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Committed surgeons in Michigan advancing patient health through education and advocacy.

Estrogen Modulation of Pneumonia: An IgA Effect

Abubaker A. Ali, MD; Lawrence N. Diebel, MD; David M. Liberati, MS
Wayne State University

Objective: Laboratory and clinical studies demonstrate a salutary effect of estradiol (E_2) on pneumonia and other infectious complications following trauma. Secretory immunoglobulin A (SIgA) is a principle antibody in respiratory and other mucosal secretions. In previous studies we have demonstrated polyimmunoglobulin receptor (pIgR) mediated transport of IgA across intestinal epithelial cells is upregulated by Toll-Like receptor 4 ligand (TLR-4) and E_2 . We hypothesized that the protective effect of E_2 on the development of pneumonia may be related to modulation of IgA transport into respiratory secretions. This was studied in an *in vitro* model.

Methods: Calu-3 respiratory epithelial cell monolayers were established in a two chamber cell culture system. Calu-3 respiratory epithelial cell monolayers were then treated with either E_2 or dihydrotestosterone (DHT) for 3 days. Dimeric IgA was added to the basal chamber of Calu-3 cells and IgA transcellular transport indexed by recovery of SIgA in the apical chamber media. In separate experiments, *Klebsiella pneumoniae* (10^4 CFU/ml) was added to the apical chamber of treated Calu-3 cell monolayers and bacterial passage across Calu-3 cells determined by bacterial recovery from basal chamber media. Calu-3 cells not treated with E_2 or DHT served as control.

Results: (mean \pm SD, N = 3 for each group)

	SIgA transcytosis (ng/ml)	Bacterial passage at 240 min. (CFU/ml)
Calu-3 (no E_2 /DHT)	2.9 \pm 0.1	0.9 \pm 0.04
Calu-3 + E_2 (0.1 μ M)	10.1 \pm 0.2*	0.3 \pm 0.02\$
Calu-3 + E_2 (1.0 μ M)	17.2 \pm 0.4*#	---
Calu-3 + DHT (0.1 μ M)	3.1 \pm 0.1	1.0 \pm 0.04
Calu-3 + DHT (1.0 μ M)	4.3 \pm 0.2	---

*p<0.001 vs. Calu-3 no E_2 /DHT and DHT treated groups, #p<0.001 vs. all other groups, \$p<0.001 vs. all other groups. Bacterial passage across Calu-3 cells without SIgA was 1.5 \pm 0.03 CFU/ml. Exposure of Calu-3 cells to E_2 increased SIgA transcellular transport in a dose dependant fashion. E_2 but not DHT decreased bacterial passage across Calu-3 respiratory cell monolayers.

Conclusion: The protective effect of E_2 against the development of pneumonia may be related to augmented transport of IgA into mucosal secretions.

Core Muscle Size as an Indicator of Increased Thoracic Injury in Trauma Patients

Bedabrata Sarkar, MD

University of Michigan

Research question/objective: In previous studies, we have measured the total volume of muscle in the chest region and found it to be strongly correlated with a decrease in the severity of chest injuries in our study subjects. This is likely due to the muscles coupling with the bony thoracic cage which increases the strength of the whole. Healthy core muscle mass indicates there is more muscle in all areas of the body. This study sought to determine if the size and quality of an occupant's core muscles, specifically the psoas muscle, correlated with a decreased incidence of injury in the thorax following a traumatic event.

Methods: Our study population was comprised of front seat, outboard occupants involved in frontal motor vehicle crashes. These occupants benefitted from airbag deployment and were wearing 3-point lap and shoulder belts. One hundred three (103) of these occupants also had CT scans at their initial hospital evaluation. Occupants were further classified by thoracic skeletal and organ injuries. We analyzed the CT scans of these patients using a novel, semi-automated image processing protocol, measuring each occupant in precise and granular detail, specifically looking at psoas muscle size at the fourth lumbar vertebra (L4). For comparison, 2,000 adult trauma patients who had been scanned at our institution were identified. Despite significant injury mechanisms, a majority of the control population had no notable torso injuries.

Results: While the psoas area for the control group approached a normal configuration, our case occupant population had more individuals with a psoas muscle cross section area of less than 2,000 mm² (54% vs. 33%). Case occupant skeletal and internal harm distributions trended toward lower psoas muscle area compared to the control population. Occupants with lower core muscle size suffered from increased skeletal and internal harm.

Significance of Results: This study used a novel image processing protocol to determine if the size of an occupant's core muscle would mitigate thoracic injuries. While previous research has concentrated on extremity muscle activation, no research groups have focused on the effects the core muscles of the body may have for occupants involved in trauma.

Mortality Implications of Nucleated Red Blood Cells in Trauma Versus Non-Trauma Patients

Nadia M. Obeid, MD, Ilan Rubinfeld, MD
Henry Ford Hospital

The presence of nucleated red blood cells (NRBC) in blood has previously been identified as a poor prognostic indicator. We sought to investigate the incidence of NRBC in our critically ill patients, specifically comparing trauma versus non-trauma patients, and its relationship to mortality.

We hypothesized that NRBC positive status would have a different predictive value in trauma patients than in non-trauma patients.

This was a retrospective study reviewing hospital administrative data spanning from 2007 to 2010 regarding all patients admitted to our surgical intensive care unit (SICU) regardless of NRBC status. We excluded length of stay less than 1 day and patients <18 years of age. We then identified those with positive NRBC values. We compared mortality rate in the non-trauma and trauma patients with and without presence of NRBC in peripheral blood. We also analyzed the highest NRBC value in relation to other acuity markers such as arterial lactic acid and white blood cell (WBC) count. Categorical variables were analyzed with Chi-square test, and multivariate logistic regression was performed using SPSS (IBM, New York).

Of 9,690 admissions in the SICU, 7,511 were non-trauma and 2,179 were trauma patients. Of these, 1,155 non-trauma patients and 208 trauma patients were noted to have positive NRBC values. Mortality with NRBC positive value in non-trauma and trauma patients was 24.1% and 27.4% with OR being 8.9 and 7.6, respectively. The differences were not statistically significant. The mortality was only 3.7% in patients without NRBC in peripheral blood. With NRBC >20 value, OR in non-trauma and trauma patients was 26 and 16, respectively. There was no statistical difference observed in these two groups with NRBC positive or NRBC >20 value with respect to mortality ($p>0.3$). We also found that NRBC positive, NRBC >20, age >60, elevated lactate, and elevated WBC were independent predictors of mortality in both trauma and non-trauma patients.

In our surgical ICU, we noted an association between the presence of NRBC and increased mortality. It served as an independent predictor of mortality in both trauma and non-trauma patients. We observed no statistical difference in the two groups in relation to mortality. Further prospective studies with formal acuity adjustment are needed to evaluate NRBC by involving ISS and APACHE score in the SICU setting.

**Prospective Surveillance for Lower Extremity Deep Vein Thrombosis In
Surgical Intensive Care Unit Patients**

Nichole Urban, MD, Felicia A. Ivascu, MD

Oakland University William Beaumont School of Medicine

Despite the increased emphasis on prevention of venous thromboembolism (VTE), it remains a significant cause of morbidity and mortality in the intensive care setting. A retrospective review at our institution showed the incidence of occult deep venous thrombosis (DVT) in our surgical intensive care unit to be much higher than previously thought, despite the use of prophylaxis in this population. The purpose of this study was to prospectively evaluate the prevalence of lower extremity DVT in critically ill surgical patients to confirm the findings of the retrospective study.

During the period of March 1st to June 30th, 2010, duplex ultrasound was used to prospectively screen all patients admitted to the surgical intensive care unit (SICU) with an anticipated length of stay over five days. Patients were screened initially on average at day six of their stay in the SICU, followed by repeat screening examinations at four to six day intervals regardless of initial results. Demographic data, co-morbidities, acute physiology and chronic health evaluation (APACHE) III score, admitting service and diagnosis, VTE risk factors, and type of VTE prophylaxis were also recorded.

There were 196 patients evaluated with an average age was 67.8 years, APACHE III score of 62, and an ICU length of stay of 20.5 days. A 31% prevalence of DVT was found; 14 patients had isolated intramuscular calf DVT, 14 had posterior tibial or peroneal DVT, and 33 had femoro-popliteal DVT. Twelve of 61 patients were found to be positive for DVT after an initially normal examination; the average number of ICU days to development of DVT was 10 days. Age, gender, APACHE III score, admitting diagnosis and service were not associated with presence of DVT. The only significant risk factor for DVT was the type of prophylaxis; patients receiving only sequential compression devices as prophylaxis had a 45% prevalence of DVT, while patients receiving pharmacologic prophylaxis in addition to SCDs had a 27% prevalence of DVT. ($p = .021$) Congestive heart failure ($p = .045$) renal failure ($p = .019$) were significantly associated with femoro-popliteal DVT; patients with sepsis were also noted to have a relatively high incidence of femoro-popliteal DVT ($p = .055$).

Deep vein thrombosis remains a significant, potentially life-threatening complication in patients with extended surgical intensive care unit stays despite aggressive prophylaxis. Prospective duplex ultrasound surveillance is warranted in these patients, particularly in those with congestive heart failure, renal failure and/or sepsis given their increased incidence of femoro-popliteal disease.

Posterior Interosseous Artery Pedicle Flap: A Consistent and Durable Method for Soft Tissue Coverage

Kari Paulson¹ MD, Mehul Mehta² MD, Elango Edhayan¹ MD, FACS
¹St John Hospital and Medical Center, ²Hand Surgery Associates of MI

Introduction: Reconstruction of soft tissue defects of the hand requires early coverage to minimize infection, allow early mobilization, reduce hospital stay and achieve good functional results. Since the introduction of antebrachial reverse island flaps based on the radial artery by Lu and Wan in 1982, and based on the ulnar artery by Li in 1984, this kind of flap has been widely used to repair soft tissue defects of the hand. Its advantages include good texture and skin matching. However, sacrificing the radial or ulnar artery may impair hand vascularity. Costa et al. first published the posterior interosseous flap in 1988 after a consistent anastomosis between the posterior interosseous artery and the anterior interosseous artery on the dorsal side of the wrist had been elucidated in cadaver studies. This allowed adequate flap coverage without sacrificing one of the main arteries supplying the hand.

Since 1995, we have applied this type of flap with slight modifications to repair soft tissue defects of all types in 10 patients with excellent long-term results.

Study Design: This is a retrospective study of 10 patients who underwent hand soft tissue reconstruction using posterior interosseous artery pedicle flaps. Operative technique was performed similar to that described in the literature with slight individual modifications elaborated in the methods. Pre-operative ultrasound was used if indicated. Demographic data such as age, gender, size of pedicle, use of a bone or tendon graft, and method of closure of the donor site were obtained from the medical records. Patients were seen in subsequent examinations and the long-term function, sensation, strength and appearance of the hands were documented. The patient's perceptions of the operative experience, post-operative course and their individual opinions regarding appearance of the flap and function of the hand were acquired in follow-up interviews.

Results: Of this series of 10 patients, there were no cases of flap necrosis. Overall, patients experienced uncomplicated recovery with relatively quick return to function with intensive hand therapy. Few cases underwent post-operative modification such as defatting. The sensation of the flaps with nerve repair was recovered by the second year postoperatively. No tendon release was required in all tendon graft cases. The bone graft healed by postoperative month 3 in all cases. There was no adverse influence on the function of the hand or forearm from patients' perspectives.

Conclusion: Since little is published about the posterior interosseous artery pedicle flap, this series serves as a reminder that this is a viable option and a useful tool for difficult closures of injured hands.

A Comparison of Short-term Outcomes After Robotic and Laparoscopic Colon and Rectal Surgery

Casillas MA Jr., Lampman R, Cleary RK
Saint Joseph Mercy Health System, Ann Arbor

Purpose: In recent years, robotic assisted laparoscopic (RAL) surgery has been proposed as an alternative to conventional laparoscopic surgery (LS) for colorectal procedures. The purpose of this study was to analyze prospective data collected on the first 60 colon and rectal robotic procedures performed by a single surgeon on a dedicated Colon and Rectal Surgery service.

Methods: Observational retrospective research based on a prospectively collected robotic-assisted and laparoscopic colorectal database from October 2009 to October 2010 was queried. De-identified demographic, intraoperative and postoperative data were collected and analyzed.

Results: 60 consecutive robotic-assisted and 28 laparoscopic colorectal procedures were analyzed. In the RAL group, 28 were female, 32 were male; mean age was 59 years. The average BMI was 26.5. The American Society of Anesthesiologists' (ASA) class distribution was 45 (75%) ASA II patients and 15(25%) ASA III patients. Mean operative time was 193 minutes. The average length of incision was 5.7 cm. Intraoperative estimated blood loss (EBL) was 78ml. There was one conversion to open. The major complication rate was 6.7 percent with no anastomotic leaks and one surgical site infection (SSI). The average hospital length of stay was 4.5 days. In comparison, the LS group had 13 female and 15 male patients. The mean age was 59 years with an average BMI of 26.7. The ASA class distribution was 17 (61%) ASA II patients and 11 (39%) ASA III patients. The mean operative time was 161 minutes, and the average incision length was 7.3cm. The average EBL was 116ml. There were five conversions to open, and the major complication rate was 14% with one anastomotic leak and two SSIs. The average hospital length of stay average was 8 days.

