ( $p = 0.11$ ). There were no significant differences in the one-year cumulative risk of esophageal perforation (LM 0.8% vs. PD 1.6%,  $p = 0.32$ ) or 30-day mortality (LM 0.3% vs. PD 0.5%,  $p = 0.71$ ). LM was associated with an 82% lower rate of re-intervention ( $p < 0.01$ ), 29% lower rate of subsequent diagnostic testing ( $p < 0.01$ ), and 53% lower rate of re-admission ( $p < 0.01$ ). Total and out-of-pocket costs were not significantly different ( $p > 0.05$ ).

**Conclusions:** In the United States, LM appears to be the preferred treatment for achalasia. Both LM and PD appear to be safe interventions. Along a short time-horizon, the costs of LM and PD were no different. Mirroring findings from randomized trials, LM is associated with fewer re-interventions, less diagnostic testing, and fewer hospitalizations.



## Lucas W. Thornblade, MD

Research Resident

Hometown: Castleton, VT

Medical School: Boston University

Research Interests: Value in surgical care, comparative effectiveness in surgical outcomes

## Faculty Mentor

Farhood Farjah, MD, MPH

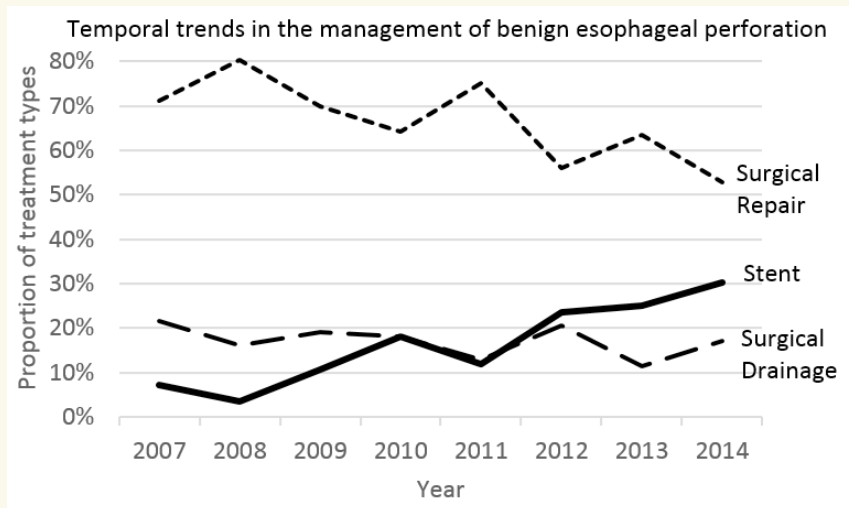
### A NATIONWIDE RISE IN THE USE OF STENTS TO MANAGE BENIGN ESOPHAGEAL PERFORATION

Thornblade LW, Cheng AM, Wood DE, Mulligan MS, Saunders MD, He H, Oelschlager BK, Flum DR, Farjah F

**Background:** Surgical repair or drainage is the standard treatment for benign esophageal perforation. We hypothesize that increasing enthusiasm and experience with esophageal stents—approved by the Food and Drug Administration for management of malignant strictures and/or fistulas—has led to greater use of stents for the management of benign esophageal perforation.

**Methods:** We conducted a retrospective cohort study (2007–2014) of patients with benign esophageal perforation using MarketScan—a national database of healthcare claims for individuals (and their dependents) with employer-provided commercial insurance. Inclusion criteria were an International Classification of Diseases diagnostic code for perforation *and* a Common Procedure Code for either repair, a drainage procedure (mediastinum and/or pleural spaces), or esophageal stent. All subjects had six months of continuous enrollment (i.e. follow-up) unless disenrollment was due to death. Regression models were used to evaluate unadjusted and adjusted trends in treatment, outcomes, utilization, and costs over time.

**Results:** A total of 659 patients (mean age 49 years, 41% women) were treated for benign esophageal perforation (surgical repair: n=449, 69%; surgical drainage: n=110, 17%; stent: n=100, 15%). Stent use increased from 7% in 2007 to 30% in 2014 (Figure). Over the same period, the frequency of surgical repair decreased from 71% to 53%, whereas the frequency of surgical drainage did not change over time. Stent use increased by 28% per year (incidence rate ratio=1.28, 95% confidence interval 1.17–1.39,  $p<0.001$ ) after adjustment for changes over time in age, sex, comorbidity index, health insurance type, and the frequency of recent esophageal instrumentation in the two weeks prior to diagnosis. There were no significant changes in risk-adjusted deaths, discharges home, length-of-stay, readmissions, or costs over the same period for the overall cohort (all  $p>0.05$ ).



**Conclusions:** The use of stents for the management of benign esophageal perforation has increased by over four fold in just eight years. A multi-site clinical registry of off-label use of esophageal stents would likely clarify the potential advantages and disadvantages of stenting in the management of benign esophageal perforation.





**Andrew J. Riggle, MD**

*Surgical Critical Care Fellow*

Hometown: Medford, WI

Medical School: University of Minnesota

Research Interests: Quality improvement and outcomes

**Faculty Mentor**

Lisa K. McIntyre, MD

## ERROR PATTERNS IN UNANTICIPATED TRAUMA DEATHS – TEN YEARS LATER

Riggle AJ, Cuschieri J, Robinson BR, Maine R, Bulger ME, Mandell SP, Maier RV, McIntyre LK

**Background:** Recognition of error patterns associated with unanticipated deaths is a cornerstone of trauma quality improvement. Institutional protocols are developed and tracked as a corrective measure. The purpose of this study was to review current error patterns in comparison to those identified 10 years earlier and to quantify outcome differences during this period of quality improvement work.

**Methods:** All trauma deaths at a high-volume, Level I trauma center hospitalized from 2005 to 2014 were reviewed. Identification of those patients who were considered to have opportunities for improvement was performed by two separated and independent evaluations. The first was weekly surgical morbidity and mortality (M&M) conference reviews of all trauma deaths and those with evidence of error were included. Second, as part of continued quality improvement all deaths with a greater than 50% probability of survival based on injury scores are screened annually by the Trauma Quality Process Improvement Program for any possible areas of improvement. Identified errors were assigned to clinical categories (hemorrhage, airway, management of unstable patient, procedures, prophylaxis, missed diagnosis, and other) and then grouped by historical taxonomy which included error domain (location), type, and cause.

**Results:** Trauma deaths occurred in 2,659 patients (4.4%). 77 (2.8%) patients were identified as an unanticipated death with opportunity for improvement by either M&M or TQIP process. The most common errors were associated with the management of unstable patients (n=19). Error type most frequently identified was related to the treatment phase of care (n=44). The clinical grouping distribution of the 2004 and 2014 data sets were compared and found to be statistically different with a  $p=0.007$ . The most common error in the 2004 group was failure to achieve hemorrhage control (n=18) whereas for the 2014 group was management of the unstable patient (n=19). The error domain was different between time periods with the ICU being the most common location for error occurrence in the 2004 group and the ward in 2014 (24 vs. 19,  $p=0.03$ ). Over ten years, the number of patients with uncontrolled hemorrhage decreased from 18 to 6, and complications related to over-resuscitation with fluids from 3 to 0. These changes coincide with the implementation of quality improvement protocols to guide resuscitation.

**Conclusions:** Unanticipated trauma deaths remain a small but consequential group of trauma admissions at Level I trauma centers. Over the past decade, errors in one mature trauma center have shifted from the management of hemorrhage to decisions made during the care of the unstable patient. The location of errors has transitioned from the ICU to the ward. Future work will need to focus on complex decision making in environments with ever dwindling clinical support. Finally, collaboration between trauma centers for the recognition and avoidance of preventable deaths is essential.



## Christopher S. Crowe, MD

Plastic Surgery, R1

Hometown: Danville, CA

Medical School: Stanford University

Research Interests: Microsurgery, hand surgery, lower extremity reconstruction

## Faculty Mentor

Jeffrey B. Friedrich, MD

### META-ANALYSIS OF PHALLOPLASTY OUTCOMES

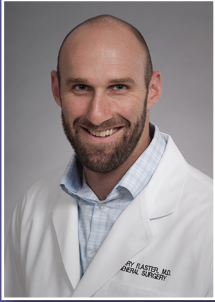
Crowe CS, Morrison SD, Remington AC, Friedrich JB

**Background:** Phalloplasty is associated with improved quality of life in those with acquired or congenital absence of the penis, or female-to-male (FtM) transgender patients seeking gender-confirming surgery. However, urethral and flap complications remain a significant drawback of these procedures. This study compares data from available literature on phalloplasty outcomes.

**Methods:** A comprehensive literature search of PubMed, MEDLINE, and Google Scholar database was conducted through July 2015 for studies relating to phalloplasty. Data on techniques, complications, outcomes, and patient demographics were collected and aggregated. Meta-analysis using the random-effects model with subgroup analyses was performed by procedure type and indication.

**Results:** Ninety-nine studies (2,350 patients) were included in the analysis. The radial forearm free flap (RFFF) was the most commonly utilized procedure (54 studies, 1,544 patients). The overall urethral complication rate was 30.3% (95% CI: 0.246-0.367,  $p<0.001$ ). RFFF had the highest rate of urethral complications at 34.4% (95% CI: 0.273-0.423,  $p<0.001$ ) with FtM patients receiving the RFFF having a urethral complication rate of 41.5% (95% CI: 0.323-0.514,  $p=0.093$ ). The flap complication rate was 9.1% (95% CI: 0.068-0.119,  $p<0.001$ ). Voiding while standing was accomplished in 80.3% of patients (95% CI: 0.678-0.887,  $p<0.001$ ). Sexual function was achieved at a rate of 67.9% (95% CI: 0.520-0.805,  $p=0.028$ ). Overall patient satisfaction was measured to be 87.8% (95% CI: 0.798-0.929,  $p<0.001$ ). FtM patients had worse overall outcomes compared to non-FtM patients.

**Conclusions:** Urethral complications are the most common adverse outcomes associated with phalloplasty and occur more often in FtM patients. Micturition, sexual function, and satisfaction were achieved in the majority of patients.



**Harry V. Flaster, MD**

Research Resident

Hometown: Phoenix, AZ

Medical School: Stanford University

Research Interests: Trauma surgery, thoracic surgery, surgical outcomes

**Faculty Mentor**

Shapira Oz, MD

Hadassah–Hebrew University Medical Center, Israel

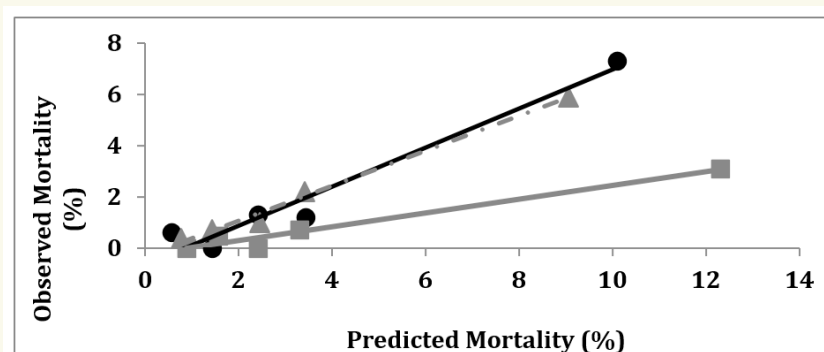
## COMPARISON OF THE SOCIETY OF THORACIC SURGEONS, EUROSCORE I AND EUROSCORE II IN ISRAELI PATIENTS UNDERGOING CARDIAC SURGERY: PROGRESS TOWARDS AN INTERNATIONAL STS DATABASE

Flaster H, Blumenfeld O, Shapira O

**Background:** The need for reliable databases and risk models in cardiac surgery to monitor performance, predict and improve outcomes is well established. The purpose of this study was to compare two well validated cardiac surgery risk scores in an Israeli center for cardiac surgery, in order to determine the best risk model to apply to all cardiac surgery centers in Israel.

**Methods:** The Society of Thoracic Surgery (STS) risk score, the EuroSCORE I and the EuroSCORE II were compared on their ability to accurately predict 30 day mortality. The study cohort consisted of 1,279 consecutive patients over a seven-year time period. Data were prospectively entered into our departmental STS-linked database, deidentified, and then used to calculate STS, EuroSCORE I and the EuroSCORE II, 30-day mortality and the observed vs. expected 30-day mortality was compared for each score.

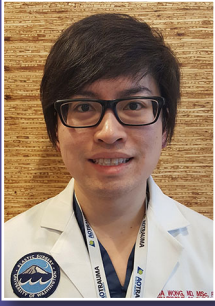
**Results:** The observed 30-day in hospital operative mortality in our cohort was 1.95%. The average STS, EuroSCORE I and EuroSCORE II predictive scores for 30 day in-hospital mortality were 3.12%, 3.31% and 7.97% with O/E ratios of 0.62, 0.59 and 0.24, respectively. Model calibration was similar between the STSM and EuroSCORE II, and both were significantly more accurate than EuroSCORE I which tended to overestimate mortality.



**Figure 1:** Round black dots are the STS score, triangles are the EuroScore II, and the Logistic Euroscore are the gray squares.

**Conclusions:** This study demonstrated that both the STS and EuroSCORE II risk prediction models performed equally well, while the EuroSCORE I overestimated mortality. The STS database is now being introduced in all cardiac surgery centers in Israel. This is the first time the STS data has been implemented nationwide outside of the United States.





**Joshua N. Wong, MD, MSc**  
*Surgical Critical Care Burn Fellow*

**Faculty Mentor**  
 Tam N. Pham, MD

Hometown: Edmonton, AB  
 Medical School: University of Alberta  
 Research Interests: Efficiency and delivery of regionalized burn care

## FEASIBILITY, SAFETY, AND ACCEPTABILITY OF AN INTERACTIVE COMPUTER-BASED PHYSICAL THERAPY PROGRAM IN BURN PATIENTS

Wong JN, Pham TN, Gibran NS, Fudem GM, Carrougher GJ, Baker C, Bunnell AE

**Background:** A critical component of burn injury recovery is rehabilitation therapies. However, the delivery of skilled therapy can be limited by local expertise, cost, staffing and patient motivation. Advanced therapy software employing motion-capture technology can augment rehabilitation by delivering therapy in addition to the conventional regimen, standardizing interventions, and improving patient motivation by collecting metrics on therapy amount and outcomes. Jintronix is a Kinect® Xbox software that combines therapy and interactive gaming to improve engagement, distract from discomfort, and record patient performance. Our objective was to determine the feasibility, safety and acceptability of a Jintronix therapy program among hospitalized adult burn patients.

**Methods:** A prospective feasibility study was conducted on adult burn subjects admitted to a single burn center from August through October 2016. The study protocol involved 1 session with 14 Jintronix modules targeting the burned areas, an acceptability survey and safety analysis. Qualitative analysis was used to detect recurrent themes in patient subjective responses.

**Results:** A total of 20 of 23 subjects approached completed the study (See table). Mean module completion time was 41.4±9.6 minutes. Eleven (55%) subjects completed all the modules; reasons for incompleteness were baseline shoulder abduction pain and poor balance. Nearly all subjects responded that the activity was comfortable (18), safe (20), and would improve strength and range of motion (20). A mean pain VAS score of 3.8±2.8 (0-10 VAS) was reported, and was localized to the burned area. There were 4(20%) near falls in subjects requiring therapy assistance. Qualitative analysis highlighted that the activity distracted the subject from pain during therapy and the scores were self-motivating. Negative themes included “inaccurate depth” perception and “too lengthy” for a specific module. Five subjects spontaneously requested a repeat trial and 3 requested provision of software upon discharge for their own Kinect device.

**Conclusions:** This prospective study indicates that Jintronix-based therapy was feasible for hospitalized burn patients. The intervention is generally safe as subjects avoided major complications and only had a mild to moderate level of pain in affected burn areas. Subjects valued the experience as a tool to assist in their recovery, indicating a high level of acceptability. Participants also made valuable suggestions for software modifications to improve safety and compliance. This feasibility study provides the rationale for efficacy studies where interactive consoles can augment rehabilitation during inpatient and post-discharge recovery. Technology-assisted rehabilitation holds the promise to raise the recovery trajectory in burn injured patients.

**Table. Patient Characteristics (N=20)**

Sex M (%)	16 (80)
Age in years (range/median)	21-76 (44)
Burn Size (%) (range/median)	2-50 (15)
Days in Hospital (range/median)	2-78 (12)
Video Game Experience N(%)	12 (60)
ICU admission N(%)	13 (65)
Previously intubated N(%)	9(45)

**Figure. Jintronix Therapy**





**Barclay T. Stewart, MD, MscPH**

*General Surgery, R4*

**Faculty Mentor**

Charles Mock, MD, PhD, MPH

Hometown: Beaufort, SC

Medical School: Medical University of South Carolina

Research Interests: Health systems strengthening in low- and middle-income countries

## EXPLORING THE RELATIONSHIP BETWEEN SURGICAL CARE CAPACITY AND OUTPUT IN GHANA: THE HIDDEN ROLES OF NON-MATERIAL STRUCTURES AND PROCESSES

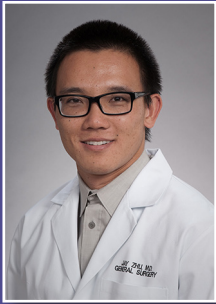
Stewart BT, Gyedu A, Gaskill C, Boakye G, Quansah R, Donkor P, Volmink J, Mock C

**Background:** Surgical capacity assessment results have served as proxies for surgical output in low- and middle-income countries (LMICs). We sought to explore the relationship between surgical care capacity and output (i.e., number of operations performed per year and operation rate per 100,000 population) in Ghana to improve our understanding of how to better assess capacity and, ultimately, strengthen health systems to meet surgical needs.

**Methods:** Surgical care capacity assessments were performed at 37 hospitals nationwide (25 first-level, 9 regional, and 3 tertiary hospitals) using World Health Organization guidelines; availability of 21 essential resources was used to create a composite capacity score that ranged from 0 (no availability of essential resources) to 63 (constant availability of essential resources) at each hospital. Data on surgical specialty availability (e.g., availability of specialty trained surgeons), number of hospital beds, number of functional operating theaters, and operations performed over one year at each hospital were collected. Ghana Statistical Service and Ministry of Health provided hospital catchment populations. The relationship between capacity, surgical specialty coverage, and output was explored with zero-truncated generalized negative binomial regression modeling.

**Results:** The median surgical capacity score was 31 [interquartile range (IQR) 27 - 40; range 13 - 60]. All hospitals had medical officers who were able to perform some degree of surgical care; 5 hospitals had one surgical specialty available (14%); 11 had two specialties available (30%); and 8 had more than two specialties available (22%). The median number of operations per year was 1,580 (IQR 736 - 2,167) at first level hospitals; 1,767 operations (IQR 1,018 - 2,643) at referral hospitals; and 12,509 operations (IQR 3,773 - 22,260) at tertiary hospitals. Further, median number of operations per 100,000 catchment population per year (i.e., operation rate) was 1,028 (IQR 725 - 1,746) at first level hospitals; 105 operations per 100,000 population (IQR 79 - 157) at referral hospitals; and 445 operations per 100,000 population (IQR 150 - 595) at tertiary hospitals. There was no correlation between capacity and number of operations performed per year ( $p=0.32$ ) or rate of operations per 100,000 population per year ( $p=0.29$ ), even when adjusted for specialty availability, number of hospital beds, and number of functional operating theaters.

**Conclusions:** Contrary to current understanding, existing surgical capacity assessments may not accurately predict surgical output or the ability for hospitals to meet the surgical demands of the populations they serve. Other structure (e.g., policies, protocols, incentive schemes) and process elements (e.g., service delivery) should be measured to improve the validity of capacity assessments and to ensure that hospitals are maximizing available resources to provide surgical care. Other factors that influence output should also be considered, including both demand-side (e.g., population awareness of surgical need and access to care, ease of healthcare navigation) and supply-side factors (e.g., intrinsic and extrinsic motivation of staff, enabling work environment, strong emotional infrastructure).



**Jay Zhu, MD**  
Research Resident

**Faculty Mentor**  
David Dichek, MD  
UW Department of Medicine

Hometown: San Diego, CA  
Medical School: University of Southern California  
Research Interests: Vascular biology

## SMOOTH MUSCLE CELL TGFBR2 DELETION IN MICE RESULTS IN AORTIC HYPERCONTRACTILITY AND IMPAIRED RELAXATION

Zhu J, Alp FI, Wei H, Angelov SN, Dichek DA

**Background:** Abnormality in smooth muscle cell (SMC) TGF  $\beta$  signaling has been proposed as a critical driver in the development of aortic aneurysms and dissections associated with heritable conditions such as Marfan Syndrome and Loeys Dietz Syndrome. In an established mouse model used to study the underlying mechanisms of these conditions, postnatal disruption in SMC TGF  $\beta$  signaling leads to severe aortopathy including ulceration, dilation, and medial thickening. However, the exact mechanisms by which SMC TGF  $\beta$  signaling perturbations lead to aortopathy remain poorly understood. We hypothesized that loss of SMC TGF  $\beta$  signaling causes deficits in aortic medial SMC contractility and changes in contractile protein composition that ultimately result in aortic degeneration.

**Methods:** We used mice with “floxed” *Tgfb2* alleles (encoding a receptor critical for TGF  $\beta$  signaling) and compared littermates with and without tamoxifen inducible smooth muscle cell specific Cre alleles (SMC CreER). All mice were treated with tamoxifen at 6 weeks of age, and aortas were harvested at 14 weeks following treatment. Using tension myography we characterized the contractile and relaxation responses of murine ascending aortas to phenylephrine, sodium nitroprusside, and acetylcholine. We also extracted medial protein and compared the amount of contractile proteins using SDS PAGE.

**Results:** Isolated aortic rings from mice with deficient SMC TGF  $\beta$  signaling showed increased contraction to phenylephrine (E<sub>max</sub>: 13.5 mN vs 7.8 mN in controls;  $p < 0.0001$ ;  $n = 19/20$ ) and potassium chloride (E<sub>max</sub>: 7.5 mN vs 5.7 in controls;  $p < 0.0001$ ;  $n = 19/20$ ). Moreover, levels of smooth muscle myosin heavy chain protein were at least as high in aortas with deficient SMC TGF  $\beta$  signaling as in control aortas, consistent with their capacity to generate increased contractile force. Surprisingly, aortic segments from mice with deficient SMC TGF  $\beta$  signaling also had impaired endothelium dependent relaxation to acetylcholine (E<sub>max</sub>: 37% vs 97% in controls;  $p < 0.0001$ ;  $n = 19/20$ ). Endothelium independent relaxation to sodium nitroprusside was similar between the two groups. CD31 immunostaining of vessel segments revealed equivalent endothelial integrity in both groups.

**Conclusions:** Physiologic SMC TGF  $\beta$  signaling is an important determinant of both SMC contractility and endothelial function. Disruption of physiologic SMC TGF  $\beta$  signaling may lead to TAAD through direct effects on SMC as well as through indirect effects on endothelial function. Our results also suggest an unanticipated role for SMC TGF  $\beta$  signaling in regulating endothelial mediated vasomotor function.





Rebecca G. Maine, MD, MPH

Surgical Critical Care Fellow

Faculty Mentor

Saman Arbabi, MD, MPH

Hometown: Pittsburgh, PA

Medical School: University of California, San Francisco

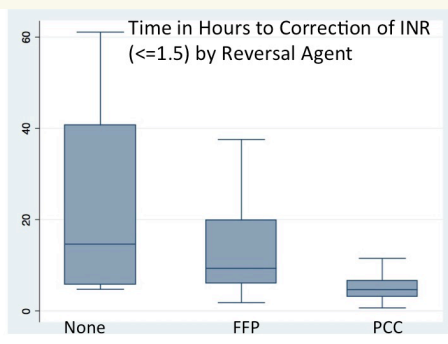
Research Interests: Trauma and global surgery

## IMPACT OF PROTHROMBIN COMPLEX CONCENTRATE (PCC) ON TIME TO REVERSAL OF COAGULOPATHY AND USE OF FRESH FROZEN PLASMA IN PATIENTS WITH TRAUMATIC BRAIN INJURY

Maine RG, Cuschieri J, Robinson B, Shoultz T, Riggle A, Cook M, Arbabi S

**Background:** Warfarin use is noted in as many as 20% of trauma patients and has been associated with worse neurologic outcomes. Rapid reversal of coagulopathy in patients with traumatic brain injury (TBI) has been associated with improved survival. In 2011, Washington State implemented a protocol to use Prothrombin Complex Concentrate (PCC) with or without Fresh Frozen Plasma (FFP) rather than FFP alone to more rapidly reverse pre-hospital warfarin anticoagulation in TBI. We hypothesize that patients who received PCC compared to those who do not correct their coagulopathy more rapidly, receive less FFP, have improved functional outcomes, and lower mortality.