Conclusions: Short-term outcomes for robotic colorectal surgery for benign and malignant disease are comparable to laparoscopic surgery. Importantly, robotic surgery is safe. While operating time may be longer for robotic surgery, blood loss was less and fewer number of SSI occurred. Further studies in regards to long-term outcomes should be investigated in future randomized clinical trials.

Development of an Artificial Placenta: 24 Hour Venovenous Extracorporeal Life Support in Premature Lambs

Gray BW, Mychaliska GB
University of Michigan

An extracorporeal artificial placenta would change the paradigm of treating extremely premature infants who suffer substantial mortality and morbidity. We hypothesized that a venovenous extracorporeal life support (VV-ECLS) artificial placenta would maintain fetal circulation, hemodynamic stability, and provide adequate gas exchange for 24 hours. A near-term neonatal lamb model (130 days; term=145 days) was used (n=9). Two small hysterotomies were performed to expose the fetal neck and abdomen. The right jugular vein and umbilical vein were cannulated with 10-12Fr cannulas, and VV-ECLS was then initiated. The circuit consisted of a peristaltic roller pump (MC3, Ann Arbor, MI) and a 0.5m² hollow fiber oxygenator (Terumo Cardiovascular Systems, Ann Arbor, MI). Lambs were maintained on VV-ECLS in the uterus for 4 hours and then transferred to an “amniotic bath” for up to 24 total hours of support. Five of 9 fetuses survived for 24 hours. Of those that survived, average mean arterial pressure (aMAP) during the first 4 hours was 69±10mmHg and 36±8mmHg the remaining 20 hours. aMAP at 24 hours was 28±4mmHg. The mean fetal heart rate was 227±37 at 4 hours and 209±23 at 24 hours. Mean VV-ECLS flow was 327±76mL/min and remained stable throughout. Using a gas mixture of 50%O₂/3%CO₂ and sweep flow of 1-2L/min, the mean pH was 7.27±0.09, pO₂ 35±12mmHg, and pCO₂ 48±12mmHg. Necropsy revealed a patent ductus arteriosus in all cases, and there was no gross intracranial hemorrhage. Complications in the failed attempts included technically difficult cannulation, multi-system organ failure, and sepsis. The VV-ECLS artificial placenta maintained fetal circulation and hemodynamic stability and provided adequate gas exchange for 24 hours. Future studies will enhance stability and address the factors necessary for long-term support.

Laparoscopic Colectomy Significantly Decreases Length of Stay When Compared to Open Operation

Amalia Stefanou, MD, Ilan Rubinfeld, MD
Henry Ford Hospital

Purpose: It is widely accepted that laparoscopic colon resection results in a shorter length of stay for patients. Yet this has never been analyzed with intent to acuity adjust the patient population. The existing literature tends not to adjust for biases in patient selection that could provide an alternative explanation for length of stay. The goal of our study is to evaluate National Surgical Quality Improvement Program (NSQIP) data to investigate if this is a valid assumption, and how mode of operation affects length of stay.

Methods: Using four years of NSQIP public use files (PUF 2005-8), we used CPT coding to select all colectomies and further label the laparoscopic procedures. Patients were labeled as to being outside the 75 percentile of surgical length of stay (SLOS). Logistic regression analysis was used to predict this outlier status. We also utilized linear regression predicting SLOS directly. Acuity adjustment was done using most popular variables from multiple NSQIP annual reports. This work was done under the approval of our institutional review board and the data use agreement of the American college of surgeons. Data was analyzed in SPSS (SPSS, Chicago, IL).

Results: A total of 45645 colectomies were reviewed, of which 12455 were laparoscopic. The 75th percentile for SLOS was 11 days. This implied 9249 (27.9%) of the open colectomies were outliers, while only 1152 (9.2%) of laparoscopic colectomies were outliers ($p < .001$). When optimizing a simple linear regression to predict SLOS, using common acuity adjustors (i.e. age, functional status, ASA, wound category, age, various occurrences, etc.), the variable marking open procedures consistently had a coefficient of 1.8, implying open procedures increased SLOS by 1.8 days, with a $p < .001$. Utilizing logistic regression to predict outlier status, open colectomies were associated with an odds ratio of 2.27 for outlier status, $p < .001$. Thus implying an independent effect on SLOS.

Conclusion: Our data indicates that laparoscopic colectomy independently decreases length of stay when compared to patients who undergo open operation. When comparing patients in these two categories we were able to compare the groups and use statistical methods to control for selection bias of patients who might be more "surgically fit". Additionally, costs are under increasing scrutiny and laparoscopic procedures generally are more expensive to the institution, demonstrating an across the board improvement in SLOS will be helpful in policy discussions.

Positive Lymph Node to Recovered Lymph Node Ratio as a Predictor of 5-Year Survival in Colon Cancer

Stephen Swistak, MD, Elango Edhayan, MD, FACS
St. John Hospital and Medical Center

The number of lymph nodes recovered from colon resections for colon cancer is variable despite the best efforts of the surgeon. Recovery of 12 lymph nodes has been set as a benchmark quality indicator however a recent study of SEER hospitals revealed only 58% of colon resections recover 12 or more lymph nodes. The ratio of the positive lymph nodes to total number of lymph nodes recovered, referred to as the positive lymph node ratio (pLNR), has been shown to positively correlate with metastatic disease in the South Korean population. Our study assessed the positive lymph node ratio (pLNR) in an American database of colon cancer resections as a predictor of 5-year survival.

Our study is a retrospective review of 160 patients that received surgical treatment for colon cancer at St John Hospital and Medical Center between January 1, 2000 and December 31, 2004. The positive lymph node ratio (pLNR) was calculated. The patients were followed up for a period of 5 years. Data collection was stopped when either the patient was deceased or reached 60 months of survival from the day of surgery. Data was analyzed for the entire cohort and also in the smaller subset of patients in whom a minimum of 12 lymph nodes were recovered.

Data analysis revealed an overall average pLNR of 0.30 with a mean length of survival of 33.3 months regardless of the number of nodes recovered. Subjects were then divided into 3 subgroups based on their pLNR status. Group 1 (n=91) had a pLNR of less than 0.25, Group 2 (n=43) had a pLNR of 0.26 to 0.50 and Group 3 (n=26) had a pLNR greater than 0.51. The average length of survival for Group 1, Group 2 and Group 3 was 39.4 months, 29.7 months and 18 months respectively. Only 3 subjects within Group 3 survived the entire 60 month post-op period. When the data was narrowed to only subjects in whom a minimum of 12 lymph nodes were recovered, the overall average pLNR decreased to 0.24 while the mean survival increased slightly to 35.6 months. Three subgroups were again created with the same parameters. Average length of survival for Group 1 (n=58), Group 2 (n=21) and Group 3 (n=11) was 41.4 months, 31 months, and 13.7 months respectively. With a minimum of 12 lymph nodes recovered, there were no survivors at 5 years post-operatively within Group 3. Our study indicates that the pLNR is a good predictor of 5-year survival in colon resections for lymph node positive colon cancer. Ratio-based lymph node staging is easily reproducible and we suggest is a valid prognostic surrogate in lieu of a 12 lymph node resection.

Intra-Tumoral Acetic Acid Injection Eradicates Human Prostate Cancer Tumors in a Murine Model

Jasneet Singh Bhullar MD

Providence Hospital and Medical Centers

Purpose: Prostate cancer treatment is associated with substantial morbidity. Ideal treatment of localized prostate cancer would be an effective local therapy with minimal morbidity. Direct injections have been used to treat benign prostatic hyperplasia without major complications. We evaluated the local oncotoxic effects of acetic acid in a prostate cancer xenograft murine model

Methods: Acetic acid was chosen from different biologically compatible oncotoxic chemicals on the basis of preliminary laboratory tests, while the acetic acid concentration for was determined on basis of a pilot study with different concentrations. PC3 and LNCaP human prostate cancer cells were injected to grow subcutaneous tumors in *SCID* mice. For each cell line, 14 mice underwent tumor injection with 25% acetic acid treatment (0.05 ml/100 mm³ of tumor) after the tumor size reached >300 mm³. Post treatment, one mouse/group was euthanized after 6 hrs, 24 hrs, 1 week and 2 weeks and the remaining mice (n=10) were sacrificed at 120 days. Control mice (8/group) were euthanized after they met the humane criteria for tumor burden and overall health.

Results: Tumor necrosis was observed immediately post injection and by 24 hrs ulceration and crusting of the overlying skin was noted, which eventually healed to scars by 23±5 days. Histological examination showed tumor degeneration and necrosis with feeding vessel obstruction. Ten treated mice in both groups survived for 120 days, which was much longer than the mean survival of PC3 (40±9 days) and LNCaP (56±10) control mice.

Conclusions: Direct injection of acetic acid successfully eradicated prostate cancer tumors generated from both cell lines. This treatment option could potentially be used in patients for treatment of early localized prostate cancer and as non-operative management of locally advanced prostate cancer. This is the first reported successful use of local chemical therapy for prostate cancer.

Epithelial Mesenchymal Transition Correlates with Increased Aggressiveness in a Murine Model of Pancreatic Adenocarcinoma

Filip Bednar, Marina Pasca di Magliano, Diane Simeone
University of Michigan

Epithelial mesenchymal transition (EMT) is a developmental process critical for proper gastrulation, organogenesis, and body patterning (Thiery et al., Cell, 2009). It has also been implicated in the process of tumorigenesis, metastatic spread, and maintenance of stem-like cells in tumors (Yang et al., Cell, 2004; Mani et al., Cell, 2008). Pancreatic ductal adenocarcinoma (PDA) is the fourth leading cause of cancer-related death in the United States today. Unlike in many other cancers, current treatments have not led to a significant improvement in survival from this disease over the past three decades. Elevated expression of mesenchymal markers vimentin and fibronectin in completely resected pancreatic ductal adenocarcinomas (PDA) correlate with worse long-term patient outcomes (Javle et al., Ann Surg Onc, 2007). EMT also contributes to the chemoresistance observed in many human pancreatic cancer cell lines (Arumugam et al., Cancer Res, 2009). These observations implicate EMT as one of the essential processes promoting the aggressive behavior of PDA. Despite previous work, our understanding of the role of EMT in pancreatic cancer progression is incomplete and would benefit from further study in animal models of the disease.

To study the contribution of EMT in pancreatic cancer biology, we utilize a newly developed, low passage pancreatic cancer cell line derived from a pancreatic ductal adenocarcinoma in a Pdx-Cre, LSL-Kras^{G12D}, p53^{+/-} murine model of PDA, a transgenic model system that recapitulates the phenotype of the human disease (Hingorani et al., Cancer Cell, 2005). FACS analysis of this cell line using the EpCAM marker demonstrates that it is composed of two subsets of cells, an epithelial and mesenchymal type. Molecular characterization by qRT-PCR and immunofluorescence microscopy reveals the presence of a mesenchymal subpopulation expressing vimentin, N-cadherin, and Zeb1, all markers of mesenchymal cells, while the epithelial subpopulation expresses E-cadherin and epithelial receptors EGFR and PDGFR β . We show that the epithelial subset comprises 1-15% of the total population in *in vitro* cultures and gives rise to the mesenchymal subset through a spontaneous EMT process. In contrast, the mesenchymal subset of cells does not revert to the epithelial phenotype. In *in vitro* tumorsphere assays, the mesenchymal subpopulation forms significantly higher number of spheres than the epithelial population of cancer cells, demonstrating enhanced anchorage-independent growth. Subcutaneous injections of epithelial and mesenchymal cells into NOD/SCID mice reveal increased rate of tumor growth from the mesenchymal subpopulation compared to the epithelial population of cells. Our data confirm the observation that EMT correlates with increased aggressiveness of PDA. This cell line forms a new unique system to study the role of EMT in the progression of PDA in murine models of the disease with an intact microenvironment.

Negative Margins Predict Improved Survival for Merkel Cell Carcinoma Patients

Loren Masterson, MD; Richard Keidan, MD, FACS
Oakland University William Beaumont School of Medicine

Objectives: Merkel Cell Carcinoma is a rare neuroendocrine cutaneous neoplasm with a reported 28% 2 year mortality rate. We analyzed our therapeutic modalities which included possible surgery, radiation and/or chemotherapy to determine the relationship between margin status and disease free survival.

Methods: On retrospective review, 67 patients were treated at William Beaumont Hospital for Merkel Cell Carcinoma between 1988 and 2010. Twenty patients were excluded – 9 for inadequate followup, 6 for Stage IV disease and 5 with unknown primaries. Forty five of the remaining 47 patients underwent wide local excision, with possible sentinel lymph node biopsy and lymphadenectomy. Seven (15.5%) of these 45 patients were found to have positive margins. Median follow-up time for patients undergoing wide local excision was 2.7 years, with a living follow-up time of 4.5 years.

Results: Two year Overall Survival (OS) for Stage I - III patients was 74%. All 7 patients with positive margins had Stage III disease. These 7 patients demonstrated a 1 year Disease Free Survival (DFS) of 33% and 2 year OS of 29% compared to 47% and 50% respectively for the 10 Stage III patients with negative margins. Primary head and neck tumors accounted for 71% of the patients with positive margins.

On our retrospective review, it appears that the finding of positive margins was an indication for more aggressive treatment. Adjuvant radiotherapy was given to 100% of patient with positive margins, compared to 69% of patients with negative margins. Additionally, chemotherapy was given to 57% of patients with positive margins compared to 25% of patients with negative margins.

Conclusions: In this series of patients with Merkel Cell Carcinoma treated with curative intent, positive margins were an independent predictor of poor survival. Despite more aggressive therapy, results were still poor. This underscores the importance of achieving negative surgical margins.

IL-17 Promotes the Induction of Antitumor Effector T-Cells

Martin Egenti, MD, Alfred E. Chang, MD
University of Michigan

Enhanced solid tumor growth and metastasis have been observed in IL-17 knockout mice when compared with wild-type mice. However, there are still controversies with regards to the dual roles of Th17 cells and the IL-17 they produce in both tumor promotion and elimination and how these are achieved.

The purpose of this experiment is to demonstrate that IL-17 promotes the induction of antitumor effector T-cells.

We isolated tumor draining lymph nodes (TDLN) cells from both wild-types (WT) and IL-17 knockout (KO) mice bearing D5 melanoma and MCA sarcoma. The TDLN cells were then activated with CD3/CD28 monoclonal Antibody and IL-2. We then added exogenous IL-17 to the TDLN cell cultures from both WT and KO mice. Flow cytometry and intracellular staining was used to detect the number of activated CD8+ and CD4+ T-cells that produce the effector cytokines IFN- γ and TNF- α . Programmed Death 1(PD-1), a marker of T-cell anergy was also measured using extracellular staining and flow cytometry. We also measured the amount of IL-10, a suppressive cytokine, in the TDLN cells supernatants using ELISA.

After activation, IFN- γ and TNF- α producing CD8+ and CD4+ effector T-cells were significantly higher in the WT vs. KO TDLN cells. By contrast, PD-1 producing CD8+ and CD4+ T-cells were higher in the IL-17 KO vs. WT TDLN cells. Also, the amount of IL-10 produced by TDLN cells from IL-17 KO mice was significantly higher than WT mice. We also found a dose dependent increase in the amount of IFN- γ and TNF- α produced after the addition of recombinant IL-17 to both the WT and KO TDLN cells.

IL-17 promotes the induction of IFN- γ and TNF- α producing CD8+ and CD4+ antitumor effector T-cells.

**The Initial Experience of a Single Surgeon with Sentinel Lymph Node Biopsy in Melanoma:
Assessment of Accuracy, Morbidity, and Patterns of Failure in False Negative Patients**

Philip A. Fong, MD; Richard Keidan, MD FACS

Oakland University William Beaumont School of Medicine

A: Published guidelines for sentinel lymph node biopsy (SLNB) for melanoma propose that a surgeon be proctored on a minimum of 30 cases in order to surmount the associated learning curve and insure diagnostic accuracy. We propose that SLNB can be performed safely with appropriate accuracy in the surgeon's initial experience and that false negative results may be due to patient factors rather than operator learning curve.

B: A retrospective chart review of the first 98 melanoma patients undergoing sentinel lymph node biopsy was performed for tumor depths 0.76mm or greater by a single surgeon (RK). All patients received preoperative lymphoscintigraphy in the nuclear medicine department prior to SLNB biopsy. Methylene blue dye was used to provide visual confirmation of sentinel nodes. The ability for the surgeon to identify a sentinel lymph node(s), surgical morbidity, and factors contributing to a false negative were analyzed.

C: Ninety eight patients underwent lymphatic mapping. Three patients did not map out a SLN and a biopsy was not attempted. The ninety five patients that were included for analysis had a sentinel node that was revealed by lymphoscintigraphy and had SLNB performed. Intraoperative identification and SLN retrieval was successful in all Ninety five cases. Postoperative morbidity occurred in fourteen patients (14%), with seven (7%) developing seromas and two (2%) developing lymphedema. Four patients with negative SLNB developed regional recurrence in that nodal basin and were therefore classified as false negative SLNB. Of these, two patients had synchronous malignancies in the same basin (one with inflammatory breast cancer and one with multiple myeloma). The other two patients had a previous wide excision of the primary tumor, potentially altering lymphatic drainage. Three of the four false negative patients had primary tumors located in the head and neck.

D: For patients with an identifiable SLN by pre-operative lymphoscintigraphy, SLN operative identification and retrieval was 100% successful in this consecutive series. Morbidity and false negative rates were low and on par with published standards. Given that these 95 patients comprised a single surgeon's initial clinical experience with SLNB for melanoma, we did not identify a learning curve. Factors associated with false negative SLNB include the presence of synchronous malignancies involving the SLN basin, prior wide excisions, and the head and neck primary site.

Raman Spectroscopy for the Diagnosis of Lung Cancer: Preliminary Findings

Brian Lace MD^{1,4}, Rachel Kast PhD^{3,4}, Sally M Yurgelevic MS^{3,4}, Alexandria G Dulchavsky^{1,4},

Scott Dulchavsky MD/PhD^{1,4}, Madhu Prasad MD^{1,4}, Gregory W Auner PhD^{3,4}, Michael Simoff MD^{1,4}

¹Henry Ford Hospital; ³Smart Sensors and Integrated Microsystems, Wayne State University; ⁴Henry Ford Innovation Institute

Raman Spectroscopy is a technique that measures the scattering of light as a means for identifying the molecular fingerprint of materials. Its primary use has been in the field of material sciences to identify the molecular properties of specific materials. Extensive research is currently being undertaken to utilize this technology for characterization of biological tissues. Lung cancer is the most common cause of cancer related death, for both men and women, in the world. Currently, tissues samples are required for the histologic diagnosis of lung cancer. Raman spectroscopy provides a method to aid in establishing an “optical biopsy” for the diagnosis of cancer. The purpose of this study is to differentiate between normal and malignant lung tissues using near-infrared Raman spectroscopy.

Tissue samples were acquired from the Tissue Procurement Facility of the Josephine Ford Cancer Center and the Department of Pathology of the Henry Ford Health System. For this preliminary study, 38 samples from 19 different patients were tested (one tumor and one normal sample from each patient). Pathologic diagnoses of these samples include adenocarcinoma, squamous cell carcinoma or metastatic lesion.

Prior to measurement, samples were removed from a -80° C freezer and defrosted for 15 minutes. When possible, a portion of each sample was saved for future testing. Sample measurements consisted of 8 accumulations of 20 seconds each measured at 50x magnification and 785 nm excitation wavelength. Data collection lasted approximately 3 hours per sample, resulting in 12-16 measured spectra per sample. Following measurement, spectra with high tissue fluorescence were excluded.

Data was preprocessed using a spike elimination algorithm, and each Raman spectrum was vector normalized to the range 1440-1460 cm^{-1} . Data was then exported to SPSS, where principal component analysis was used to reduce the dimensionality of the dataset. Finally, the principal components were input to discriminant function analysis for classification using leave-one-out validation.

Examination of the resulting Raman spectra showed distinct differences between normal and tumor spectra, especially in the 1200-1300 and 1500-1650 cm^{-1} ranges. After processing the data, normal and tumor spectra could be distinguished with 86.4% sensitivity and 91.5% specificity.

The primary outcome of this research is to develop a comprehensive diagnostic tool using a database of Raman signatures for all lung specimens available in the tumor bank. This database will be used to develop a portable surgical tool for real-time in-vivo diagnosis.

Receptor Changes in Metachronous Breast Tumors - Our Experience of 10 years

Amruta Unawane MD, Jasneet Singh Bhullar MD, Gokulakrishna Subhas MD,

Hussein Poonawala, Vijay K. Mittal MD FACS

Providence Hospital and Medical Centers

All patients with breast cancer are at risk for synchronous and metachronous tumors. We explored the pattern of hormone receptor expression and conversion into metachronous tumors to establish a relationship between the two.

We reviewed charts of 108 women diagnosed and treated for primary breast cancer presenting with metachronous cancer over past 10 years. The significant factors analyzed were age, grade, size, location and mean duration of detection of metachronous tumors. Profile patterns of Estrogen Receptor (ER), Progesterone Receptor (PR) and Her2/neu receptors were explored.

We observed the mean age at diagnosis was 59.4 years and subsequent second primary was within 2.2 years. Of 33 patients with ER⁺/PR⁺ primary tumor, 23 (68%) retained the status in the metachronous tumor. Of the 49 patients with ER⁻/PR⁻ primary tumor, 45 (92%) retained receptor status subsequently. 15 from 21 (71%) patients with ER⁺/PR⁻ primary tumors, retained status and highest concordance, 92% (65/70), was seen with PR⁻ primary tumors. Unusually ER⁺/PR⁺ combination did not exist in either the primary nor metachronous tumor group. Most Her2⁻ tumors (22/30, 70%) remained negative, but 50% (8/16) of Her 2⁺ (Grade 3) tumors became negative (Grade 0). Radiation as well as chemotherapy was not strongly associated with receptor changes.

To conclude, most metachronous tumors retained the ER/PR patterns of the primary tumor. PR negativity is strongly associated with development of metachronous tumors. Half of primary tumor Her2 expression was lost in metachronous tumors, most probably due to Herceptin therapy. Metachronous tumors are least likely to have the ER⁻/PR⁺ phenotype.

Utilization of Ambulatory ECMO as a Bridge to Lung Transplant Promotes Early Physical Therapy and Reduces Duration of Mechanical Ventilation

Muhammad Faraz Masood, MD, Jules Lin, MD
University of Michigan

Severe respiratory failure needing prolonged mechanical ventilation in patients awaiting lung transplant is associated with higher morbidity and mortality. Venovenous Extra Corporeal Membrane Oxygenation (ECMO) was used as a bridge to lung transplant. Using a right internal jugular single dual-lumen cannula, patients were able to be extubated, and to participate in physical therapy (PT) while awaiting lung transplantation. We retrospectively analyzed our data from 3 consecutive patients. The etiology of the end stage pulmonary disease was idiopathic pulmonary fibrosis (IPF) in all three patients. The average age of the patients was 52.2 (41-62) years. All three were males, and developed acute exacerbation of their IPF (AE-IPF). They were intubated at a mean of 1.6 (0.01-3) days after presentation and placed on ECMO at a mean of 6 (3-8) days after intubation. Total time on ECMO was an average of 8.6 (8-11) days. One patient developed pre-operative ventilator associated pneumonia. All patients were decannulated within 24 hours of lung transplant. The most common mode of physical therapy, while on ECMO included ambulation (2) and bed side biking (1). All patients were discharged home with a mean ICU and hospital LOS of 22.3 (9-44) and 36.6 (30-44) days respectively. Thirty-day mortality rate was zero. One patient died 7 months after transplantation from complications of a severe cytomegalovirus infection. Two patients are currently 30 and 8 weeks post lung transplantation and are doing well. Utilization of ambulatory ECMO as a bridge to lung transplant allows extubation and pre transplant physical therapy preventing further deconditioning and will hopefully lead to improved lung transplant outcomes in patients with hypoxemic respiratory failure due to AE-IPF.

Single Versus Double Chest Tube Drainage after Thoracotomy for Lobectomy

Christopher P. Gayer, Frank A. Baciewicz

Wayne State University, Detroit Medical Center, and Karmanos Cancer Institute

Purpose: After pulmonary lobectomy, traditional teaching involves placing two chest tubes on the operative side: one straight tube placed at the apex for evacuation of air and one curved tube placed on the diaphragm for fluid drainage. This study investigates whether one apical chest tube is as effective as two chest tubes after pulmonary lobectomy.

Methods: Between July 2008 and November 2009, 40 consecutive patients with lung cancer underwent thoracotomy and lobectomy. The initial 20 patients had placement of two chest tubes (straight apical #32 French and curved diaphragmatic #28 French) while the latter 20 patients had placement of a single straight apical #32 French chest tube. All 40 patients had epidural catheters placed for 72 hours after surgery for pain control. We compared patient demographics, lobe resected, pathology, total hospital days, total chest tube days, total chest tube drainage, days to oral pain control, and pain as assessed by the visual analog pain scale (VAS).

Results: The groups were similar in demographics, comorbidities, pulmonary function tests, and lobe resected as well as pathology. Length of stay (7.8 ± 0.8 vs. 7.9 ± 0.7), total chest tube days (5.9 ± 0.5 vs. 6.9 ± 0.6) and daily amount of chest tube drainage in milliliters (1971 ± 170 vs. 2201 ± 231) were less in the single tube group; however, they did not achieve significance. Similarly, post-operative prolonged airleak (greater than 7 days) and residual airspace after tube removal ($>10\%$ residual pneumothorax visualized on chest X-ray) were not significantly different in the two groups but were less in the single tube group (2.2 ± 0.7 vs. 2.9 ± 0.7 days and 1 vs. 3 patients, respectively). While the total days from operation to oral pain control was similar in the single and double chest tube groups, postoperative pain as assessed by the VAS pain scale was lower in the single tube group each of the first four postoperative days (POD) with the difference achieving significance on postoperative days 3 and 4.

	Single tube	Double tube	p value
Days to oral pain control	3.9 ± 0.3	4.4 ± 0.2	0.164
VAS score: POD 1	6.2 ± 0.6	7.0 ± 0.6	0.400
VAS score: POD 2	5.4 ± 0.7	6.7 ± 0.4	0.112
VAS score: POD 3	3.6 ± 0.5	5.9 ± 0.5	0.009
VAS score: POD 4	3.2 ± 0.6	5.4 ± 0.6	0.013

Conclusion: Single apical chest tube drainage after thoracotomy for lobectomy is as effective as apical and diaphragmatic double tube drainage. Single tube drainage improves patient's postoperative comfort and may result in less chest tube drainage, fewer chest tube days, and a shorter hospital stay.