**Methods:** We reviewed all patients admitted to Harborview Medical Center, between January 2011 and May 2016 with TBI (Head abbreviated injury score  $>2$ ) and an elevated INR ( $\geq 1.5$ ). Patients not on warfarin prior to admission were excluded. We compared the primary outcomes of time to INR correction and FFP use. Secondary outcomes included mortality, functional scores at discharge and thrombotic complications. Data was compiled from the trauma registry, the electronic medical record's laboratory information, and blood bank and pharmacy records.



**Results:** We identified 301 patients, of whom 151 were reversed with FFP only, 98 received PCC with or without FFP, and 51 received no reversal agent. PCC use increased over time, from 3.2% of patients in 2011 to 55.4% in 2014. Patients who received PCC were more severely injured with a median injury severity score (ISS) of 26 (IQR: 17-26) for the PCC group, 17 (14-26) for the FFP group and 14 (9-21) for the group that was not reversed ( $p < 0.001$ ). Patients that received PCC had a higher initial INR 2.5 (2-3.3) compared to 2 (1.7-2.5) for the FFP group and 2.1 (1.7-2.5) for the unreversed group ( $p < 0.001$ ). Despite this difference, patients who received PCC more rapidly normalized ( $\leq 1.5$ ) their INRs ( $p < 0.001$ ) (see figure). Patients who received PCC received an

average of 1.95 units of FFP compared to 2.66 units in patients reversed with FFP only ( $p < 0.001$ ). There was no difference in mortality, functional outcomes between reversal agents when corrected for age, injury severity, hypotension, and initial neurologic function. Furthermore no difference in thrombotic complications was seen but only 12 complications occurred in the cohort.

**Conclusions:** Since implementation of the head injury coagulopathy policy, PCC use has increased, primarily in the most severely injured and coagulopathic TBI patients. PCC administration corrected INR more rapidly and was associated with transfusion of less FFP, but was not associated with improved mortality. Despite being given to more critically ill patients, there was no increase in thrombotic complications in the patients who received PCC. Further evaluation of this protocol with a larger population or a randomized clinical trial is needed to assess the benefit and harm of PCC in this population.



**Robert A. Tessler, MD**

*Research Fellow*

**Faculty Mentor**

Frederick P. Rivara, MD, MPH

*UW Department of Pediatrics*

Hometown: New York, NY

Medical School: University of California, San Francisco

Research Interests: Violence prevention, pediatric trauma, injury prevention

## STATE ALCOHOL TAXES AND FIREARM FATALITIES

Tessler RA, Quistberg DA, Rowhani-Rahbar A, Vavilala MS, Rivara FP

**Background:** Exposure to firearms is a major public health problem. Between the years 2007 and 2014 over a quarter of a million deaths were attributed to guns in the United States. Taxes on alcohol have been shown to reduce hazardous drinking, a known risk factor for firearm injuries and fatalities. Our objective was to determine the association between state level alcohol taxes and firearm homicide and firearm suicide rates.

**Methods:** This is an ecological cross-sectional study of US states and Washington D.C. for the years 2007– 2014. State-year-age groups were the units of analysis. Five age groups were used for analysis: 15–24 years, 25–34 years, 35–54 years, 55–74 years, and 75 years and older. The exposure was state and year specific beer, wine, or spirits excise tax and the main outcomes were the rate per 100,000 person-years of firearm homicide and firearm suicide for each state-year-age group. Statistical analysis was performed using generalized linear mixed modeling with negative binomial distribution and robust standard errors to estimate incidence rate ratios and 95% confidence intervals. Publicly available firearm homicide and suicide counts less than 10 are suppressed by the CDC. Imputed values for suppressed data were used for estimates and upper and lower ranges were generated using zero and nine in place of imputed values.

**Results:** Among 15–24 year-olds and 25–34 year-olds, higher beer excise tax (continuous per \$USD) was associated with lower firearm homicide rates (IRR 0.66, 95%CI 0.53–0.82 and 0.76 95%CI 0.62–0.92, respectively). Among 25–34 year-olds higher wine excise tax was associated with lower firearm homicides (IRR 0.89, 95%CI 0.80–1.00). Among 55–74 year-olds and those over 75 years old, higher beer excise was associated with higher homicide rates (IRR 1.22 95% 1.02–1.47 and 1.78 95%CI 1.06–2.98, respectively). Sensitivity analyses in these older age groups show wide variation in magnitude and direction of this association. There were no associations among any age group with higher alcohol excise taxes and firearm suicides.

**Conclusions:** Higher beer excise tax was associated with lower firearm homicides among 15–24 year-olds and 25–34 year-olds. Higher wine excise tax was associated lower firearm homicides among 25–34 year-olds. Alcohol tax policy may represent a public health strategy to influence firearm-related fatality in populations at high risk for homicide.



**Stephen J. Kaplan, MD, MPH**  
*Virginia Mason General Surgery, R3*

**Faculty Mentor**  
Tam N. Pham, MD

Hometown: Pinetop, AZ  
Medical School: University of Arizona  
Research Interests: Geriatric injury, critical care, social determinants of health

## PARASPINOUS MUSCLE SARCOPENIA PREDICTS ONE-YEAR MORTALITY IN OLDER ADULT TRAUMA PATIENTS: DEVELOPMENT AND VALIDATION OF PROGNOSTIC THRESHOLDS

Kaplan SJ, Penn K, Koren M, Gross JA, So G, Taitsman LA,  
Mitchell SH, Bentov I, Arbabi S, Hough CL, Reed MJ, Pham TN

**Background:** Opportunistic screening for sarcopenia, as a surrogate marker for physical frailty, provides important long-term prognostic information in older trauma patients. Paraspinous muscles are integral parts of “core” muscle groups that contribute to strength and balance. Paraspinous muscle measurements are fast and obtainable by either chest or abdominal CT scan during routine trauma evaluation. We hypothesized that cross-sectional assessment of the paraspinous muscle group provides an alternative to techniques established for abdominal musculature in the detection of sarcopenia. This study aimed to develop and validate optimal prognostic thresholds to predict one-year all-cause mortality using paraspinous muscles at the T12 vertebral level.

**Methods:** In this retrospective cohort study, we examined cross-sectional areas of the paraspinous muscles at the T12 vertebral level and of all abdominal muscles at the L3 vertebral level using abdominal CT imaging in trauma ICU patients age 65 and older at a single level one trauma center between 2011 and 2014. Skeletal muscle index (SMI) was calculated as muscle cross-sectional area divided by height-squared (cm<sup>2</sup>/m<sup>2</sup>). Patients were divided into a development group and a validation group, representing the first two and last two years of the cohort. Sex-specific optimal thresholds of SMI to predict all-cause, one-year mortality were identified using receiver-operator characteristic curves for the first 2 years of the cohort. T12 threshold performance was compared between groups using Cox regression with adjustment for age, comorbidity index, and injury factors. A T12-based model for the entire cohort was compared to an L3-based model using established L3 SMI thresholds.

**Results:** Of the 341 patients meeting inclusion criteria, 213 (62%) were in the development group and 128 (38%) were in the validation group. Age, gender, BMI, L3 & T12 SMIs, comorbidity, mechanism of injury, injury severity, ICU & hospital lengths of stay, discharge disposition, total hospitalization cost, 30-day mortality, and one-year mortality did not differ between the groups. Optimal thresholds for T12 SMI predicting one-year mortality were 8.7 cm<sup>2</sup>/m<sup>2</sup> for women, and 10.1 cm<sup>2</sup>/m<sup>2</sup> for men. Ninety-six (45%) patients in the development group and 41 (32%) in the validation group were below these thresholds. One-year mortality adjusted hazard ratios for low T12 SMI were 5.8 (95%CI 1.2–28.3, development cohort) and 5.5 (1.1–28.7, validation cohort). There was no difference in predictive performance between T12- and L3-based models (T12 relative hazard area under the curve (AUC)=0.72 [0.64–0.81] vs. L3 AUC=0.66 [0.57–0.75], p=0.60).

**Conclusions:** Paraspinous muscle sarcopenia predicts one-year mortality. Its assessment at the T12 level is faster, available from either chest or abdominal CT scan, and performs well compared to established abdominal cross-sectional measurement techniques. Paraspinous muscle sarcopenia should be considered a good surrogate marker for physical frailty in older trauma patients.





Catherine E. Kling, MD, MPH

Transplant Surgery Fellow

Hometown: Melbourne, Australia

Medical School: Vanderbilt University

Research Interests: Kidney transplant, liver transplant, outcomes

Faculty Mentor

Lena Sibulesky, MD

## ALCOHOL-INDUCED HEPATIC CIRRHOSIS IS RISING AMONG YOUNG ADULTS

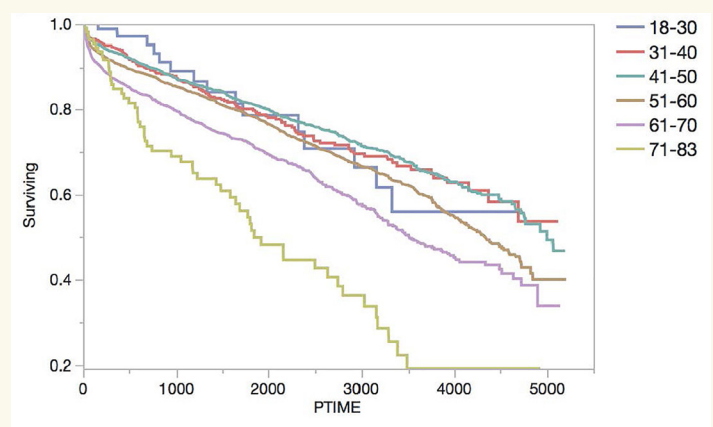
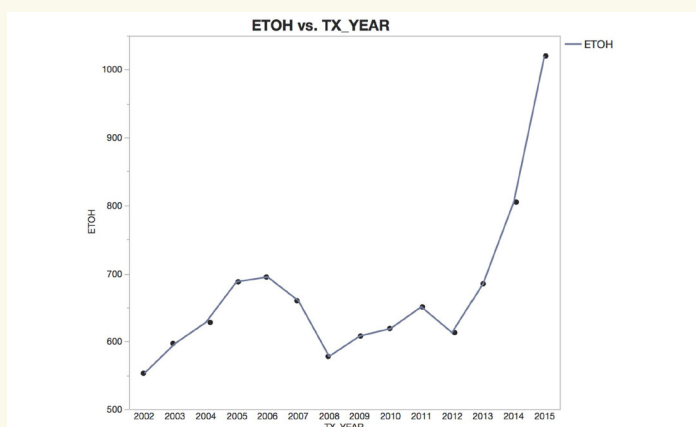
Kling CE, Perkins JD, Donovan DM, Carithers RL, Sibulesky L

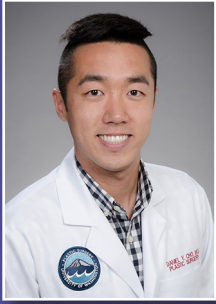
**Background:** Alcoholic cirrhosis is a common indication for liver transplant. Recent population-based studies have shown that although overall prevalence of alcohol use is unchanged, there has been a substantial increase in heavy and binge drinking – important factors for developing alcoholic liver disease. Binge drinking is most widespread in young adults, especially on college campuses with up to 50% prevalence. We sought to examine temporal trends in the indication for liver transplant, with a focus on alcoholic cirrhosis.

**Methods:** Patients undergoing liver transplant between 2002 and 2015 were obtained from the United Network of Organ Sharing Standard Transplant Analysis and Research file and were characterized by etiology of their liver disease. Patients with acute alcoholic hepatitis and alcohol-induced cirrhosis with concomitant HCV infection were excluded. For alcoholic cirrhosis patients, time series analysis was performed and before and after groups were compared using a student's t-test. We compared patient =survival based on the recipients' age using the Kaplan-Meier estimator.

**Results:** Of 74,216 liver transplant recipients (67.0% male) 29.2% underwent transplant for HCV, 22.4% for hepatocellular carcinoma, 12.7% for alcoholic cirrhosis, and 35.7% for other etiologies. The total number of transplants increased 34% between 2002 and 2015. Among alcoholic recipients, the mean BMI was not statistically different over time but the mean MELD increased from 21 in 2002 to 29 in 2015 ( $p < 0.05$ ). There were significantly more liver transplants performed for alcoholic liver disease in 2014 and 2015 than prior years ( $p < 0.01$ ), and this trend was significant for all age groups younger than 60 years old in 2015. Time series analysis showed a significant increase in liver transplants for alcoholic cirrhosis beginning in 2013 ( $p < 0.05$ ), with significantly more transplants done in the 41–50 age group ( $p < 0.05$ ) after 2013, and a trend towards significance in age groups 18–30, 31–40 and 61–70. Patient survival was best for age groups 31–40 and 41–50 years, followed by 18–30, 51–60, 61–70 and 71 years and older.

**Conclusions:** The incidence of liver transplant for alcoholic cirrhosis significantly increased in recent years, particular in younger age groups, possibly due to adolescent onset of alcohol abuse. Screening and preventive measures aimed at early detection and risk reduction should be tailored towards these groups.





**Daniel Y. Cho, MD, PhD**

*Plastic Surgery, R2*

Hometown: Paramus, NJ

Medical School: Brown University

Research Interests: Bone tissue engineering, polymeric drug delivery, biomaterials, craniosynostosis

**Faculty Mentor**

Jeffrey B. Friedrich, MD

## **PENILE REPLANTATION: A RETROSPECTIVE ANALYSIS OF OUTCOMES AND COMPLICATIONS**

Cho DY, Morrison SD, Goldsberry S, Rahnama-Azar AA, Friedrich JB

**Background:** Penile amputation is a surgical emergency with significant immediate and long-term sequelae, including negative physical and psychosocial outcomes related to the loss of the ability to urinate standing, inability to engage in penetrative sexual intercourse, and unsatisfactory cosmetic appearance. Unfortunately, due to the uncommon nature of these injuries, there is a lack of evidence-based guidelines for optimizing outcomes in penile replantation.

**Methods:** A comprehensive literature search of the Medline, PubMed, and Google Scholar databases was conducted with multiple search terms related to penile replantation. Data on outcomes, complications, and patient satisfaction were collected and analyzed.

**Results:** A total of 74 articles met inclusion criteria encompassing one hundred and six patients who underwent penile replantation. Unfortunately, outcome, complication, and satisfaction data were not standardized across all patients and studies. Penile amputation most often resulted from self-mutilation associated with psychosis or trauma. The majority were complete amputations (74.8%). Full sensation was maintained in 68.4% of patients. Most reported adequate urinary function (97.4%) and normal erection (77.5%). Skin necrosis (54.8%) and venous congestion (20.2%) were the most common early complications. Urethral stricture (11.0%) and fistula (6.6%) were common urethral complications. Most (91.6%) patients reported overall satisfaction although there was a lack of patient-reported outcomes. Multivariate analysis suggested that complete amputation ( $\beta=3.15$ , 95% CI 0.41-5.89,  $p=0.024$ ), anastomosis of the superficial dorsal artery ( $\beta=9.88$ , 95% CI 0.74-19.02,  $p=0.034$ ), and increasing number of nerves coapted ( $\beta=1.75$ , 95% CI 0.11-3.38,  $p=0.036$ ) were associated with favorable sexual, urinary, and sensation outcomes. Increasing number of vessels anastomosed ( $\beta=-3.74$ , 95% CI -7.15 - -0.32,  $p=0.032$ ) was associated with unfavorable outcomes.

**Conclusions:** Penile replantation is an emergent surgical procedure performed by urologists and/or plastic surgeons in an attempt to improve outcomes in patients who have undergone this devastating injury. Multiple techniques have been described in the literature ranging from simple repair of the tunica to microsurgical repair of the blood vessels and nerves. Although penile replantation is associated with complications, it has a high rate of satisfaction and efficacy in appropriately selected patients. The results of our study suggest that coaptation of multiple nerves and anastomosis of the superficial dorsal artery should be completed to improve functional results. Further research is necessary to develop a standardized algorithm for surgeons performing penile replantation to optimize functional and cosmetic outcomes.



## Patrick C. Sanger, PhD

Medical Student, 4th year

Presenting on behalf of Cameron E. Gaskill, MD, MPH, Research Resident

## Faculty Mentor

Heather L. Evans, MD, MS

Hometown: Fort Lauderdale, FL

Medical School: University of Washington

Research Interests: Health informatics, quality improvement, patient-centered care

### USE OF CROWDSOURCING TO TRIAGE SURGICAL SITE INFECTIONS

Gaskill CE, Broman KK, Lordon RJ, Sanger PC, Cooper JB,  
Whitney J, Do B, Lober WB, Poulouse BK, Evans HL

**Background:** Surgeon assessments of wound photography can be used to accurately monitor patients for surgical site infections (SSI) after discharge. Currently, remote wound surveillance would require surgeons to review daily images from all post-operative patients, a time-consuming process exhausting surgeons' resources and time. Groups of untrained persons have been used to assess various medical data through crowdsourcing, and may be able to monitor large volumes of surgical wounds for SSI. However, the ability of these non-medically trained populations to assess and triage wound photographs has yet to be evaluated.

**Methods:** Ten case scenarios (6 SSI, 4 non-SSI) presented as 4-6 sequential days of surgical wound photographs and symptoms were presented as a survey through Amazon Mechanical Turk (mTurk), a global crowdsourcing platform. Participants were given the definition of an SSI, but received no other diagnostic training. Participants were asked to assess each scenario day and indicate if an SSI was present, their level of confidence in their assessment, and a triage recommendation for treatment or follow-up. SSI and non-SSI cases were analyzed separately to determine diagnostic accuracy and appropriateness of triage recommendation for each case type.

**Results:** 1171 untrained participants completed the survey within 6 hours. After quality control for survey completion, 993 participants and 3311 cases were included for analysis. 530 (53%) of participants were female, average age was 35.5 years (SD±11.38), and 741 (74.6%) had personal or professional experience with surgical wounds. Overall diagnostic accuracy was 34.6%; 18.1% of SSIs and 59.6% of non-SI were correctly identified. A personal history of SSI was associated with improved accuracy in both SSI (19.8% v 16.2%, p=0.037) and non-SSI cases (62.9% v 55.8%, p=0.008). Higher levels of confidence were associated with higher accuracy in non-SSI cases (OR 1.34 95%CI 1.28-1.43, p<0.001), however was associated with lower accuracy in SSI cases (OR 0.84 95%CI 0.80-0.86, p<0.001). Triage recommendations were correct in 52.8% of cases; 45.7% of non-SSI cases were over-triaged and 57.6% of SSI cases were under-triaged.

**Conclusions:** Crowdsourcing without training had poor performance in the detection of SSI using wound photography. More work is required to establish how to best train and apply crowdsource populations to outpatient surveillance of SSI, as well as establish standards for wound image features of SSI before widespread implementation is possible.





**Kevin M. Sullivan, MD**

*General Surgery, R3*

Hometown: Milwaukee, WI

Medical School: Medical College of Wisconsin

Research Interests: Surgical oncology

**Faculty Mentor**

James O. Park, MD

## ROBOTIC TRANSDUODENAL RESECTION OF AN AMPULLARY NEUROENDOCRINE TUMOR

Sullivan KM, Seo YD, Park JO

**Background:** Neuroendocrine tumors (NET) are uncommon, and the ampulla of Vater is a rare location of NETs. Local resection of ampulla of Vater neoplasms is an accepted treatment modality for benign tumors. Several different approaches to local resection have been employed, ranging from open transduodenal ampullectomy to laparoscopic approaches. Experience using a robotic transduodenal approach to local resection of ampullary tumors has been scarcely reported.

**Methods:** Our patient is a 52-year-old woman who was found to have a non-functioning, 1 cm ampullary NET during ERCP and EUS work-up of post-cholecystectomy epigastric and right upper quadrant abdominal pain. Preoperative laboratory studies were normal except for an elevated serum chromogranin A level. A CT scan was negative for metastatic disease.

**Results:** The patient was brought to the operating room for resection by a laparoscopic robot-assisted transduodenal ampullectomy. A longitudinal duodenotomy was performed, followed by ampullary resection and transverse enterotomy closure. The procedure was uncomplicated, however, her post-operative course required a return to the operating room due to concern for a Richter's hernia at a port site. Her final pathology revealed a WHO grade 2 NET.

**Conclusions:** Laparoscopic robot-assisted transduodenal ampullectomy is a feasible operation with similar side effect profile to other laparoscopic procedures.



**Brinkley K. Sandvall, MD**

*Plastic Surgery, Chief Resident*

Hometown: Arlington, TX

Medical School: Baylor College of Medicine

Research Interests: Hand surgery and general reconstruction

**Faculty Mentor**

Kari A. Keys, MD

## **SEVERE INJURIES FROM FIREWORKS: INJURY PATTERNS, TREATMENT, AND FIREWORKS TYPES**

Sandvall BK, Jacobsen L, Miller EA, Dodge RE, Vavilala MS,  
Quistberg A, Rowhani-Rahabar A, Friedrich JB, Keys KA

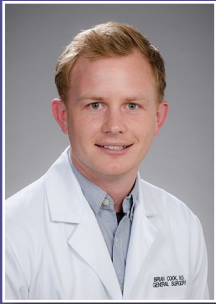
**Background:** Severe injuries from fireworks are of particular interest from the perspective of resulting impairment and increased health care utilization. We sought to examine the effect of fireworks type on severe injury patterns and permanent impairment after fireworks-related injuries.

**Methods:** Adult and pediatric patients who sustained fireworks-related injuries were identified from the hospital's Trauma Registry. Patients were eligible if they sustained an injury due to fireworks requiring either inpatient admission and/or an operation July 2005 to September 2015. A retrospective cohort study was conducted. The two main outcomes were injury patterns (combination of body region and injury type) and permanent impairment.

**Results:** The study included 294 patients. There were 119 patients (40%) admitted who did not undergo surgery, 163 patients (55%) who required both admission and surgery, and 12 patients (5%) who underwent outpatient surgery. There were two deaths. Shells/mortars caused the highest proportion of injuries (39%). There was significant variation in the distribution of injuries per body region by FW type. The number of operations ranged 0 to 15 (mean 1.6), and the mean among fireworks types varied significantly. Shells/mortars were associated with the highest rates of surgery.

Compared to legal fireworks, illegal fireworks had two times greater risk of any face injury (OR 1.96, 95% CI 1.05-3.64) and three times greater risk of an operative hand injury (OR 2.73, 95% CI 0.77-9.67). Compared to legal fireworks, shells/mortars had a 1.5 times greater risk of any hand injury (OR 1.45, 95% CI 1.02-2.04) and four times greater risk of an operative hand injury (OR 3.97, 95% CI 1.13-14). With regard to eye and hand severity, 21% of patients sustained globe injuries, 70% of globe-injured patients experienced partial or complete permanent vision loss, and 18% underwent enucleation. Rockets had approximately twice the risk of vision-related permanent (OR 2.41, 95% CI 0.57-2.29). 61% of patients sustained hand injuries. 64% of hand-injured patients underwent at least one hand surgery, and 37% required at least one partial or whole finger/hand amputation. Compared to homemade fireworks, shells/mortars were twice as likely to cause hand-related permanent impairment (OR 1.96, 95% CI 1.10-3.50).