Impact of Acute Renal Failure on Survival After LVAD HM II Implantation

Jamil Borgi, MD, Robert J. Brewer, MD, Hassan W. Nemeah, MD, Scott E. Henry, MD, Barbara Czerska, MD, Celeste T. Williams, MD, David E. Lanfear, MD, Cristina Tita, MD, Conrad Drost, RN, Cheryl Smith, BSN, Josh Chernich, RN, Hani N. Sabbah, MD, Gaetano Paone, MD, Jeffrey A. Morgan, MD
Henry Ford Health System, Detroit, MI

Purpose: Acute renal failure (ARF) is a known complication after left ventricular assist device (LVAD) implantation. We sought to evaluate the effect of postoperative ARF on survival in patients with chronic heart failure undergoing HeartMate II (HM II) LVAD implantation.

Methods and Materials: Between March 2006 and June 2009, 41 patients with chronic heart failure underwent implantation of a HeartMate II LVAD at our center. Patients who developed postoperative ARF (n=15), as defined by the RIFLE criteria, were compared to patients who did not develop ARF (n=26) for pre-LVAD clinical characteristics, intraoperative parameters, and Kaplan Meier survival. Multivariate Cox Regression Analysis was also performed to assess whether postoperative ARF independently affected survival.

Results: Mean was 53.7 ± 11.5 years for the ARF group and 51.0 ± 12.2 years for the non-ARF group ($p=0.502$). There was no significant difference in gender or race distribution, preoperative incidence of diabetes, hypertension, chronic renal insufficiency, chronic obstructive pulmonary disease, peripheral vascular disease, or reoperations between the groups ($p=NS$). There was a higher percentage of patients with nonischemic dilated cardiomyopathy in the ARF group (86.7% vs. 53.8%, $p=0.004$). Cardiopulmonary bypass (CPB) times were 119.1 ± 36.7 for the ARF group and 75.7 ± 34.1 for the non-ARF group ($p=0.029$). Mean support time was 155.5 days (2-455) for the ARF group and 303.5 days (101–1,016) for the non-ARF group ($p=0.006$). Survival was significantly decreased in the ARF group at 30 days (80.0% vs. 100%), 180 days (65.2% vs. 100%), 1 year (65.2% vs. 100%), and 3 years (48.0% vs. 65.5%, $p<0.001$). For the subgroup of ARF patients requiring hemodialysis (n=5), survival was decreased more substantially, with 60.0% survival at 30 days, 40.0% survival at 180 days, and 0% survival at 1 year ($p<0.001$) [Figure]. Postoperative intensive care unit and overall hospital stays were significantly longer for ARF patients (15.7 ± 12.2 vs. 7.3 ± 4.5 and 27.0 ± 20.9 vs. 19.8 ± 7.5 , respectively, $p=0.013$). In a multivariate Cox Regression Analysis, postoperative ARF was an independent risk factor for mortality (OR 2.3338, 95% CI 1.081-5.056, $p=0.021$).

Conclusions: Acute renal failure after LVAD implantation adversely affected short and long-term survival. Predictors of ARF included nonischemic dilated cardiomyopathy and prolonged CPB times. Establishment of a mathematical model to preoperatively predict the risk of this complication may serve to improve patient selection and postoperative outcomes as well as reduce the associated cost of LVAD implantation.

Staphylococcus Aureus Identification and Antibiotic Resistance Determination Using Raman Spectroscopy

Amy R. Spencer, MD, Michael D. Klein, MD
Wayne State University/Detroit Medical Center

Our objective was to develop a new method to quickly and accurately detect the presence of Staphylococcus Aureus (*S. Aureus*), as well as its antibiotic susceptibility.

We applied Raman Spectroscopy, using near infrared light, to samples of *S. Aureus* to obtain spectral patterns. One hundred-twenty spectra were obtained from 4 different strains of *S. Aureus* – 2 sensitive to methicillin (MSSA), 1 resistant to methicillin (MRSA), and 1 strain of MRSA with reduced susceptibility to vancomycin (RVS-MRSA). The spectra were pre-processed using BacLearner software, and analyzed with SPSS[®] Statistics 19.

Raman Spectroscopy correctly classified specimens as MRSA vs. MSSA with 90.2% accuracy (sensitivity of 96%, specificity of 85%). RVS-MRSA was correctly classified with 96.3% accuracy when compared against MRSA (sensitivity of 100% and specificity of 93%), and 96.5% accuracy when compared with MSSA (sensitivity of 100%, specificity of 94.8%). Test-train analysis was performed to train the SPSS[®] program to classify new spectra according to a pre-formed model, with 98% accuracy for distinguishing MRSA from MSSA, 98% accuracy for distinguishing RVS-MRSA from MRSA, and 95% accuracy for distinguishing RVS-MRSA from all other *S. Aureus* samples.

In conclusion, Raman Spectroscopy is a quick and reliable method of identifying MSSA and MRSA in a sample. Furthermore, it can quickly determine the level of antibiotic resistance of MRSA to help guide antibiotic treatment plans. This method can have broad applicability for fast and easy detection and treatment of bacterial infections in the hospital, outpatient, and office settings.

Clinicopathological Significance of Expression of Estrogen Receptor-Beta (Er β), Progesterone Receptor(Pr) and Vascular Endothelial Growth Factor-A (Vegf-A) In Colorectal Cancer

Deepa Taggarshie MD MRCS M Phil, Vijay K Mittal MD FACS
Providence Hospital and Medical Centers

Background: Estrogen-receptor-beta (ER β), Progesterone-receptor (PR) and Vascular- endothelial-growth-factor-A have been implicated to have a role in colorectal cancer. The expression of these markers and the clinicopathological significance of the same remain unclear.

Purpose: The purpose of this study was to determine the expression of these biological markers: ER β , PR and VEGF-A in colorectal cancer cells and their prognostic significance.

Methods: An immunohistochemical assay of ER β , PR and VEGF-A was performed in 72 patients with colonic adenocarcinoma. Normal colonic tissue from the same cases was assessed as a control. The correlation of the presence of these markers with other clinicopathological features as well as survival was then determined.

Results: None of the cases showed expression of ER β or PR by the malignant cells of the tumor. Whereas, in two of the cases, ER β was detected in the normal colonic mucosa. VEGF-A was expressed strongly in the malignant colonic cells in 64 cases, in comparison with 10 cases of normal colonic mucosa. VEGF- A expression was observed in 37/40(92%) patients with colorectal cancer metastatic to nodes or distant organs, whereas 24/27 (88.8%) patients with disease limited to the colon expressed the factor. Strong VEGF-A expression did not correlate with tumor grade, angiolymphatic-involvement, stage, disease-free and overall survival. 23/26(88.4%) patients with recurrence had strong VEGF-A expression, whereas 41/47(87.2%) patients with no recurrence had strong VEGF-A expression.

Conclusions: Colorectal cancers do not express ER β or PR. Absence of ER β expression by normal mucosa contests the previous reports of a protective effect of ER β with decreased levels associated with colorectal tumorigenesis in females. VEGF-A expression in colorectal cancer compared to normal mucosa indicates that it may have a role in tumorigenesis. However VEGF-A expression cannot be used as a prognostic marker.

Increased PAI-1 in Females Compared To Males Is Protective For Abdominal Aortic Aneurysm Formation in a Rodent Model

Paul D. DiMusto, MD and Thomas W. Wakefield, MD
University of Michigan

Abdominal aortic aneurysm (AAA) is a disease that affects men four times as often as women. Earlier studies have documented over-expression of PAI-1 to be protective in males for AAA development in a rodent model. Therefore we sought to determine if a difference in PAI-1 may be partially responsible for the gender difference observed in AAAs.

Male and female wild type (WT) C57/B6 and female PAI-1 $-/-$ mice 8-12 weeks of age underwent aortic perfusion with pancreatic elastase (0.4 units/mL) for 5 minutes (N=10-12 each group). Aortic diameter was measured prior to perfusion and at harvest using video microscopy. Aortas were harvested on day 1 for mRNA analysis, and day 14 for phenotype, western blot, immunohistochemistry, and zymography for matrix metalloproteinase (MMP) activity. Serum was collected at baseline and day 14, and analyzed for plasmin by ELISA. Comparisons between groups were made using a t-test.

WT male animals had an average increase in aortic diameter at 14 days of 80%, while females only increased 32% ($p < 0.001$). PAI-1 $-/-$ females had an average 212% increase in aortic diameter, significantly more than WT females ($p < 0.001$). Higher PAI-1 gene expression in WT females compared to males was observed ($p = 0.0257$). Western blot at day 14 revealed 61% higher PAI-1 protein levels in the females compared to the males ($p = 0.0098$). Immunohistochemistry for macrophages revealed 46x less macrophages in the WT female compared to the WT male ($p = 0.017$) and 50x less macrophages in the WT female compared to the PAI-1 $-/-$ female.

Zymography revealed less proMMP 9 ($p = 0.034$), proMMP2 ($p = 0.0009$) and active MMP2 ($p = 0.0112$) in the WT females compared to WT males. There were higher levels of proMMP9 ($p = 0.025$), proMMP2 ($p = 0.0144$) and active MMP2 ($p = 0.0060$) in the PAI-1 $-/-$ females compared to the WT females. There was no difference in serum plasmin levels at baseline between the WT females and PAI-1 $-/-$ females. However, PAI-1 $-/-$ females had significantly higher serum plasmin levels at day 14 compared to WT females ($p = 0.0027$).

Wild type female mice are protected from aneurysm formation in the elastase model, recapitulating the human phenotype. Female elastase perfused mice have higher levels of PAI-1 compared to males both early and late during aneurysm formation. This correlates with decreased levels of MMP 9 and 2 in the female. PAI-1 $-/-$ females develop significantly larger aneurysms than WT females, which correlates with higher MMP 9 and 2 levels in PAI-1 $-/-$ animals. These findings demonstrate that PAI-1 is protective for aneurysm formation in the elastase model, and may be partially responsible for the gender difference seen in humans.

A Simplified Frailty Index to Predict Postoperative Adverse Outcomes and Mortality in Vascular Surgery Patients

Joseph Karam MD, Ilan Rubinfeld MD MBA
Henry Ford Hospital

A: Quality improvement and outcome analysis has become a crucial part of today's practice of Surgery. The population of vascular surgery patients would particularly benefit from accurate outcome prediction given the typical presence of multiple co-morbidities and potentially high physiologic stress procedures. Frailty has been established as an important predictor of healthcare outcomes. We sought to investigate the frailty index as an predictor of mortality and adverse occurrences in vascular surgery patients..

B: Under the Data Use Agreement of the American College of Surgeons, and with IRB approval, the National Surgical Quality Improvement Program (NSQIP) Participant Utilization File was accessed for the years 2005-2008 for inpatient vascular surgery patients. Using the "Canadian Study of Health and Aging" Frailty Index (FI), 11 variables were matched to the NSQIP database. Increase in FI implies increase in frailty. The outcomes assessed were mortality, wound infection and any occurrence. We then compared the effect of FI, age, Functional status, Relative value units (RVU), American Society of Anesthesiology (ASA) score and wound status on mortality. Statistical analysis was done using chi-square analysis and stepwise logistic regression.

C: 67308 patients were identified in the database, 3913 wound occurrences, 6691 infections, 12847 occurrences of all kinds, and 2800 deaths. As the FI increased, postoperative wound infection, all occurrences and mortality increased ($P < 0.001$) (Table 1). Stepwise logistic regression using the FI, with NSQIP variables of age, work RVU, ASA class, wound classification, emergency status and functional status showed FI to have the highest odds ratio (OR) for mortality (OR 2.058, $p < 0.001$).

D: A simplified Frailty index can be obtained by easily identifiable patient characteristics allowing for accurate prediction of post-operative morbidity and mortality in the vascular surgery population.

Does Implementing a Preoperative Checklist Improve Surgical Outcomes?

Amanda McClure, MD, Ashraf Mansour, MD, Jeff Kirk, MD, Christopher Chambers, MD, PhD, Robert Cuff, MD
Grand Rapids Medical Education Partners, Michigan State University

Background: Recent trials have demonstrated that implementing the preoperative World Health Organization checklist in the operating room reduces errors. In response to higher than expected rates of surgical site infection (SSI) and deep venous thrombosis (DVT), our hospital implemented a modified checklist aimed at timely preoperative antibiotic administration and appropriate DVT prophylaxis.

Purpose: To review the outcomes of elective general and vascular surgical procedures in our hospital after implementing a modified surgical checklist.

Methods: Our hospital participates in the National Surgical Quality Improvement Program (NSQIP). The NSQIP collects data from 239 hospitals nationwide. A certified surgical clinical nurse reviewer from each site enters data on surgical patients during an 8-day cycle. A total of 135 variables are captured, including preoperative, intraoperative and 30-day postoperative datapoints. Site specific reports are generated to compare 30-day mortality and complications. Risk adjustment generates an observed versus expected (O/E) ratio for each center and identifies the best and worst performers.

Results: From January 2006 to July 2009, 5,799 general and vascular surgery cases were entered in the database, compared to 694,934 from other hospitals in the program. During that time, there were 209 (3.6%) SSI, 59 (1.0%) DVT and 16 (0.3%) pulmonary embolisms (PE). After implementing the checklist in July 2009, there 1070 cases entered compared to 187,908 nationwide. There were 26 (2.4%) SSI, 12 (1.1%) DVT and 7 (0.7%) DVT. Internal chart audit prior to July 2009 showed that on-time antibiotic administration was only done in 85% of cases. After checklist implementation, the compliance rate averaged at 97%, resulting in a significant decrease in surgical infections. Despite a higher rate of compliance with DVT prophylaxis measures, the rate of DVT and PE did not change.

Conclusion: The implementation of a surgical checklist can drive a significant change in behavior leading to a measurable lower rate of infections. Despite a better compliance with DVT prophylaxis measures, the rate did not drop significantly. Longer term data are needed to see if these changes are sustainable.

General Anesthesia: An Independent Risk Factor for Myocardial Infarction after Carotid Endarterectomy (CEA)

Stefan W. Leichtle, MD, Walter M. Whitehouse Jr., MD
St. Joseph Mercy Hospital, Ann Arbor

The influence of anesthesia type on perioperative complications in CEA is controversial. The purpose of this study was to investigate if general (GA) or regional (RA) anesthesia is an independent risk factor for cardiovascular complications or death using the American College of Surgeons' NSQIP database.

All patients undergoing elective primary CEA listed in the NSQIP database were assessed for postoperative complications. The independent contribution of GA or RA to the risk of postoperative MI, stroke and death was assessed, using a multivariate model and stratifying on propensity score with 49 covariates.

Inclusion criteria were met by 26,069 cases. CEA was performed under GA in 22,053 cases (85%) and under RA in 4,016 cases (15%). The incidence (%) of postoperative complications (POC) in GA and RA as well as the odds ratios (OR) with confidence intervals (CI) for POC in GA are shown in Table 1.

	Incidence		OR (95% CI)	P
	GA	RA		
<i>MI</i>	0.6 0	0.2 7	2.2 (1.2- 4.1)	0.0 1
<i>Stroke</i>	1.6 0	1.6 3	1.1 (0.8- 1.4)	0.7 1
<i>Death</i>	0.7 0	0.6 7	0.9 (0.7- 1.5)	0.9 7

Table 1: Incidence of and odds for POC

General anesthesia for CEA was found to be an independent risk factor for postoperative MI, a finding of particular importance considering recent comparisons of CEA to carotid artery stenting.

The Relationship Between Intensity of Limb Salvage Care and Amputation Rates Among Medicare Beneficiaries

Kerianne H. Holman, John D. Birkmeyer
University of Michigan

The intensity of limb salvage care provided to patients with at-risk limbs varies across the United States. Our goal was to determine whether higher-intensity limb salvage care correlates with lower amputation rates at a regional level.

Using inpatient Medicare data for years 2003-2006, we measured the frequency and number of revascularizations performed prior to amputation among amputees, as an indicator of the intensity of limb salvage care provided regionally. Multiple linear regression was used to calculate risk-adjusted amputation rates for each hospital referral region (HRR) in 2006, adjusting for the underlying demographics of that region's Medicare population. Pearson's correlation test was used to determine the relationship between regional intensity of limb salvage care and amputation rates.

Averaging across all HRRs in 2006, the average age of Medicare beneficiaries per HRR was 75.3 years (SD \pm 0.5 years); the average proportion of females per HRR was 57.7% (SD \pm 1.7%); the average proportion of blacks per HRR was 7.3% (SD \pm 8.7%); and the average socioeconomic status (SES) per HRR was 1.8 on a scale of 1 to 3 (SD \pm 0.4, with 1 = low SES and 3 = high SES). In our univariate analysis of limb salvage care, lower amputation rates were found in HRRs in which a greater proportion of amputees underwent at least one revascularization prior to amputation (R = -0.42, $p < 0.0001$); in which a greater number of open revascularizations were performed prior to amputation (R = -0.41, $p < 0.0001$); and in which a greater number of endovascular revascularizations were performed prior to amputation (R = -0.17, $p = 0.0038$). In our multivariable analysis, all three measures of limb salvage care remained significantly correlated with lower amputation rates.

More aggressive attempts at revascularization prior to amputation correlate with lower amputation rates at the HRR level. Open revascularizations are more strongly correlated with lower amputation rates than endovascular revascularizations. Further studies are necessary to determine whether these correlations indicate causality.

Patency of Sutureless Venous Anastomosis in Hybrid AV Grafts: Comparison to Traditional Anastomosis

Colin Brandt, MD; Elango Edhayan, MD, FACS
St. John Hospital and Medical Center

Approximately 300,000 Americans are currently receiving hemodialysis. While arteriovenous fistulas are the preferred method of dialysis access, arteriovenous grafts (A-V Grafts) are useful in patients with previous failed access attempts or those without adequate native veins. The 6-month patency rate of traditional AV grafts is reported as approximately 65%, with a 1 year patency range of 59-90%. The median patency time of grafts is 10 months. 85% of A-V graft failures are due to thrombosis or occlusion, with a majority due to stenosis at the venous anastomosis. The pathophysiology of this stenosis and subsequent thrombosis is related to neointimal hyperplasia at this site. Trauma from suturing the venous anastomosis has been identified as a predisposing cause for neointimal hyperplasia. A new hybrid sutureless graft has been developed to counteract the issue of venous neointimal hyperplasia and outflow stenosis. Our study evaluated the 6 month patency rates for these grafts. We also studied the complications and causes for occlusion of these grafts.

14 patients had sutureless A-V grafts (Hybrid GORETEX A-V Grafts) placed within the last 6 months. These grafts were deployed via a self expanding delivery system in the Axillary vein without use of sutures. All grafts were placed by a single surgeon. 6 of these patients underwent primary venous angioplasty upon placement. 8 grafts incorporated an axillary artery to axillary vein bypass while 6 were brachial artery to axillary vein. Patient progress was followed at 2 weeks, 4 weeks and 6 months. Demographic data was also collected. A graft was deemed functional with successful use for hemodialysis. Primary graft failure was assigned to grafts that were non-functional secondary to stenosis at the venous anastomosis. All patients with non-functioning grafts underwent radiological evaluation to diagnose the reason for graft failure as well as subsequent intervention to attempt to restore function.

There were 3 graft occlusions during our follow up period. One patient had primary graft failure at 4 weeks secondary to stenosis at the axillary vein anastomosis. A venous stent was placed at the site to restore graft function.

Two graft failures were seen in patients on Coumadin. Both had bleeding after successful hemodialysis, leading to hematoma formation and excessive compression at the graft site. Fistulogram showed no venous stenosis and thrombolysis restored graft function.

Two patients presented post operatively with vascular steal syndrome. Both underwent open banding at the arterial anastomosis. The complication was resolved and function of the graft was preserved.

Our 6 month primary patency rates for sutureless hybrid vascular grafts was 93% compared to a reported 6 month patency rates of 65% with traditional anastomosis. Our early data suggests that this is a viable and potentially superior option for A-V grafts compared to the current standard technique.

Endovascular Abdominal Aortic Aneurysm Repair: Community Hospital Experience

1. Manish Khare, MD, 2. Thomas M Siegel, MD

1. Department of Surgery, Wayne State University, 2. Oakwood Hospital

Hypothesis: To demonstrate that results similar to high-volume academic centers can be achieved in the community setting when treating abdominal aortic aneurysm (AAA) using endovascular techniques, given appropriate volume and skill sets.

Design: A retrospective review of medical records was performed for the patients operated on from January, 2001 to August, 2010.

Setting: Oakwood Hospital, Dearborn, MI

Patients: Total 97 endovascular abdominal aneurysm repair were performed. 72 were men and 25 were women.

Interventions: 93 patients underwent elective endovascular repair for unruptured AAA and 4 patients had ruptured AAA, which subsequently underwent successful endovascular repair. There were no conversions to open repair during or after endovascular repair.

Main outcome measures: We analyzed intraoperative, early & late postoperative outcomes.

Results: Most patients were between 60 and 80 years of age. The youngest patient was 48 year old and oldest was 93 year old. The aneurysm size range was 5.0 to 9 cm.

15 patients had associated iliac, femoral and popliteal aneurysms, which are either observed or treated during/ after endovascular repair. One patient also had descending aortic aneurysm, which was observed due to small size. 8 patients had type I leak and were treated during the same operation with relining graft. 20 patients had type II leak, 19 were observed and 1 treated with embolization later. 2 patients developed type III leak, which are treated with relining graft 5 & 7 months after the endovascular repair. No graft migration is found in any patient. 6 patients developed acute right lower extremity ischemia on immediate postoperative period, all of them taken to operation room to perform endarterectomy/ thrombectomy with femoral patch angioplasty or bypass graft in the limb. Limb could not be salvaged in one of these patients, who subsequently underwent above knee amputation and later died of sepsis & renal failure.

2 patients developed groin wound infection, improved with conservative treatment.

2 patients developed ischemic colitis, one patient underwent sigmoid colectomy & other treated with observation, both got better.

Follow-up:

Follow-up is 6 month to 8 years (most patients fall between 2-5 years of follow-up) CT angiogram is the main tool for checking endoleak and graft migration. 73 patients had CT angiogram and 6 patients had retroperitoneal ultrasound (due to non contrast related renal failure). 9 patients did not have any follow-up at all. 7 patients died within 6 months from natural causes. 2 patients died immediate post op (Rupture AAA & acute limb ischemia/ amputation/sepsis)

Conclusion: Endovascular aneurysm repair in the community setting is a safe and durable procedure, even in a medically high-risk population. Comparable outcomes can be achieved to tertiary care centers, in carefully selected patients with favorable anatomy.

Lack of Emergency Room and Primary Care Genitourinary Physical Examination Before Urologic Consultation – A Quality of Care Issue

Adam W Ylitalo, DO; James Tyburski, MD, FACS
Detroit Medical Center

A well-performed physical exam along with solid history-taking is the foundation of medical evaluation. Many urological diagnoses may be obtained from this information alone; however, the genitourinary physical exam (GU-PE) is often poorly executed or missing altogether during an initial patient evaluation by primary hospital and emergency department (ED) teams. The purpose of this investigation was to report the frequency of the GU-PE performed during initial patient evaluations, and to determine if this frequency differed by patient characteristics such as age or gender.

For six weeks between July and August 2010, 420 consecutive patients evaluated by the urology consultation service at six hospitals specializing in pediatric and adult services in a large metropolitan area had medical charts reviewed retrospectively by a single reviewer (AWY). The frequency of a GU-PE performed by the ED or primary hospital team was recorded and analyzed.

Of the 420 patients ranging in age from 1 day to 95 years requiring a urological consultation, 63 were excluded due to lack of documentation. Of the remaining patients, 88/324 (27.2%; $p < 0.0001$) had a GU-PE performed by the ED and 98/319 (30.7%; $p < 0.0001$) had a GU-PE performed by the primary hospital team prior to urological consultation. The ED was six times more likely to perform a GU exam on a male compared to a female (OR=6.276; 95% CI: 2.898, 13.590; p -value <0.0001) such that males had a 36% chance of exam while females had an 8% chance of exam. The primary team was not significantly more likely to perform a GU-PE on a male compared to a female (OR=1.656; 95% CI: 0.974, 2.816; p -value=0.0623). Age was a significant determinant of GU-PE for either evaluation team (OR=0.985; 95% CI: 0.975, 0.995; p -value=0.026) with younger patients more likely to receive an exam; for example, 10 year olds had a 60% probability of exam while 80 year olds had a 34% probability of exam.

A GU-PE is an important diagnostic tool to identify pathology. The results of our study indicate that exams are performed less than a third of the time prior to obtaining urological consultation. Frequency of GU-PE differed by patient characteristics such as age and gender. The low rate of pre-consultation examination creates concern for quality of care, correctness of billing by the primary team (since they are missing a portion of the “directed” exam), and unnecessary urological consultations. Further evaluation of the scope and impact of this effect may have implications for quality and cost of medical care.

Ghrelin Mediates Development of Glucose Intolerance Induced by mTOR Inhibition

Danielle Fritze, MD and Michael Mulholland, MD PhD
University of Michigan

Ghrelin is a 28-amino acid peptide hormone which stimulates initiation of food intake and aids in the regulation of glucose metabolism. Mammalian target of rapamycin (mTOR) is an intracellular energy sensor. The TOR signaling pathway has been implicated as an important factor influencing ghrelin production. Rapamycin, an mTOR inhibitor used for immunosuppression, also frequently causes hyperglycemia and diabetes in patients treated chronically. This study explores the mechanism by which mTOR inhibition leads to hyperglycemia, specifically focusing on the roles of ghrelin and the ghrelin receptor.

Studies were conducted using mice fed either normal chow or high fat chow to induce obesity. Inhibition of mTOR signaling was accomplished with daily administration of intra-peritoneal rapamycin (1mg/kg). Insulin and glucose tolerance tests were conducted to characterize the resultant alterations in glucose homeostasis. Serum acyl-ghrelin and insulin levels were determined via radioimmunoassay. To assess insulin signaling, mouse skeletal muscle was harvested following systemic administration of insulin. Within these samples, phosphorylated AKT (pAKT: a downstream product of insulin signaling) levels were evaluated by western blotting. Immunohistochemistry was used for determination of glucose transporter (GLUT4) translocation. To study the role of ghrelin in the development of hyperglycemia induced by mTOR inhibition, parallel experiments were conducted using wild type mice, ghrelin receptor knock-out mice and wild-type mice receiving intra-peritoneal injections of the ghrelin-receptor antagonist [D-Lys3]-GHRP-6 (10umol/kg).