**Conclusions:** Our results question the safety of federally-legal shells/mortars. Shells/mortars are disproportionately associated with specific severe injury patterns to the hand and face. Their injury severity and risk profile more similar to illegal fireworks than to other legal fireworks types.



**Brian J. Cook, MD**  
General Surgery, R2

Hometown: Sacramento, CA  
Medical School: University of California, San Francisco  
Research Interests: General surgery, transplant, trauma

**Faculty Mentor**  
Martin Montenovo, MD

## CLINICAL IMPACT AND RISK FACTORS OF PORTAL VEIN THROMBOSIS IN THE WAITLIST FOR LIVER TRANSPLANTATION

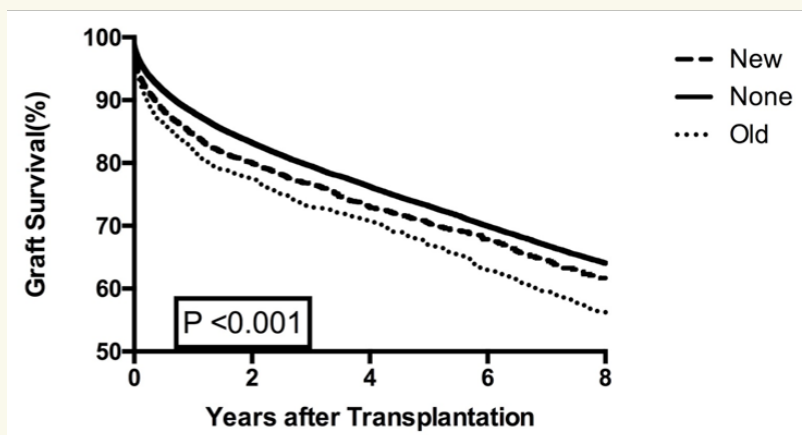
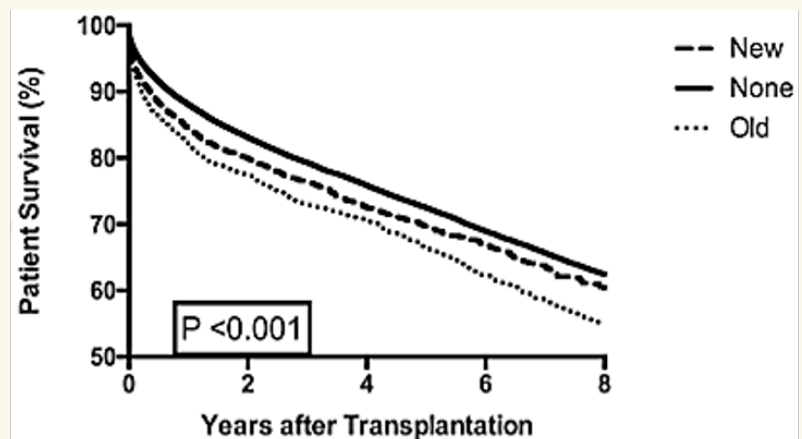
Cook B, Reyes J, Perkins J, Montenovo M

**Background:** Liver transplantation (LT) is challenging in patients with portal vein thrombosis (PVT), has historically been a contraindication. Known complications of LT in patients with PVT include increased OR time, transfusion rate, risk of reoperation, and ICU stay. The aims of this study are: 1-assess the impact of PVT on the waitlist (WL) outcomes; 2-identify risk factors for development of PVT while on the WL; 3-study the impact of PVT on patient and graft survival.

**Methods:** Retrospective cohort analysis of the Organ Procurement and Transplant Network database of primary LT performed in the U.S. adult population between January 2002 and June 2014. We excluded multi-organ transplant, living donor, or split liver transplants. Cohort data was assessed using student t-test, chi-square test, Kaplan-Meier and log-rank chi-square test. Multivariate logistic regression models were used to identify risks associated with development of PVT while on the WL.

**Results:** 128,160 subjects were included in the study. The rate of PVT has increased during the study period. PVT at listing is associated with increased risk of being delisted (11 vs. 9%) and death during transplant (0.7 vs 0.3%). Risk factors associated with development of PVT while in the WL included diabetes (30.8% vs. 24%), NASH (18.2 vs 12%), ascites, and BMI. 63,265 patients underwent LT during the same period. 3,612 (5.8%) had newly diagnosed PVTs at the time of surgery, whereas 1,708 were listed with PVT. The presence of PVT is associated with worse patient and graft survival (see figures).

**Conclusions:** PVT represents an increasing management and outcome burden in LT. PVT at listing and/or at the time of transplant is associated with worse patient and graft survival. Larger studies are needed to better develop optimal therapeutic and preventive strategies for PVT in LT candidates.







**Cordelie E. Witt, MD**

*Research Resident*

**Faculty Mentor**

Frederick P. Rivara, MD, MPH

*UW Department of Pediatrics*

Hometown: Seattle, WA

Medical School: University of Michigan

Research Interests: Processes of care and patient outcomes

## TRANSCRANIAL DOPPLER EMBOLI MONITORING AND STROKE RISK IN BLUNT CEREBROVASCULAR INJURY

Witt C, Bonow R, Mossa-Basha M, Chesnut R, Vavilala M, Rivara F, Cuschieri J, Arbabi S

**Background:** Blunt injury to the carotid (ICA) or vertebral arteries (VA) is a risk factor for stroke. Microemboli monitoring with transcranial Doppler (TCD) ultrasonography is noninvasive, and may enable risk stratification and targeted therapies for patients at highest risk. The objective of this study was to determine whether TCD microemboli monitoring enables stroke risk stratification among patients with blunt cerebrovascular injury (BCVI).

**Methods:** This retrospective cohort study included all patients with blunt ICA or VA injury admitted to our level I trauma center from April 2005 – June 2015 and survived > 48 hours. The primary exposure was TCD-based detection of microemboli. In stroke patients, only exams prior to stroke were considered; in patients without stroke, exams prior to the latest stroke in our dataset (15 days) were considered (“at-risk period”). The primary outcome was in-hospital stroke attributed to BCVI, detected >24 hours after arrival. Antiplatelet and anticoagulant medications were assessed, and medication escalation was defined as advancement from aspirin to higher dose aspirin, clopidogrel, and/or therapeutic anticoagulation in the at-risk period.

**Results:** Over ten years, we identified 1,197 patients with BCVI; 54 developed delayed stroke attributed to BCVI (4.5%; overall stroke rate 8.1%). For context, our institution evaluated 47,733 blunt trauma patients over the same timeframe, yielding a BCVI rate of 2.7%. Ninety percent of patients underwent TCD exams. Of patients with positive TCD exams, 29% had medications escalated in the at-risk period compared to 7% with negative TCDs. We considered the 492 patients with at least one grade I injury. Seven had delayed BCVI stroke in the distribution of the grade I injury (1.4%); four of these had TCDs performed prior to stroke. Pre-stroke TCDs were positive for only one patient; this was the only stroke patient who had medications escalated during the at-risk period. Next, we considered ICA injuries of varying grades. Of 279 patients with isolated ICA injuries, nine had delayed stroke. TCDs were positive in the pre-stroke period in five of nine patients (56%) with delayed stroke compared to 52/270 patients (19%) without stroke (OR = 7.6, 95% CI 1.6–36.4). After adjusting for injury grade and considering patients with either isolated or non-isolated ICA injuries, TCD positivity remained predictive of delayed stroke (aOR 3.78, 95% CI 1.38–10.22). In additional analyses, greater maximum number of microemboli and persistently positive TCDs conferred increased stroke risk. Escalation of medical therapy did not clearly affect TCD results or the risk of stroke; TCDs were more likely to remain positive in patients receiving escalated therapy (7/18 = 39% vs. 6/37 = 16%), and all patients who developed stroke after positive TCDs did so despite more aggressive care. Finally, we considered VA injuries of varying grades. Of 476 patients with isolated VA injuries, eight had delayed stroke (1.7%). None of those with delayed stroke had positive TCDs prior, compared to 55/413 (13%) of patients without stroke. Medication escalation did not clearly affect TCD results. Likewise, among VA injury patients with multiple vascular injuries, positive TCDs were not significantly associated with delayed stroke (OR 1.51, 95% CI 0.16, 7.49).

**Conclusions:** In the largest BCVI cohort studied to date, we observe a high rate of BCVI-related stroke. TCD emboli monitoring may help stratify stroke risk among patients with ICA injuries; however, it is not beneficial for patients with grade I injuries or VA injuries of any grade.



**Matthew A. Bartek, MD, MPH**

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Medical School: University of Massachusetts

Research Interests: Vascular surgery, health services

**Faculty Mentor**

Danielle C. Lavalley, PharmD, PhD

## CAN WE CROWDSOURCE RESEARCH PRIORITIZATION FOR BACK PAIN?

Bartek MA, Truitt AR, Widmer-Rodriguez SL, Tuia JE, Bauer Z, Comstock BA, Edwards TC, Lawrence SO, Monsell SE, Patrick DL, Jarvik JG, Lavalley DC

**Background:** Obtaining patients' perspectives and stakeholder engagement to guide system-wide care decisions and research prioritization is challenging, costly, and time-consuming. Amazon's Mechanical Turk (mTurk) platform has gained popularity over the past decade as a crowdsourcing platform to reach large numbers of individuals to perform tasks for a small reward. The appropriateness of such crowdsourcing methods in medical research has yet to be clarified.

**Research Question:** What is the utility of using Amazon's Mechanical Turk for back pain research prioritization and specifically, do individuals on MTurk who screen positive for back pain prioritize future back pain research topics similarly to those who screen negative for back pain?

**Methods:** We conducted cross-sectional surveys on MTurk to assess participants' back pain and allow them to prioritize research topics. To assess back pain, we used the 24-point Roland Disability Questionnaire (RDQ) and paid respondents \$0.10 to complete it. We offered both those with back pain (RDQ score  $\geq 7$ ) and those without back pain (RDQ  $< 7$ ) an opportunity to rank their top 5 (of 18) research topics for an additional \$0.75. We compared demographic information and research priorities between the two groups. Additionally, we performed qualitative analysis on free-text commentary and additional topics that participants were able to suggest.

**Results:** We screened 2173 individuals for back pain over 33 days and invited 528 (24%) who screened positive to complete the prioritization, of whom 350 (66% of eligible) did. We then screened 664 individuals over 7 days and invited 474 (71%) without back pain to complete the prioritization, of whom 389 (82% of eligible) did. Those with back pain who prioritized were comparable to those without in terms of age, education, marital status, and employment. The group with back pain had a higher proportion of women (67% vs. 58%,  $p=0.02$ ). The groups' rank lists of research priorities were highly correlated: Spearman's correlation coefficient was 0.88 when considering topics ranked #1, and 0.90 when considering topics ranked in the top 5. The two groups agreed on 4 of the top 5 and 8 of the top 10 research priorities.

**Conclusions:** Crowdsourcing platforms, such as MTurk, provide a rich opportunity to efficiently reach large groups of individuals to provide their opinions for a nominal fee. In comparison to traditional stakeholder and patient engagement activities—which are time-intensive and costly—it may provide an appropriate, reliable, and inexpensive strategy for obtaining opinions about prevalent or well-understood conditions, such as back pain. However, the MTurk population does not represent the general population nor at-risk populations. Future efforts to understand how to supplement such activities will augment this as an effective stakeholder engagement tool.



Mengyuan T. Liu, MD

Plastic Surgery, R3

Hometown: Seattle, WA

Medical School: Case Western Reserve University

Research Interests: Craniofacial, migraine surgery, eyelid ptosis correction, free flap outcomes

Faculty Mentor

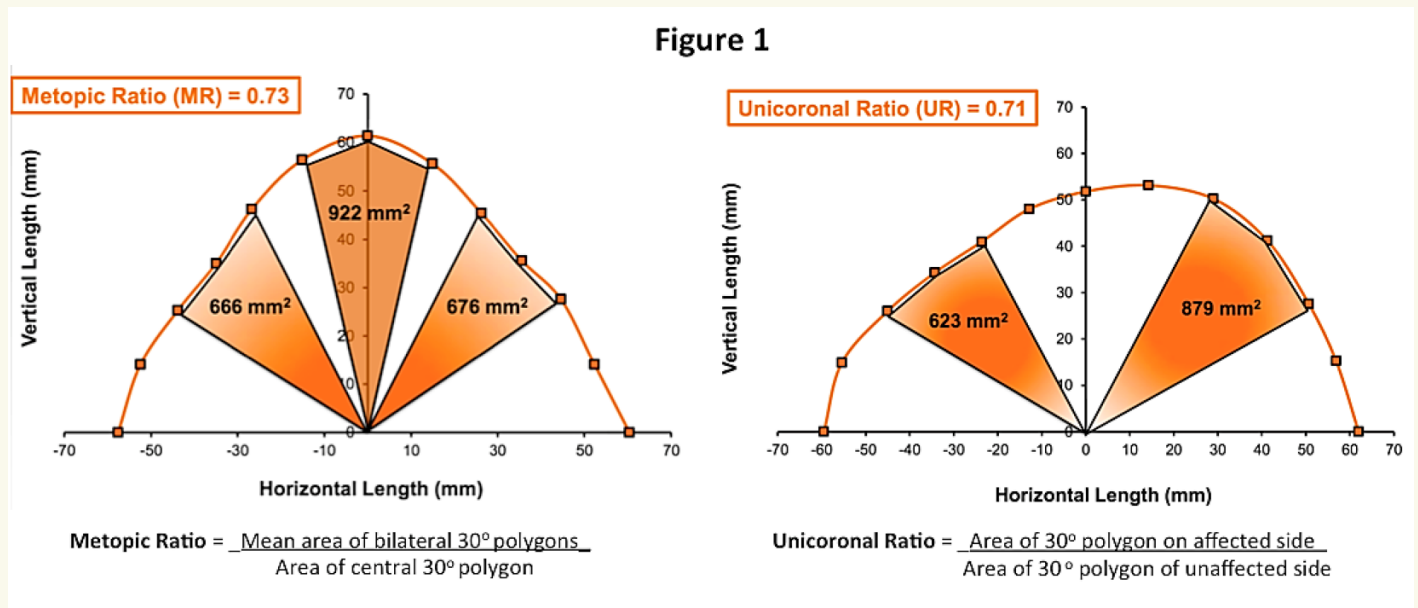
Richard A. Hopper, MD, MS

## PREDICTORS OF SHAPE MAINTENANCE FOLLOWING FRONTO-ORBITAL ADVANCEMENT FOR SINGLE SUTURE SYNOSTOSIS

Liu MT, Skladman R, Pet MA, Hopper RA

**Background:** To evaluate whether pre-operative deformity or degree of surgical expansion plays a greater role in the bandeau position at 2 years following fronto-orbital advancements in patients with non-syndromic, isolated metopic or unicoronal synostosis.

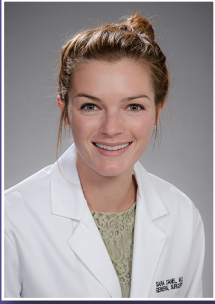
**Methods:** After IRB approval, the medical charts and pre-operative, immediate post-operative, and 2-year follow-up CT scans of patients who underwent fronto-orbital advancement for isolated unicoronal or metopic synostosis over a 12-year period at a single institution were analyzed. Axial Cartesian plots of the frontal bone were used to calculate Unicoronal Ratio (UR) or Metopic Ratio (MR) (Figure 1). The 2-year ratios were compared to the pre-operative and immediate post-operative ratios using linear regression.



**Results:** For metopic patients (n=57), the 2-year MR had a significant positive correlation with the immediate post-operative MR (coefficient=0.443, p<0.00001), but did not have a correlation with the pre-operative MR (coeff=0.100, p=0.668). In unicoronal patients (n=36), the 2-year UR did not have significant correlations with either the immediate post-operative (coeff=0.222, p=0.065), or the pre-operative UR (coeff=0.295, p=0.067).

**Conclusions:** The bandeau position at two years after fronto-orbital advancement is strongly associated with immediate post-operative shape in metopic, but not unicoronal synostosis. Pre-operative asymmetry does not influence the 2-year bandeau shape of either metopic or unicoronal synostosis. The degree of surgical correction plays a greater role in long-term outcomes of metopic synostosis compared to unicoronal synostosis.





Sara K. Daniel, MD  
General Surgery, R2

Faculty Mentor  
Venu G. Pillarisetty, MD

Hometown: Seminole, FL  
Medical School: University of Virginia  
Research Interests: Hepatobiliary oncology and surgical education

## A STANDARDIZED PERIOPERATIVE CARE PATHWAY FOR PANCREATICODUODENECTOMY PATIENTS FACILITATES SAFE DISCHARGE ON OR BEFORE POSTOPERATIVE DAY FIVE

Daniel SK, Mann GR, Park JO, Pillarisetty VG

**Background:** Pancreaticoduodenectomy is a procedure with known high morbidity and mortality, as well as a prolonged length of stay (LOS). We hypothesized that standardization of perioperative care to promote early ambulation and feeding would allow for early and safe discharge. We therefore engaged our multidisciplinary team members to develop a comprehensive perioperative care pathway with an expected discharge on postoperative day five for patients undergoing pancreaticoduodenectomy

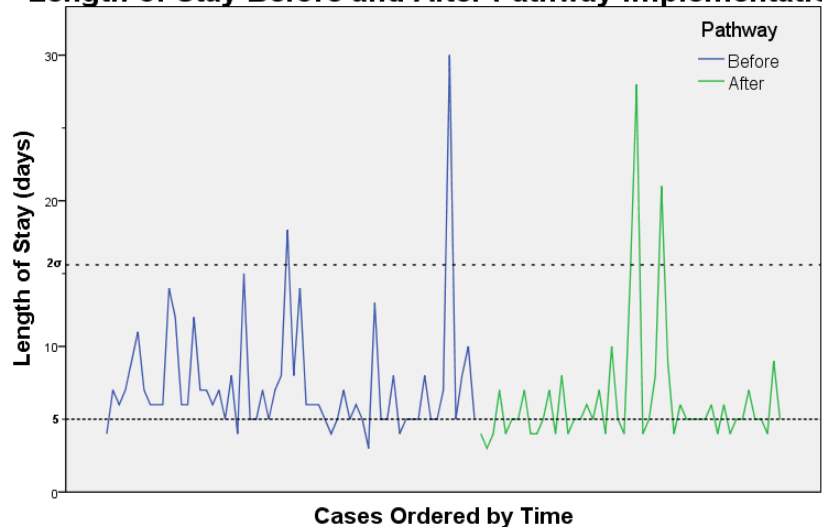
**Methods:** Implementation of our standardized perioperative care pathway was on 6/1/2015. Following IRB determination that this qualified as a quality improvement project, we performed a retrospective chart review and compared cases performed in the year following implementation to those performed the prior year. Data analysis was performed using SPSS.

**Results:** One hundred nine patients underwent pancreaticoduodenectomy during the 2 year period of study, 60 before and 49 following pathway implementation. Complete 30 day follow up data was available for 107 (98%) patients. The groups were similar in terms of preoperative comorbidities.

Following pathway implementation, there was a trend towards reduced median (6 to 5 days) and mean (7.4 to 6.3 days) LOS ( $p=0.191$ ). Overall morbidity was similar between the two group (33% prior vs. 39% after,  $p=0.560$ ). Readmission within 30 days of date of surgery was 0.14 prior to pathway and 0.21 afterwards ( $p=0.322$ ). Patients discharged  $\leq 5$  days after surgery ( $n=53$ ) had similar readmission rates to those discharged  $\geq 6$  days following surgery ( $n=54$ ) in the combined group of patients (0.17 vs. 0.17;  $p=0.966$ ). Furthermore, average date of readmission was similar between patients with LOS  $\leq 5$  and  $\geq 6$  (14.4 vs. 15.8 days;  $p=0.618$ ). Interestingly, epidural placement was associated with increased LOS ( $p=0.024$ ) and these were placed more often prior to pathway implementation (0.45 vs. 0.08;  $p<0.001$ ).

**Conclusions:** Implementation of a standardized perioperative care pathway for pancreaticoduodenectomy is safe and facilitates early discharge. Decreased epidural placement may partially explain the decreased LOS.

Length of Stay Before and After Pathway Implementation





**Shane D. Morrison, MD, MS**

*Plastic Surgery, R3*

Hometown: Tucson, AZ

Medical School: Stanford University

Research Interests: Gender-confirming surgery, microsurgery, genitourinary reconstruction, education

**Faculty Mentor**

Jeffrey B. Friedrich, MD

## TRAINING IN TRANSGENDER PATIENT CARE - A NATIONAL SURVEY OF PLASTIC SURGERY AND UROLOGY RESIDENTS AND RESIDENCY DIRECTORS

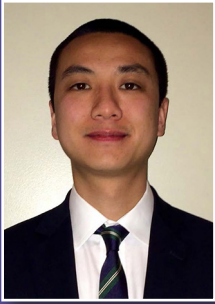
Morrison SD, Chong HJ, Dy GW, Osbun NC, Holt SK, Vedder NB, Sorensen M, Joyner B, Friedrich JB

**Background:** Gender dysphoria is estimated to occur in up to 0.9% of the United States population. With increasing awareness and decreasing stigma surrounding transgender issues, it is predicted more patients will begin to seek medical and surgical transition. We sought to characterize transgender-related educational content provided in United States plastic and urologic surgery residencies, predictors of having transgender-specific curricula, and trainee perceptions of transgender patient care.

**Methods:** Program directors (PD) from 219 United States ACGME-accredited plastic surgery (91) and urology (128) programs, and residents at greater than 20 representative urology and plastic surgery programs were asked to complete a web-based survey between November 2015 and March 2016. Respondents were queried on the extent didactic and clinical hours dedicated to transgender-related curricular content, types of clinical exposure available, and perceptions regarding the importance of transgender-specific education.

**Results:** One hundred fifty-four (70.3%) PDs responded, and 145 (66.2%) completed the questionnaire. Three hundred twenty-two plastic surgery residents or fellows responded to the survey (80% response rate) and 294 urology residents or fellows responded to the survey (73% response rate). PDs reported a median of 1 didactic hour (interquartile range [IQR], 2 hours), and 2 clinical hours (IQR, 10) dedicated to transgender content. Of 71 plastic surgery and 74 urology PD respondents, 18.3% and 41.9% provided no didactic exposure; and 33.3% and 29.7% provided no clinical exposure, respectively. 64% of plastic surgery trainees had education on or direct exposure to transgender care during residency. Overall, the majority of respondents believed that training in gender-confirming surgery is important and 72% endorsed the necessity of gender-confirming surgery fellowship training opportunities. 54% of urology trainees reported exposure to transgender patient care. Most urology trainees (77%) felt gender-confirming surgical training should be offered in fellowships.

**Conclusions:** The median reported time dedicated to transgender education was minimal across US plastic surgery and urology programs, though highly variable. The majority of PDs endorse transgender-focused education as important, yet there were significant regional differences in attitudes. The majority of trainees endorsed the importance of residency and fellowship training in gender-confirming surgery, and had exposure to transgender patient care. In order to better serve the transgender population, formal fellowship training in gender-confirming surgery should be considered.



**Thomas H. Shoultz, MD**

*Surgical Critical Care Fellow*

Hometown: Mobile, AL

Medical School: University of Alabama at Birmingham

Research Interests: Geriatric trauma outcomes

**Faculty Mentor**

Tam N. Pham, MD

## PROVIDER UNDERSTANDING AND PERCEPTIONS OF FRAILTY: ASSESSING CURRENT KNOWLEDGE, ATTITUDES, AND BELIEFS IN AN URBAN TRAUMA CENTER

Shoultz TH, Moore M, Reed MJ, Kaplan SJ, So G, Bentov I,  
Taitsman LA, Mitchell SH, Hough CL, Arbabi S, Pham TN

**Background:** The growing aging population has led to greater numbers of older frail patients hospitalized after trauma. The older frail patient has limited physiologic reserve and is extremely vulnerable to the stress of surgery, immobility, and critical illness. Future quality improvement in geriatric trauma therefore relies on more consistent identification of frailty. However, little is known about providers' knowledge, attitudes, and beliefs toward frailty. The goal of this study was to gain insight into providers' understanding, current practices and beliefs about frailty assessment.