In normal and obese mice, inhibition of mTOR signaling by rapamycin was associated with glucose intolerance and insulin resistance. These changes were significantly correlated with elevated levels of plasma acyl-ghrelin (139pg/ml in rapamycin-treated normal mice vs. 91pg/ml in controls, $p < 0.05$). Blockade of the action of ghrelin by a ghrelin receptor antagonist or ghrelin receptor gene deletion attenuated the effects of mTOR inhibition on glucose homeostasis. There was no difference in insulin levels between rapamycin-treated mice and controls. Insulin signaling, however, was suppressed by mTOR inhibition. Rapamycin-treated mice had lower levels of skeletal muscle pAKT. This difference was abolished in ghrelin receptor gene deletion mice and those treated with ghrelin receptor antagonists. Membrane translocation of GLUT4, a glucose transport protein which facilitates glucose uptake in skeletal muscle and adipocytes, was diminished in rapamycin-treated animals both at baseline and in response to insulin. These effects were also attenuated or abolished by blockade or deletion of the ghrelin receptor.

Inhibition of mTOR causes derangement in glucose homeostasis via suppression of insulin signaling and impairment of GLUT4-mediated glucose uptake in skeletal muscle. Glucose intolerance and insulin resistance are strongly associated with elevated plasma acyl-ghrelin, and also reversed by ghrelin receptor blockade or deletion. Ghrelin is thus implicated as an important mediator in the development of hyperglycemia induced by mTOR inhibition, and a potential therapeutic target in the treatment of diabetes.

Colectomies Returning to the Operating Room: What's That All About?

Reddy, S., Reickert, C., Rubinfeld, I.

Henry Ford Health System

Purpose : Unplanned return to operating room (URR) within 30 days after the initial index procedure is one of the adverse events recorded in National Surgical Outcomes Project (NSQIP) database and used as a quality indicator. We sought to identify perioperative factors and post operative occurrences that were associated with URR in patients undergoing colectomy.

Methods : Under the data use agreement, and with the approval of our IRB, we reviewed perioperative variables of all patients who underwent index colorectal surgery (IS) collected in NSQIP database from 2005 -2008. Odds ratio (OR), Chi square, logistic regression were performed using SPSS 19 (IBM, NY).

Results : Of 45645 colectomies analyzed, with a total of 3643(7.9%) URR. Demographics and associated outcomes are summarized in the attached table. Pre operative wound infection (6.0 OR), pneumonia (6.4OR), dehiscence (18.8OR) and post operative organ space infection (11.4OR) increased likelihood of URR. The association between URR and organ space SSI is increasing progressively from 2006 to 2008(OR- 10.5, 11.2 & 12.6 respectively). Using logistic regression we established the following independent predictors of URR: male gender, smoking hx, serum albumin, steroids use, history of MI & COPD, ASA class (2, 3 and 4), post op-pneumonia, deep SSI, organ space SSI, dehiscence, renal insufficiency, pre operative Ventilation, dialysis, pulmonary embolism, reintubation and prolonged ventilation (P<0.001). Mortality in URR is 7.5% vs 1.3% for non-URR (OR 3.9).

Conclusions : Unplanned return to OR is multifactorial and is related to both, preexisting conditions in the patient and surgical skills particularly in relation to prevention of leaks which is associated with organ space SSI. Identifying modifiable perioperative risk factors in colorectal procedures may improve outcome.

Parathyroidectomies Using IOPM: When Should We Stop Measuring IOPTH levels?

Aditya Gupta, MD; Amruta Unawane, MD; Gokulakrishna Subhas, MD; Barry R Hershman, MD; Sumet Silapaswan, MD; Ramachandra Kolachalam, MD; William Kestenberg, MD; Lorenzo Ferguson, MD; Michael J Jacobs, MD and Vijay K Mittal, MD
Providence Hospitals and Medical Centers

Intraoperative parathormone monitoring (IOPM), in use for the last 15 years now, has facilitated minimally invasive parathyroidectomy. It was introduced in our hospital in January 2007; we undertook this study to determine if a drop in IOPTH levels below 50% of baseline is sufficient to terminate the procedure, or should we wait for the values to normalize.

From January 2007 to Sep 2010, 107 patients underwent parathyroidectomies with IOPM. A retrospective review was done on these 107 patients, who underwent initial parathyroidectomy by general surgeons for primary hyperparathyroidism. Patients were followed up with serum calcium levels ranging from 6-48 months.

Most patients (n=82, 77%) were women, and the age ranged from 19-91 years (mean=59). A drop to more than 50% from the baseline PTH level was noted in the 5-minute sample in 83 (77%) patients, while in 15 (14%) patients the drop occurred in the 10-minute sample. It required 20-minute and 25-minute samples to achieve >50% drop in 4 and 3 patients respectively, while 2 patients had to undergo additional exploration, subsequently registering a significant drop at 40 minutes.

IOPM, though it increased the mean operative time, significantly decreased the number of specimens excised. There was a decrease in removal of normal parathyroid glands, thyroid lobectomies and hospital stays. Moreover, for single gland parathyroid adenomas, once the PTH values dropped to less than 50% in the 5 minute sample, they continued to decrease in the subsequent samples. In 23 cases requiring bilateral exploration, the PTH values had already decreased to >50% in 14 cases but had not normalized (ref range 8-74), leading to additional exploration. However, subsequent pathology analysis showed that the initial gland removed was the adenoma in all these cases, with subsequent resections being either normal parathyroid tissue or of non-parathyroid cytology.

We reach the conclusion that in cases of minimally invasive parathyroidectomy, if the initial 5-minute PTH value decreases to less than 50% of the baseline, it should be sufficient evidence to terminate the procedure. This would translate into significant laboratory and personnel cost savings over time. However, this should also be carefully correlated with pre-operative Ultrasound /Sestamibi Scan findings.

Is Screening Urine Analysis Necessary in all Pediatric Burn Patients?

Kartheek B. Nagappala MD & Christina M. Shanti MD

Children's Hospital of Michigan, Wayne State University/Detroit Medical Center

The use of urine analysis as part of initial laboratory work-up of pediatric burn patients at the time of admission has been a routine practice at our institution. We hypothesize that routine urine analysis in these patients has no impact on length of stay and is also not cost-effective.

A retrospective chart review was conducted on all pediatric burn patients admitted to our institution from 2006 to 2008. Demographics were obtained as well as burn-related data (mechanism of injury, total body surface area [TBSA], length of stay, need for surgical intervention), and urine analysis results. Statistical analysis was performed using SPSS. This study was IRB approved.

A total of 909 patients were analyzed; 134 were excluded for lack of a urine analysis being performed at the time of admission. Of the 775 patients enrolled, 38 were found to have urinary tract infections (UTI) as defined by the Center for Disease Control and Prevention. The majority of these patients were female (87.5%). The most common burn mechanism associated with the diagnosis of UTI was scald burns (47.4%), followed by contact burns (26.3%). Average age of patients enrolled was 4.7 (SD \pm 4.9) years, length of stay was 3.9 (SD \pm 5.9) days, with average TBSA burned being 4.7 (SD \pm 8.6) percent. There was no association between incidence of UTI and percent TBSA affected ($p = 0.30$). Of the 38 patients with a UTI, only 8 were treated (1% of all enrolled). The reasons for not treating included specimens deemed contaminated by the treating physician or a negative repeat UA. Diagnosis of a UTI did not increase length of stay ($p = 0.23$), nor did it negatively impact burn-related clinical improvement. Urinalysis with microscopic exam costs \$36 at our institution. During the study period, a total of \$27,864 was used to perform this test.

Urine analysis as part of the admission work-up for pediatric burn patients is not clinically indicated nor is it cost-effective. It should be reserved for patients whose clinical symptoms warrant further investigation.

Exploring NSQIP Pulmonary Data: How Do Pre-Operative Respiratory Co-Morbidities Impact Post-Operative Respiratory Complications

Arielle Hodari, Subhash Reddy, Ilan Rubinfeld
Henry Ford Hospital

Hypothesis: The purpose of the study is to identify known respiratory-based co-morbidities pre-operatively and determine their impact on respiratory outcomes postoperatively.

Methods: Under the data use agreement and with the approval of our IRB, we reviewed five years (2005-2009) of NSQIP Public Use Files. Those with respiratory co-morbidities (RCM) were labeled and evaluated in comparison to the rest of NSQIP patients who did not have RCM with respect to postoperative respiratory adverse events and mortality. Chi square test and multi variate logistic regression were performed using SPSS (SPSS, IBM New York). Data reported here was significant at $p < .001$.

Results:

Of 971,455 patients evaluated, 361,412 had RCM. Among the RCM, pre operative pneumonia was associated with higher mortality (OR 20.2) when compared to COPD (OR 5). Table 1 summarizes RCM and smoking history and postoperative respiratory events. Of all the patients evaluated, 5535 had pre operative pneumonia and their mortality was greatly increased over patients without pneumonia (OR 20.283). Patients with dyspnea at rest were at increased risk of poor respiratory outcomes. As the number of RCM increased there was statistically significant increase in occurrence of postoperative respiratory adverse events including mortality (Table 2, $P < 0.001$). By multivariate regression analysis we find ASA class, pre operative functional health status, wound classification, pre operative bilirubin and RCM were independent predictors of mortality with $P < 0.0001$.

Conclusion:

In our review we do find a significant associate with RCM and postoperative respiratory adverse events including mortality. Further prospective studies are required to explore this association and look for countermeasures.

Reversibility of Abdominal Wall Atrophy and Fibrosis Following Primary or Mesh Herniorrhaphy

Culbertson EJ and Mulholland MW
University of Michigan

Hernia formation is associated with abdominal wall atrophy and fibrosis in a rat hernia model, and we sought to study whether primary or mesh herniorrhaphy are able to reverse these changes.

A rat of model of chronic incisional hernia was used. Controls consisted of sham repair (SR) which underwent laparotomy with primary repair and did not form hernias (n=8) and unrepaired hernia in which midline laparotomy was closed with rapidly absorbing suture with subsequent hernia formation in all rats (n=8). Experimental groups included primary suture (n=8) or tension-free polypropylene mesh (n=8) hernia repair on post-operative day (POD) 35. All rats were sacrificed on POD 70. Intact abdominal wall strips were cut perpendicular to the wound for tensiometric analysis. Internal oblique muscles (IOMs) were harvested for fiber type analysis.

No hernia recurrences occurred following primary or mesh repair. Unrepaired abdominal walls demonstrated significantly greater stiffness, increased breaking strength, yield load and yield energy, a shift to increased type IIa muscle fibers compared to sham repair (15.9% vs. 9.13%, $P < .001$), and smaller fiber cross-sectional area (CSA, $1792\mu\text{m}^2$ vs $2669\mu\text{m}^2$, $P < .001$). Primary repair failed to reverse any mechanical changes, but partially restored type IIa fiber % (12.9% vs. 9.13% SR, $P < .001$, vs. 15.9% UR, $P < .01$) and CSA ($2354\mu\text{m}^2$ vs $2669\mu\text{m}^2$ SR, $P < .001$, vs. $1792\mu\text{m}^2$ UR, $P < .001$). Mesh-repaired abdominal walls demonstrated a trend toward an intermediate mechanical phenotype, but fully restored type IIa fiber % (9.19% vs. 9.13% SR, $P > .05$, vs. 15.9% UR, $P < .001$) and nearly restored CSA ($2530\mu\text{m}^2$ vs $2669\mu\text{m}^2$ SR, $P < .05$, vs. $1792\mu\text{m}^2$ UR, $P < .001$).

Mesh herniorrhaphy more completely reverses atrophic abdominal wall changes and indeterminately restores abdominal wall compliance compared to primary herniorrhaphy, despite failing to restore normal anatomical muscle position. The elastic properties of the mesh may account for these observations, and optimization of mesh physical characteristics should account for total abdominal wall compliance.

Metabolic Profiles of Patients on APRV Versus Alternative Modes

Patricia Pentiak MD, Robert Welsh MD

Oakland University William Beaumont School of Medicine

Introduction: The use of Airway Pressure Release Ventilation (APRV) has been touted as a mode for lung recruitment thereby facilitating weaning. Previous studies have shown little difference between modes of ventilation and patients work of breathing as measured by indirect calorimetry (IC). However, these studies were on clinically stable spontaneously breathing patients, not those typically found in surgical intensive care units. There are numerous patients who have benefited from this mode for lung recruitment yet are unable to be extubated. We hypothesized that there exists different resting energy expenditures (REE) for those surgical critical care patients who were unable to be successfully weaned from mechanical ventilation while on APRV.

Methods: Thirty-three surgical intensive care unit patients unable to be weaned from mechanical ventilation were studied. Energy expenditure was measured using IC by certified respiratory therapists while patients were ventilated on APRV. After a period of time, patients were then switched to another mode of ventilation and IC was repeated. Oxygen consumption, REE, CO₂ production, respiratory quotient and were measured.

Results: Patients on APRV had a mean REE of 5203 kcal/day. Following a change in ventilator settings to a more physiologic mode, mean REE decreased to 1752 kcal/day. This was a statistically significant difference in REE between the two modes using a paired t-test $p < 0.0001$. Mean and median REE change was 3450 kcal/day and 3468 kcal/day respectively. There was no correlation between APACHE score and average change in REE using a Spearman correlation.

Conclusions: In this study, patients on prolonged mechanical ventilation had statistically significantly higher REE on APRV compared to other ventilator modes. This increased metabolic demand may be responsible for continued ventilator dependence in this population using this particular ventilator mode.

CECAL LIGATION AND PUNCTURE FOLLOWED BY MRSA PNEUMONIA INCREASES MORTALITY IN MICE AND BLUNTS PRODUCTION OF LOCAL AND SYSTEMIC CYTOKINES

Erin E. Perrone¹, James G. Tyburski¹, Craig M. Coopersmith²

¹Wayne State University/Detroit Medical Center, Emory University

Mortality in the ICU frequently results from the synergistic effect of two temporally-distinct infections. This study examined the pathophysiology of a new model of intraabdominal sepsis followed by methicillin-resistant *Staphylococcus aureus* (MRSA) pneumonia.

Mice underwent cecal ligation and puncture (CLP) or sham laparotomy followed three days later by an intratracheal injection of MRSA or saline. Blood, peritoneal fluid, and bronchoalveolar lavage (BAL) samples were collected 24 hours after intratracheal injection. These samples were used for quantitative bacterial cultures and cytokine analysis.

Both CLP/saline and sham/MRSA mice had 100% survival while animals with CLP followed by MRSA pneumonia had 67% seven-day survival. Animals subjected to CLP/MRSA had increased BAL concentrations of MRSA compared to sham/MRSA animals. Animals subjected to sham/MRSA pneumonia had increased BAL levels of IL-6, TNF- α , and G-CSF compared to those given intratracheal saline while CLP/MRSA mice had a blunted local inflammatory response with markedly decreased cytokine levels. Similarly, animals subjected to CLP/saline had increased peritoneal lavage levels of IL-6 and IL-1 β compared to those subjected to sham laparotomy while this response was blunted in CLP/MRSA mice. Systemic cytokines were upregulated in both CLP/saline and sham/MRSA mice, and this was blunted by the combination of CLP/MRSA.

These results indicate that a clinically relevant model of CLP followed by MRSA pneumonia causes higher mortality than could have been predicted from studying either infection in isolation, and this was associated with a blunted local (pulmonary and peritoneal) and systemic inflammatory response and decreased ability to clear infection.

Ability of the Charlson Comorbidity Index to Predict 30 Day Morbidity and Mortality in the National Surgical Quality Improvement Project (NSQIP)

Xi Lin Jing, MD and Ilan S Rubinfeld, MD, MBA
Henry Ford Health System

The Charlson Comorbidity Index (CCI) incorporates 19 medical conditions into a weighted total with the sum ranging from 0 to 37. The index has been shown to predict one-year mortality rates. The National Surgical Quality Improvement Project (NSQIP) provides a standardized audited outcomes dataset for public use. We sought to explore the predictive value of an NSQIP-specific modified Charlson Comorbidity Index (mCCI) on 30-day morbidity and mortality. Preoperative risk factors were selected to most closely mimic those of the CCI.

Four years of NSQIP public use files (2005-2008) were analyzed. There were 12 matches to the original CCI index conditions: history of myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular event, dementia, COPD, mild liver disease, diabetes mellitus, hemiplegia, moderate to severe renal or liver disease, and metastatic tumors. These conditions were used to create a weighted sum just as in the CCI. This total for each patient constituted their mCCI index. The mCCI values for the study group were divided into six categories based on the total: 0, 1, 2, 3, 4, and 5 or more.

There were 413,900 inpatients reviewed, with 67,803 occurrences of any morbidity (16.4 %) including 44,038 (10.6%) cases of infection and 10,805 deaths (2.61 %) in the database. The following numbers of patients fell into each mCCI category: 280,632 (68%) with a mCCI of 0; 78,491 (19%) with a mCCI of 1; 25,771 (6.2%) with a mCCI of 2; 9,756 (2.4%) with a mCCI of 3; 4,995 (1.2%) with a mCCI of 4; and 14,255 (3.4%) with a mCCI of 5 or greater. As the mCCI increased, the rates of postoperative infection, morbidity, and mortality also increased ($P < 0.0001$). For example, with a mCCI of 0, the rates of postoperative infection, morbidity, and mortality were 8.7%, 12.2% and 1%, respectively. At a mCCI of 5 or greater, the rates of postoperative infection, morbidity, and mortality were 18.8%, 32.5% and 12.6%, respectively. Logistic regression confirmed mCCI's independent predictive power for mortality even when including age, ASA class, and functional status as covariates, with FI having the highest odds ratio (OR 4.47, $p < 0.001$) and a c-statistic of 0.903.

The mCCI is a new tool based on simple, preoperatively identifiable clinical information that adds additional value in the pre-operative assessment of risks for postoperative infection, morbidity, and mortality.

Effects of Vitamin D Deficiency in Critically Ill Surgical Patients

Heather S. Dolman, MD, Lisa M. Flynn, MD
Wayne State University/Detroit Medical Center

Many diseases seem to be impacted by vitamin D deficiency. Recently, the incidence of vitamin D deficiency in critically ill patients was reported to be up to 50% with a threefold increase in predicted mortality; however, limited data exists concerning vitamin D deficiency in critically ill surgical patients.

The purpose of this study is to evaluate the impact of vitamin D deficiency on length of stay, organ failure, and infections in critically ill surgical patients.

This study prospectively identified 46 adult patients admitted to the surgical ICU who had 25-hydroxyvitamin D serum levels evaluated from Jan-Dec 2010. Patients were divided into vitamin D levels (VDL) $< 20\text{ng/ml}$ vs $\geq 20\text{ng/ml}$ (normal range: 30-100ng/ml). Data are expressed as mean \pm SD.

Of the 46 patients evaluated, 35 (76%) had VDL $< 20\text{ng/ml}$ and 11 (24%) had VDL $\geq 20\text{ng/ml}$. Interestingly, parathyroid hormone levels were higher in patients with VDL $\geq 20\text{ng/ml}$ on admission, [214 \pm 151 vs 106 \pm 87 pg/ml, $p=0.04$]. The patients were 56 \pm 19 years of age with an APACHE II of 15 \pm 7. All patients with VDL $< 30\text{ng/ml}$ were treated with vitamin D 800 units daily (iv or po). Patients with VDL $< 20\text{ng/ml}$ vs $\geq 20\text{ng/ml}$ had a longer hospital length of stay (LOS) [31 \pm 32 vs 12 \pm 16 days, $p=0.04$], a longer ICU LOS [24 \pm 33 vs 10 \pm 15 days, $p=0.16$], and required longer mechanical ventilation duration [17 \pm 27 vs 6 \pm 5 days, $p=0.17$]. Infection rates were higher with VDL $< 20\text{ng/ml}$ vs $\geq 20\text{ng/ml}$, [63% (14/22) vs 25% (2/8), $p=0.07$]. Organ failures seen with VDL $< 20\text{ng/ml}$ (vs $\geq 20\text{ng/ml}$) included respiratory [59% vs 37%, $p=0.26$], need for vasopressors [27% vs 12%, $p=0.37$], and incidence of severe sepsis [31% vs 12%, $p=0.28$]. In the 10 patients with VDL $< 20\text{ng/ml}$ and an APACHE II > 17 , hospital LOS and ICU LOS were longer, [52 \pm 36 vs 13 \pm 14, $p=0.0002$ and 42 \pm 40 vs 9 \pm 13, $p=0.002$, respectively] with infections rates of 100% (10/10) vs 33% (7/21), $p=0.001$. No significant differences were seen between baseline magnesium, phosphorus, or ionized calcium.

Vitamin D deficiency in critically ill surgical patients is an important problem. Vitamin D levels of $< 20\text{ng/ml}$ have significant impact on LOS, organ dysfunction, and infection rates. More data is needed on the value of supplementation to improve these outcomes.

Comparison of Clavien Class IV and V Complications for Laparoscopic Versus Open Colectomy Using Nsqip Data and Risk Adjustment

Rupen Shah, MD Shawn Webb MD , Ilan Rubinfeld MD, MBA, Vic Velanovich MD, Mathilda Horst MD,
Craig Reickert MD
Henry Ford Hospital

Is laparoscopic colectomy independently protective from ICU level complications when compared to open colectomy? Laparoscopic colectomy has been associated with few postoperative complications compared to open colectomy. However, it is unclear whether this is true for the most severe complications typically requiring treatment in an intensive care unit. We performed a risk adjusted comparison of laparoscopic vs open colectomy.

Using the NSQIP Public Use files (2005-2008), we identified all laparoscopic and open colectomies by CPT code. Using the Clavien classification for postoperative complications, we identified NSQIP data points most consistent with Clavien Class IV requiring ICU care (postoperative septic shock, postoperative dialysis, pulmonary embolism, MI, cardiac arrest, prolonged ventilatory requirements, need for reintubation) or class V (mortality). Statistical analysis was performed with SPSS software (SPSS, Chicago, IL). Odds ratios were calculated to determine probability of having any Clavien class IV or V complication comparing laparoscopic versus open colectomy. Logistic regression was performed to account for preoperative conditions effect on complications (ASA class, wound class, gender, preoperative functional status, preoperative albumin level, azotemia, thrombocytopenia, emergency case, and age > 70).

Colectomy	Laparoscopic	Open	Univariate X ² Odds Ratio (p<.001 for all variables)	Multivariate Logistic regression OR (p<0.001 for all)
Total patients (N)	12,455	33,190		
Septic shock	1.5%	5.6%	3.88	1.64
Q-wave infarct	0.2%	0.5%	2.99	1.63
Cardiac arrest	0.3%	1.2%	4.27	2.21
Pulmonary embolism	0.4%	1.0%	2.27	1.87
Dialysis	0.3%	1.6%	4.67	1.94
Reintubation	1.4%	4.5%	3.22	1.57
Prolonged ventilation	1.6%	8.9%	5.95	1.77
Mortality	1.11%	5.8%	5.52	1.54
Any Clavien class IV or V complication	4.8%	18.9%	4.87	1.74

The univariate odds ratio of having any complication requiring ICU admission ranged from 2.27 to 5.52 times more likely if surgery was performed open than with a laparoscopic approach. Multivariate logistic regression accounting for preoperative comorbidities that might affect outcome showed a persistence of an increase in complications with an odds ratio range of 1.63 to 2.21. Evaluation of NSQIP database demonstrates laparoscopic colectomy confers an independent protective effect on the frequency of ICU level (Clavien class IV) complications. The protective effect remained evident after correcting for preoperative conditions that might have affected outcome.

Impact of FLS Training During Medical School on Performance by First Year Surgical Residents

Cristiano Alpendre, MD, David Edelman, MD
Wayne State University/Detroit Medical Center

Fundamentals of Laparoscopic Surgery (FLS) certification is a high stakes examination. The best training methods to enable successful certification are undetermined. We hypothesized that first year surgical residents (R01s) who had been pre-trained as medical students would perform better during skills training than previously un-trained R01s.

This is an IRB-approved, retrospective review of FLS training data generated from a single surgical skills laboratory from July 2007 through June 2010. During the study period there were 24 R01s with no previous FLS exposure (NOVICE group) and 7 R01s who had undergone FLS task training while medical students (MS4 group). All R01s practiced the FLS skill tasks weekly for portions of the training sessions with informal feedback and teaching. Performance goals were proposed for each task based on local and national proficiency figures. The performance outcome measure was task completion time (TCT). Pre-training performance was designated iTCT and post-training fTCT.

Table of Performance:

		Mean iTCT Seconds (\pm SD)	p-Value (Novice vs. MS4)	Mean fTCT Seconds (\pm SD)	p-Value (Novice vs. MS4)
PEG	Novice	220 \pm 99		106 \pm 52	
	MS4	80 \pm 27	=0.001	58 \pm 13	=0.023
CIRCLE	Novice	391 \pm 184		155 \pm 72	
	MS4	172 \pm 46	=0.004	93 \pm 23	=0.035
EXTRA	Novice	328 \pm 150		124 \pm 42	
	MS4	170 \pm 72	=0.012	102 \pm 31	=0.216
INTRA	Novice	621 \pm 343		205 \pm 106	
	MS4	279 \pm 130	=0.016	105 \pm 26	<0.001

The MS4 group began with iTCTs for all four tasks that were significantly lower than the NOVICE iTCTs. At completion of the 16-week training period, the MS4 group continued to demonstrate mean fTCTs that were lower for all four FLS skill tasks but only significantly for PEG, CIRCLE, and INTRA skill tasks. Both Novice and MS4 groups showed significant improvement for all four skill tasks ($p < 0.05$).

In the current milieu of work-hour limitations, the integration of FLS skill training into medical school curriculum provided a durable advantage to the pre-trained R01s which was associated with higher levels of final performance.

Accuracy of Surgery Residents' Trauma CT Scan Interpretation

Shariq Zaidi, MD; Elango Edhayan, MD
St. John Hospital and Medical Center

During late hours when there is no in-house radiologist, there can be a significant delay before scans are officially read. This study investigated whether the CT scan interpretations of Head, Chest, and Abdomen/Pelvis performed by surgical residents were as accurate as those performed by radiologists.