**Methods:** We constructed a 20-question survey using the Health Belief Model (HBM) of health behavior. This theory utilizes major constructs to explain individuals' motivations in health-promotion behavior. Queried HBM categories were: susceptibility, severity, self-efficacy, perceived barriers, and cues to action. We surveyed physicians, surgeons, advanced practice providers, and trainees. We used mixed methods with descriptive statistics and content analysis to derive major themes from survey responses.

**Results:** A total of 151 providers completed the survey with a response rate of 92%. Several themes emerged from the body of responses. While 57 respondents (38%) include age as part of the frailty definition, respondents consider a variety of other factors to define frailty, highlighting limited definitional consensus. The majority of respondents perceive frailty as important to patient health outcomes, and recognize that frailty affects multiple aspects of care and increases the risk of death. Rather than a systematic approach to frailty screening, most providers are cued to assess based on overt signs of frailty. While techniques to assess frailty range from "gestalt" to technical measures of sarcopenia and laboratory data, only 16% respondents report being familiar with existing frailty assessment tools (limited self-efficacy). Perceived barriers include the burdensome nature of assessment tools, insufficient training on frailty assessment, and lack of time during clinical practice. Most providers report that they would prefer simpler assessment tools if available, and 20% indicate the desire for additional personnel to specifically address frailty.

**Conclusions:** Most providers at an urban trauma center consider frailty an important clinical factor. However, many providers are unsure of the definition or assessment tools and do not feel empowered to assess frailty. Providers' responses suggest that additional training and education are required to systematically include frailty in clinical assessment of older adults. The development of simple tools to screen for frailty and additional resources may help address current gaps in the care of older frail patients. In the future, providers may support implementation of a systematic frailty screening process to enable Geriatric and Palliative Medicine consultations.



## Lauren A. Jacobson

Medical student, 4th year

Presenting on behalf of Brodie Parent, MD, MS, General Surgery, R4

Hometown: Post Falls, ID

Medical School: University of Washington

Research Interests: Hand and facial trauma, and surgical outcomes

## Faculty Mentor

Kari A. Keys, MD

### WOUND MORBIDITY IN ANTERIOR COMPONENT SEPARATION AND TRANSVERSUS ABDOMINIS RELEASE

Parent B, Horn D, Jacobson LA, Petersen RP, Hinojosa M, Yates R, Wright AS, Louie O

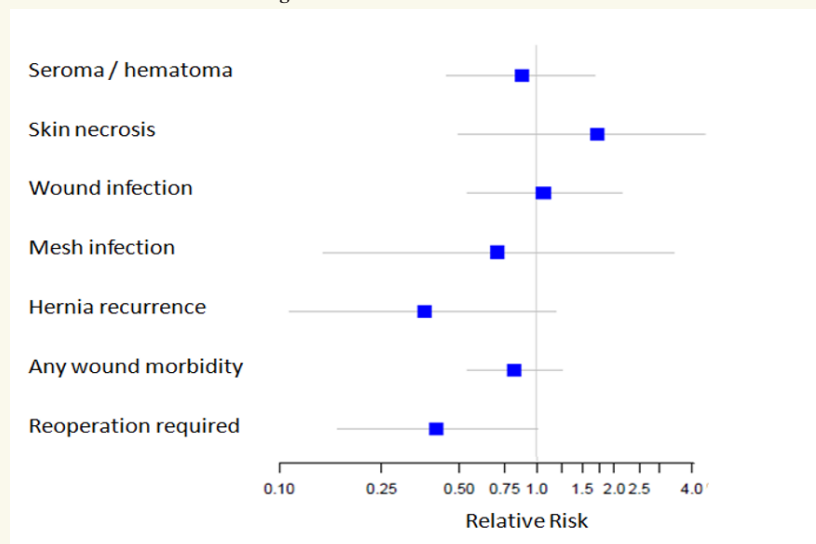
**Background:** Transversus abdominis release (TAR) is a novel approach for myofascial advancement in ventral hernia repair and has been hypothesized to have lower rates of wound complication than anterior component separation (ACS).

**Methods:** Patients who had a ventral hernia repair with either TAR or ACS from 1/10 to 1/16 were enrolled in this retrospective cohort study. Patient characteristics were collected through chart review. Primary outcomes were operative time and wound complications. Multiple linear and Poisson regression were used to determine statistical significance.

**Results:** 142 patients were analyzed; 75 subjects underwent ACS and 67 underwent TAR. There were no differences in baseline characteristics between groups, except that the ACS group had more immunosuppressed subjects (35% vs 19%). Median operative time for ACS was 6.3 hours versus 6.1 hours for TAR ( $p=0.6$ ). Overall wound complications did not differ between the two groups ( $p=0.4$ ). Compared to ACS, TAR had a similar incidence of seroma/hematoma (RR 0.9, 95% CI 0.5-1.7), wound infection (RR 1.07, 95% CI 0.5-2.2), and mesh infection (RR 0.7, 95% CI 0.2-3.4). Hernia recurrence was 12% for ACS and 4% for TAR (RR 0.4, 95% CI 0.1-1.2). Reoperation was required in 19% of ACS and 9% of TAR subjects (RR=0.4, 95% CI 0.2-1.00).

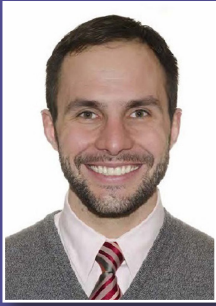
**Conclusions:** Relative to ACS patients, TAR patients had similar operative times and overall wound complications. TAR patients had trends toward fewer reoperations for complications, indicating that this technique may confer a lower risk for severe wound morbidity. This represents the largest known cohort in the literature, and aids in validation of this technique.

Figure 1. Risk estimates for wound outcomes in a cohort of subjects who underwent ventral hernia repair with transversus abdominis release, compared to a cohort of subjects who underwent anterior component separation (referent group). Data were collected from January 2010 to January 2016 at three academic surgical centers.\*



\*Statistical significance was determined using Poisson regression with robust standard errors. Model structure: 1) exposure of interest: component separation technique, 2) outcomes as listed above, 3) covariates included categorical variables for body mass index, diabetes mellitus, immunosuppressed state, and 'American Society of Anesthesiologists Classification.' A categorical variable for mesh type was included in the model which assessed mesh infection and hernia recurrence.





**Mackenzie R. Cook, MD**  
Surgical Critical Care Fellow

Hometown: Simsbury, CT  
Medical School: Duke University  
Research Interests: Long term outcomes following trauma

**Faculty Mentor**  
Bryce R.H. Robinson, MD, MS

## REVERSIBLE RESPIRATORY FAILURE IN TRAUMA: NOT AS BAD AS WE THOUGHT

Cook M, O'Connell K, Qiu Q, Maine R, Riggle A, Shoultz T, Cuschieri J, Arbabi S, Robinson B

**Background:** Significant improvements have been made in the initial care of the severely injured patient requiring mechanical ventilation that have resulted in reduced hospital mortality. The effects of respiratory failure on long-term mortality have not been investigated in trauma patients, although mortality in non-trauma patients with respiratory failure is poor. We, therefore, hypothesize that the duration of mechanical ventilation and increasing age are both associated with poor one year survival in trauma patients.

**Methods:** We undertook a retrospective review from 2011–2014 of all trauma admissions to a single level-1 center who required mechanical ventilation for at least 48 hours. We excluded patients <15 years old and those with a head abbreviated injury scale score of  $\geq 4$ . We matched patients to the Washington state death database to calculate 1 year mortality. Age cohorts of <60, 60–74 and >75 years were investigated. Univariate comparisons as well as Kaplan–Meier survival curves were constructed. Data are presented as hazard ratios (HR) with 95% confidence intervals.

**Results:** We identified 1247 patients who met our inclusion criteria and focused our analysis on hospital survivors. On univariate analysis, age  $\geq 75$  years was strongly associated with death 1 year following admission, HR: 7.4 (4.3,12.8) while each additional ventilator day was associated with death at 1 year HR: 1.02 (1.00,1.04). When all patients were examined, Kaplan–Meier survival curves demonstrated an increasing mortality associated with increasing age (Figure 1A). When only patients who survived to hospital discharge were examined, there was a far less robust association between age and 1 year survival (Figure 1B). Similarly, when the association between mechanical ventilation duration and mortality was examined in hospital survivors, no impact on mortality was present (Figure 2).

**Conclusions:** Providing appropriate counseling to critically ill trauma patients and their families is a challenge. These data demonstrate that while increasing age and ventilator times are associated with one year mortality, the overwhelming proportion of these deaths occur early and in the hospital. Compared to prior literature in uninjured patients, reversible respiratory failure in trauma does not carry the additional long term mortality risk commonly associated with mechanical ventilation. These data suggest that in trauma patients who survive to discharge, reversible respiratory failure is better tolerated than previously appreciated and neither age nor time on the ventilator should be used in isolation when guiding care.

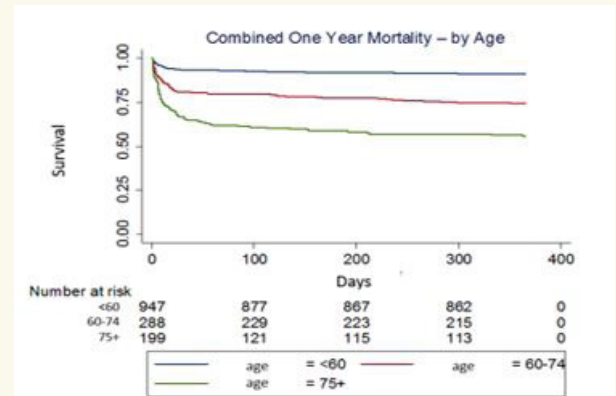


Figure 1A

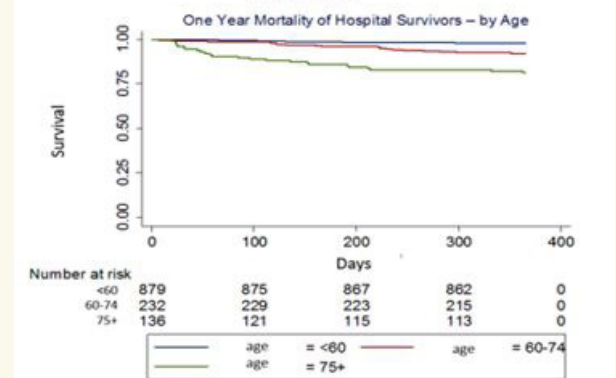


Figure 1B

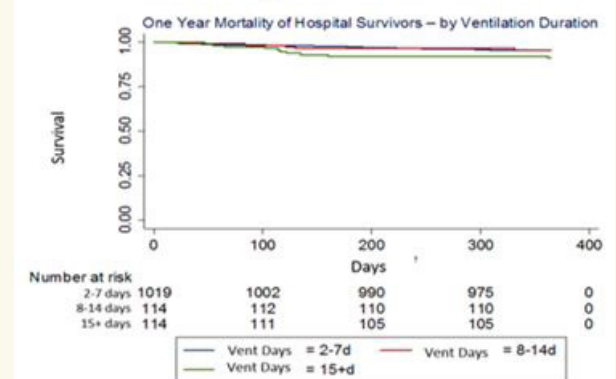
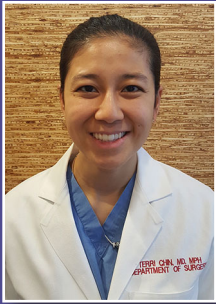


Figure 2



**Theresa L. Chin, MD, MPH**

*Surgical Critical Care Burn Fellow*

Hometown: Marlboro, NJ

Medical School: Virginia Commonwealth University

Research Interests: Quality of life in burn patients

**Faculty Mentor**

Nicole S. Gibran, MD

## BURN SPECIFIC HEALTH SCALE-BRIEF TRENDS 10 YEARS AFTER BURN INJURY: A BURN MODEL SYSTEM NATIONAL DATABASE STUDY

Theresa L. Chin TL, Carrougher GC, Amtmann D, McMullen K, Herndon D, Holavanahalli R, Meyer W, Ryan C, Nicole S. Gibran

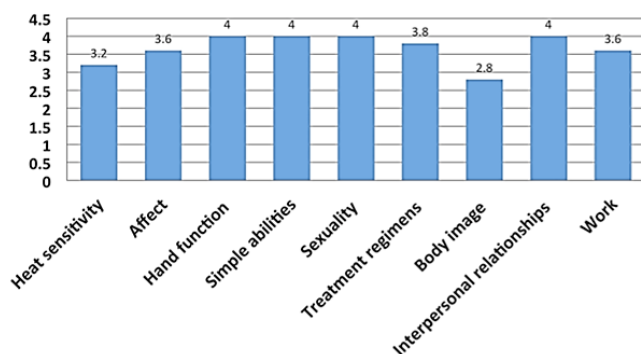
**Background:** The Burn Specific Health Scale-Brief (BSHS-B) evaluates 9 domains of burn related health and has been validated in multiple languages, suggesting significant global utility. However, existing reports typically focus on burn survivors within two years of injury. The purpose of this study is to determine whether quality of life remains a concern for burn survivors ten years after injury.