A prospective chart review was performed at a Level II trauma center. Surgery residents of this institution participated in the study and recorded interpretations of head, chest, and abdominal/pelvis CT scans during trauma patient evaluation. The electronic medical record was then reviewed and compared to radiologist interpretations of the same scans. Discrepancies for each scan were documented. From these data, percentage agreements were computed between the residents and the radiologists. Using chi-squared techniques, we analyzed whether the agreement was associated with various patient characteristics, such as age, gender, race, and type of injury as well as characteristics of the time that the patient was seen in the emergency department. Logistic regression techniques were used to determine the probability of agreement by independent factors that may have influenced agreement, such as patient age, gender, race, type of trauma, weekday/weekend, and shift. Student's t-test and ANOVA were used to investigate the mean number of discrepancies per CT scan by patient characteristics.

A total of 36 trauma patients were included in this study, accounting for 85 CT scan interpretations. This included 39 CT Head, 14 CT Chest, and 32 CT A/P. Fourteen percent of the reads had a major finding that was missed by the residents. Five percent of the CT Head reads had a missed finding and 95% were accurate. Forty-three percent of chest CT reads were noted to have a resident discrepancy. Eight of the 32 CT A/P interpretations had some discrepancy (25%). PGY1 residents read 29% of scans with a missed finding. PGY2 residents read 31% of scans with a missed finding. PGY3 residents read 23% of scans with a missed finding. PGY4 residents read 3% of scans with a missed finding. PGY5 residents read 10% of scans with a discrepancy. Inferential statistical analysis of the first interpretation of each patient's scans was analyzed as a subset. Discrepancies based on gender were not found to

be significant. Gender (p 0.293), race (p 0.440), day of scan (p0.798), and shift (p 0.792) were not statistically significant with regard to discrepancies found in scans. Penetrating trauma had 50% of scans with a discrepancy while blunt trauma had 27% with a discrepancy. This did show a trend (p 0.188). PGY level as a whole did show statistical significance with higher level of training having fewer discrepancies on interpretations. PGY1's had 57% discrepancies, PGY2 83%, PGY3 40%, PGY4 0%, and PGY5 33% (p 0.003).

Surgery residents demonstrated competency in CT scan interpretations. The accuracy of interpretation was better for CT Head compared to CT Chest and CT A/P. Gender, race, timing of scan, and type of trauma did not affect accuracy of interpretation. Senior level residents demonstrated superior CT interpretation skills compared to junior level residents and this was statistically significant. The study showed the need for further education in the junior level of residency.

Variation in Performance by Novices on Laparoscopic Virtual Reality Simulators

Alicia N Olson, MD, David A Edelman

Wayne State University Department of Surgery

Modern educational theory mandates accurate needs assessment when designing curricula. Virtual Reality (VR) simulation for motor skill training is one possible component of a well-designed surgical skills curriculum and this makes the paucity of data on pre-training skill levels for learners performing laparoscopic tasks on VR simulators a problem. We hypothesized that the initial performance levels of novices performing laparoscopic tasks on VR simulators would demonstrate a narrow normally distributed range given the absence of variability from previous practice effects.

This is a retrospective review of laparoscopic VR simulator performance data generated from a single surgical skills laboratory. Novice learners performed eight tasks on a VR (METI-Simlap) simulator. The earliest instance for each task by a learner was designated the initial performance level (iTCT). iTCTs for each task were segmented into time intervals and plotted as frequency distributions. Means with standard deviation, medians with ranges, and skewness were determined.

147 novices completed 17,799 trials during the study period. TCTs are presented by task with means and standard deviations, medians and ranges, and skewness. All tasks demonstrated wide ranges (over 10X) and positive skewness (longhigh iTCT (low performance) tails).

Task	# Learners	Total Trials	Mean iTCT (SD)	Median iTCT (Range)	Skewness
CN0	147	3346	192 (146)	138 (40-824)	1.46
CN0G	143	3749	229 (201)	115 (33-1106)	2.25
CN30	128	2578	198 (205)	170 (34-1096)	2.14
CN30G	114	2376	202 (170)	147 (43-958)	2.24
RET	111	1872	137 (75)	120 (35-437)	1.53
RETDIS	105	1573	201 (129)	173 (76-1100)	3.79
TUBE	95	1053	249 (142)	214 (59-865)	2.19
ARROW	86	1252	137 (124)	103 (44-1073)	5.47

Novice learners display a very wide range of initial performance levels on laparoscopic VR simulators despite the absence of pre-practice effects. Our findings confirm the absence of a well-defined starting level of laparoscopic skill upon which to base a training curriculum. Further studies examining the correlation of these findings to the amount and type of training required to reach proficiency are required.

Can Communication Between Residents and Non-Surgeon Professionals be Improved by Their Participation in Resident Training?

Erick F. Rivas, MD, Cheryl I. Anderson, RN, BSN, MSA, Benjamin D. Mosher, MD
Michigan State University

Feedback of residents' communication skills from non-surgeon professionals can be difficult to obtain or may be limited to grievance reports. We hypothesized that involving other professionals in resident communication training would improve communication.

A 20-question survey, using a 7-point Likert scale (1=strongly disagree) was developed to establish a baseline for communication training. Respondents were asked to collectively rate the residents and attendings as two groups.

Two hundred forty six responses were received (76% nurses), representing 15 units. 75% were female averaging 15.5 years in healthcare, compared to 13.9 years for males.

Category	REPRESENTATIVE QUESTION	Surgeon (mean)	Resident (mean)	p value (<.05)
Team Functioning	Works collaboratively with my team or unit	4.73	4.56	0.01
Communication	Communicates clearly & openly about my patients	4.78	4.69	0.15
Respect	Shows they value my input	4.44	4.55	0.10
Trust	Trusts me to make good decisions about my patients	4.53	4.51	0.79

Overall average scores in 4 categories were 4.62 for surgeons, compared to 4.57 for residents, with team functioning significantly different. Based on these findings, nurses were recruited to participate with residents in pre-written communication scenarios (e.g., withdrawal of life support, differing plans of care), using the SBAR format. Key faculty and nurse supervisors were asked to score the interactions and offer feedback. Results showed that opening remarks (Identifying self, stating purpose of call) and closing remarks (clarity of next steps) were more successful than exchanging patient situational specifics. After repeated practice, thoroughness improved and positive exchange between groups occurred.

Involving non-surgeon professionals in training residents can familiarize faculty, residents and other disciplines with effective communication skills and promote an improved team climate.

Factors Affecting Surgeons Involvement in Surgical Residents Education

Mohamed Elgamal, MD, Earl Norman, MD, FACS

Michigan State University / Kalamazoo Center for Medical Studies

Attending surgeons represent the corner stone in the training of surgical residents. A multitude of factors influence the desire of attending surgeons to participate in surgical resident education. This study aims to examine those factors and clarify the reasons why surgeons are willing to donate their time, and potentially compromise the quality of care they provide for their patients.

Surgeons who participate in residents' education, both academic and private practitioners, were invited to participate in a web based anonymous survey. The Survey consisted of ranking questions, asking the respondents to rank the advantages and disadvantages of working with residents, as well as the factors by which they assess resident performance. The survey also included questions about the degree of freedom the residents are given in managing the patients in and out of the operating room. The results were then compared among the respondents grouped according to affiliation, geographic location, type of practice and re-imburement patterns.

A total of 115 responses to the survey, 94 from national responders as well as 21 from our local program were received. 99 of the respondents volunteered to work with residents while 16 were required by their institution to work with residents. The main advantages of working with residents were the satisfaction the surgeons get from teaching a new generation of residents, followed by the exposure to the new literature that working with residents require. Financial compensation was the least important advantage to working with residents. The main disadvantages of working with residents were the mistakes residents make in managing the patients followed by increased operative time. Medical knowledge and willingness to learn where the most important attributes the surgeons appreciated in their residents, followed by technical dexterity. While most surgeons were comfortable with the residents making independent decisions in the Pre and post-operative care of the patients, the majority of surgeons retained the intra-operative decision making. There was no significant difference among the various attending groups in any of the parameters studied.

In spite of the various factors that influence the relationship between the attending surgeons and their residents, the desire to train a new generation of surgeons remained the foremost reason for the attending staff to participate in resident education.

Scholarly Activity: Investigating the Benefits and Burdens of Research During Residency

Neelima Rehil MD and Vijay Mittal MD, FACS

Providence Hospitals and Medical Centers

BACKGROUND: Scholarly activity is considered an important part of medical education in all specialties. Many programs require research for the promotion of their residents. However, the effect of such requirements on residents and their medical education is not well understood.

METHODS: A 22-question survey was sent to residents in several specialties in the Detroit, Michigan area to determine the impact of research on their training and future endeavors.

RESULTS: Of the residents surveyed, 108 of 120 residents from different specialties responded resulting in an 86.4% response rate. 98.1% (n=106) of residents surveyed conduct research at their programs. Of these, 67.5% (n=73) showed an interest in research, and 91% (n=99) felt research had a positive effect on their education. The majority of residents felt they had adequate educational 86.1% (n=93) and lab 76.8% (n=83) resources respectively. 64.8% (n=70) felt comfortable conducting clinical research. On average, residents spend 10.37 hours on research a month, and 64.8% (n=70) feel capable of conducting clinical research. Residents also felt comfortable evaluating the research of others 60.1% (n=65) and explaining research to patients 85.1% (n=92). Of the residents surveyed, 36.1% (n=39) feel that research should be mandatory, 59.2% (n=64) believe it should be optional and 4.6% (n=5) feel that it is a waste of resident time. Additionally, suggestions from residents are to allocate protected time for research.

CONCLUSIONS: From a resident's perspective, research is an important part of residency and puts little burden on residents. However, research would be more beneficial as an option rather than being mandated, unless adequate time is allocated to conducting research during the course of residency.

Effect of the New Standards for Case Logging on Resident Operative Volume: Doing Better Cases or Better Numbers?

Murthy R MD, Rubinfeld I MD
Henry Ford Hospital

A. In response to changing practice patterns and procedures, the ACGME modified the designation of major (index) operative cases to include a number of cases previously considered “minor.” This study was undertaken to study the potential effect of these changes on resident operative experience.

B. Under the data use agreement of the ACS and with IRB approval, we analyzed 4 years of National Surgery Quality Improvement Project public use files (05-08) for general and vascular surgery cases. Primary CPT coding of the case was mapped to the ACGME major case category using both the old (pre-2009) and new classification schemes. Variables were analyzed utilizing chi-square analysis in SPSS IBM 19 (IBM 2010).

C. A total of 576,019 cases were reviewed. Major cases as defined by the new classification scheme represented an increasing proportion of the cases each year, rising from 88.3% in 2005 to 95% by 2008 ($p < .001$). The converse was true as well -- major cases as defined by the old scheme fell from 71% of the total cases done in 2005 to 62% of cases by 2008 ($p < .001$). Cases covered by a resident dropped from 82% of cases in 2005 to 61% in 2008 ($p < .001$). When comparing the new classification system to the old scheme, 364,366 (63.3%) cases were considered major by both standards while 30,587 (5.3%) were considered minor by both standards; 7089 (1.2%) cases previously classified as major were changed to minor, while 173,977 (30.2%) ($p < .001$) cases previously classified as minor were now designated as major cases. This last group was analyzed further. The top procedures in this group consisted of excision or removal of breast lesion [22,175 (12.7%)], laparoscopic gastric bypass [18,825 (10.8%)], ventral hernia repair [14,732 (8.5%)], and appendectomy [10,190 (5.9%)]. Of these newly designated major cases, the proportion uncovered by residents increased steadily from 22% in 2005 to 44% in 2007 and 2008 ($p < .001$).

D. Changes in the classification scheme of the ACGME resident case log system were undertaken to accommodate changing practice patterns and procedure types. While some of the cases newly classified as major are technically advanced procedures (e.g. roux-en-y gastric bypass) undoubtedly previously captured as major in other categories, others (e.g. breast lesion excision) are not, raising the issue as to whether the major case category has been diluted by less demanding case types. The implications of these findings are worrisome – preservation of case volumes at the expense of case quality is a poor trade-off. Further study will be necessary to determine the impact of these changes on residency training.

Should Institutions Provide Incentives to Encourage General Surgery Residents and Faculty to Undertake Research?

William J. Curtiss, MD, Matthew D. Malamet, MD and Vijay K. Mittal, MD, FACS
Providence Hospital and Medical Centers

Introduction: To date, there is no uniform standard or definition of surgical research activity. There is wide variation between institutions in both the definition of scholarly activity and appropriate volume. Would an incentive-based system encourage general surgery faculty and residents to more readily seek and complete research?

Methods: A multi-question web-based survey was distributed to the Association of Program Directors in Surgery. The survey was further divided into faculty and resident-related questions evaluating the relationship between incentives and research productivity.

Results: Of the eighty respondents (32% response rate), 74% defined scholarly activity as publication in peer-reviewed journals. Most programs (71%) did not provide faculty incentives, but a minority (11%) has developed point systems. Sixty-seven percent of programs did not require research by faculty and required less than one faculty project/year to retain teaching privileges. Most programs (71%) mandated resident research, approximately half (55%) required scholarly activity for advancement. The majority of programs (90%) did not have designated research rotations, but residents were provided with research mentors and access to research facilities (76%). Most residents (62%) would be more likely to pursue research if expenses were reimbursed. Similarly, faculty would be more productive if compensated as a percentage of salary (50%) or monetarily for each publication (50%).

Conclusions: Novel incentives encouraging research by both residents and faculty may help to increase research productivity. Research space, funding and rotations are viable options for encouraging resident research. Research requirements, faculty reimbursement or point systems may motivate faculty to increase their scholarly activities.