Table:	All (n=221)
Age at time of burn: Median (IQR)	26(12-44)
% TBSA burn: Median (IQR)	22 (11-43)
% Inhalation injury (n)	22% (47)
% other injury (n)	17% (37)
% male (n)	66% (145)
<b>Etiology of Injury</b>	
Fire/flame/flash	70%
Scald/Grease/Contact/Tar	20%
Chemical/Electricity	11%
% working at time of burn (n)	52% (114)
% TBSA grafted: Median (IQR)	14 (6-30)
Length of stay: Median in days (IQR)	24 (15-37)
Ventilator free days: Median (IQR)	22 (13-33)
Amputation due to burn at discharge	13% (27)
Days to return to work: Median (IQR)	98 (64-214)

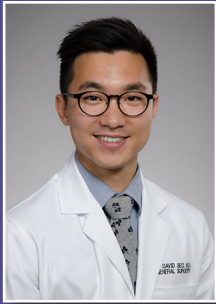
**Methods:** Cross sectional data of burn survivors injured from 1994 to 2006 to five US burn centers were collected as part of the Burn Model System National Database 10 years after injury. We report the median of the 9 BSHS-B domains including: heat sensitivity, affect, hand function, simple abilities, sexuality, treatment regimens, body image, interpersonal relationships, and work. Responses to the items in each domain range from 0-4 with lower scores indicating poorer quality of life. Statistical differences in responses were compared using Wilcoxon-Mann-Whitney test.

**Results:** Ten-year survivor injury characteristics suggest a moderate severity of injury (Table). Median BSHS-B scores (Figure) indicate that patients score lower in heat sensitivity, affect, body image, and work (Median=3.2, 3.6, 2.8, and 3.6, respectively). Affect, body image, and interpersonal scores were significantly lower for females (median=3.1, 2.8, 3.8, respectively) than males [median=3.6, 3.3, 4, respectively] ( $p=0.008, 0.004, 0.022$ , respectively)]. 114 patients were working at the time of injury and 93 returned to work/school at median of 98 days (IQR: 64-214). Eight of the 10 patients with amputations due to burn had a median time to return to work/school of 318 days (IQR: 177-451).

Burn Specific Health Scale Brief at 10 years post-burn



**Conclusions:** Our results suggest that certain domains of burn specific health may continue to affect survivors even at 10 years post injury. Interventions targeted to specific populations and domains, such as females and affect and/or body image, may be helpful to restore burn specific health. Conversely, patients with amputations are able to return to work/school but require longer follow-up and support. These results support the concept that burn injuries represent a chronic condition and that long-term medical and psychosocial support may benefit burn survivor recovery.



Y. David Seo, MD

Research Resident

Hometown: Los Gatos, CA

Medical School: University of Michigan

Research Interests: Surgical oncology and immuno-oncologic therapy

Faculty Mentors

Venu G. Pillarisetty, MD

## T-CELL RECEPTOR IMMUNOSEQUENCING REVEALS NOVEL INSIGHTS INTO THE IMMUNE RESPONSE TO HUMAN PANCREATIC CANCER

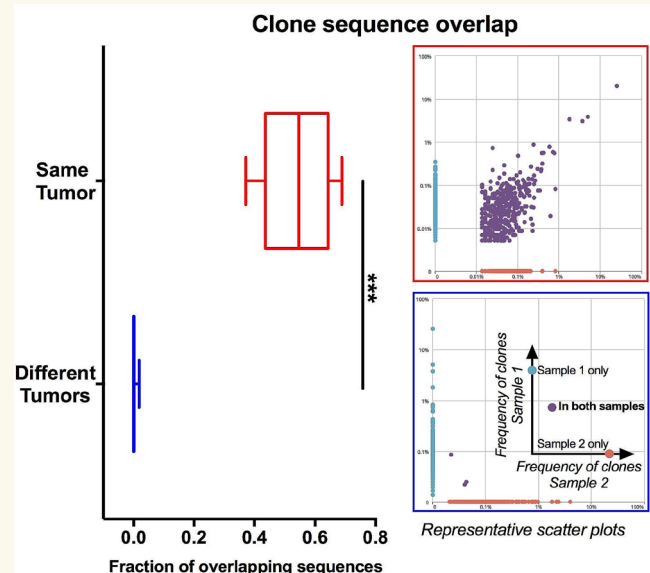
Seo YD, Jalikis FG, Jiang X, Vignali M, Robins H, Pillarisetty VG

**Background:** Despite advancements in therapy, pancreatic ductal adenocarcinoma (PDA) remains an aggressive cancer with high mortality. It is characterized by dense inflammation, including many T cells; however, it is unclear whether these T cells signify a true anti-tumor response. In the setting of disappointing early results of immunotherapy in PDA, we sought to gain a deeper understanding of the tumor-associated T-cell response.

**Methods:** With IRB approval, we obtained archival resected PDA tumors in paraffin-embedded blocks from 54 patients. We performed histopathology to identify blocks containing lymph nodes (LN) and performed T-cell receptor (TCR) immunosequencing on DNA extracted from immediately adjacent tissue. To address possible intratumoral heterogeneity, we analyzed duplicate samples from separate blocks for 10 patients. Productive clonality was defined as 1-Pielou's evenness for TCR rearrangements encoding a functional protein; TCR fraction was calculated from number of observed templates and the amount of input DNA. Two-tailed t-tests were used to compare subgroups. TCR sequence overlap between each of the 10 pairs of duplicate samples were calculated at the amino acid level.

**Results:** Among samples that did not contain LN, mean TCR fraction was 0.27, and mean clonality was 0.15 (typical peripheral blood mononuclear cell clonality is 0.08). TCR fraction was positively correlated with clonality ( $R^2=0.23$ ,  $p=0.007$ ), though this correlation was only significant in patients who received neoadjuvant chemotherapy ( $R^2=0.19$ ,  $p=0.03$ ). TCR fraction was higher in patients with positive nodal status (0.32 vs. 0.23,  $p=0.02$ ), but lower in patients who received neoadjuvant therapy (0.22 vs. 0.33,  $p=0.02$ ). There was no survival difference between high or low TCR fraction or clonality. Samples containing LN (not included in previous analyses) had higher TCR fraction (0.49 vs. 0.27,  $p<0.0001$ ) but lower clonality (0.09 vs. 0.15,  $p=0.0002$ ); this relationship was maintained regardless of nodal status. Among 10 pairs of duplicate samples, there was 53% mean overlap of TCR amino acid sequences, compared to 0.1% for pairs of unmatched samples (\*\* $p<0.0001$ ).

**Conclusions:** Here we demonstrate evidence of clonal expansion of T cells in the human PDA microenvironment. Extensive overlap of TCR sequences between two distinct samples for each of 10 pairs analyzed further suggests that the clonal expansion may be specific to tumor antigens. Neoadjuvant therapy may also influence clonal expansion, as only treated patients had a positive correlation between TCR fraction and clonality. Finally, the presence of a lymph node appears to skew TCR sequencing data toward a less clonal but more numerous population. This suggests that the most rigorous analysis of TCRs in a solid tumor microenvironment needs to exclude blocks that contain lymph nodes in order to characterize the true intra-tumoral population of T cells.



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**Melina R. Kibbe, MD, FACS, FAHA**  
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Edward G. Elcock Professor of Surgical Research  
Department of Surgery  
Northwestern University

2014

**Timothy R. Billiar, MD**  
George Vance Foster Professor & Chair  
Department of Surgery  
University of Pittsburgh

2012

**Gerald Fried, MD, FRCS(C), FACS**  
Professor of Surgery and Gastroenterology  
Adair Family Chair of Surgical Education  
Montreal General Hospital

2010

**Jeffrey B. Matthews, MD**  
Dallas B. Phemister Professor of Surgery  
Chair, Department of Surgery  
Dean for Clinical Affairs,  
Biological Sciences Division  
The University of Chicago

2008

**Timothy J. Eberlein, MD**  
Bixby Professor and Chair  
Department of Surgery  
Washington University School of Medicine

2006

**Richard H. Bell, Jr., MD**  
Professor and Chair of Surgery  
Feinberg School of Medicine  
Northwestern University

2004

**Michael T. Longaker, MD**  
Director of Children's Surgical Research in the  
Department of Surgery  
Stanford University School of Medicine

2002

**Ori D. Rotstein, MD**  
Peter A. Crossgrove Chair in General Surgery  
The University of Toronto

2000

**Lazar J. Greenfield, MD**  
Frederick A. Collier Professor and Chairman  
Department of Surgery  
The University of Michigan

1998

**Haile T. Debas, MD**  
Chancellor and Dean, School of Medicine  
University of California at San Francisco

1996

**Richard L. Simmons, MD**  
Vance Foster Professor and Chair  
Department of Surgery  
University of Pittsburgh

2015

**Walter J. Pories, MD**  
Professor of Surgery, Biochemistry and  
Kinesiology  
Brody School of Medicine  
East Carolina University  
North Carolina

2013

**Anthony Atala, MD**  
Director of the Wake Forest Institute for  
Regenerative Medicine  
The W.H. Boyce Professor & Chair of the  
Department of Urology at Wake Forest University

2011

**Julie A. Freischlag, MD**  
The William Stewart Halsted Professor  
Chair, Department of Surgery  
Surgeon-in-Chief, The Johns Hopkins Hospital  
Baltimore, MD

2009

**Michael W. Mullholland, MD, PhD**  
Frederick A. Collier Distinguished  
Professor of Surgery  
Chair, Department of Surgery,  
University of Michigan School of Medicine

2007

**Shukri F. Khuri, MD, MS (Hon.)**  
Professor of Surgery, Harvard Medical School  
Chief, Cardiothoracic Surgery,  
VA Boston Healthcare System  
Vice Chairman, Department of Surgery,  
Brigham and Women's Hospital

2005

**Barbara L. Bass, MD**  
Professor of Surgery  
Maryland University School of Medicine

2003

**Michael G. Sarr, MD**  
Professor of Surgery  
Mayo Clinic Rochester

2001

**John Mannick, MD**  
Moseley Distinguished Professor of Surgery  
Harvard Medical School, Brigham & Women's  
Hospital

1999

**Samuel A. Wells Jr., MD, FACS**  
Executive Director  
American College of Surgeons

1997

**Murray F. Brennan, MD**  
Alfred P. Sloan Chair in Surgery  
Memorial Sloan-Kettering Cancer Center

1995

**Judah Folkman, MD**  
Julia Dyckman Andrus Professor of Pediatric Surgery  
Harvard Medical School





# UW Medicine

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## DEPARTMENT OF SURGERY

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**The Helen and John Schilling Lecture** is an annual lecture established by the late Helen Schilling to bring distinguished scholars to the Department of Surgery at the University of Washington, and to enhance the Department's commitment to the highest standards of patient care, teaching, research and scholarship. It was Mrs. Schilling's wish that the lectureship be in honor of her husband, John.

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