ORAL PRESENTATIONS

External Validation of a Prehospital Critical Illness Score: A Multi-center Cohort Study ...........................................4
Kievlan DR, Martin-Gill C, Kahn JM, Callaway CW, Yealy DM, Angus DC, Seymour CW
Clinical Science

Aquaporin-4 Antagonist AER-271 Trends to Lower ICP without Altering Edema in Combined TBI and Hemorrhagic Shock in Mice .................................................................................................................................................6
Wallisch JS, Jha RM, Vagni V, Feldman K, Dixon CE, Farr G, Kochanek PM
Translational Science

Can a Program-specific Smartphone Application Be Useful to Fellows in a Critical Care Training Program? .......7
Baptist T, Brackney C
Health Services and Education Research

Outcomes of the Implementation of a Daily ICU Checklist during Rounds in a Resource Poor ICU Setting ........8
Davies O, Baldisseri M
Quality Improvement and Patient Safety

CLINICAL SCIENCE

Mortality and Acute Neurologic Events in the Cardiac Intensive Care Unit.................................................................10
Bell J, Domnina Y, Muñoz R, Panigrahy A, Milligan S, Baust T, Beluk N, Bell MJ, Sanchez-de-Toledo J

Prediction of Severe Acute Kidney Injury (AKI) by Novel Biomarkers in Patients with Sepsis ..............................11
Fiorentino M, Keener C, Smith A, Yende S, Kellum JA

The Burden of New Health Conditions in Elderly Severe Sepsis Survivors .................................................................13
Mayr FB, Linde-Zwirble W, Angus DC, Weissfeld LA, Yende S

Early Nutritional Support is Associated with Favorable Outcome in Pediatric Traumatic Brain Injury ..............14
Meinert E, Bell MJ, Buttram S, Kochanek PM, Balasabramani GK, Wisniewski S, Adelson PD

Safety and Efficacy of Warfarin Reversal with Four-Factor Prothrombin Complex Concentrate for Subtherapeutic INR in Intracerebral Hemorrhage .................................................................................................................................................15
Rivosecchi RM, Durkin J, Okonkwo DO, Molyneaux BJ

Renal Recovery at Hospital Discharge is Associated with 1-year Mortality in Patients with Sepsis-induced Acute Kidney Injury .................................................................................................................................................16
Tohme F, Wang S, Murugan R, Kellum JA
TRANSLATIONAL SCIENCE

A Zebrafish Model of Acute Kidney Injury Associated with Systemic Infection Induced by Intravascular Bacteria Injection ......................................................................................................................................................18
  Cui L, Wen X, Morrisroe S, Brilli L, Chen X, Hukriede N, Emlet DR, Kellum JA

Genetic Variants in Hyperferritinemic Sepsis ................................................................................................19
  Kernan K, Sethi R, Gonzalez L, Chandran U, Lamb J, Carcillo J

AMPK Activation Rescues Energy Depletion during Sepsis-induced AKI and May Improve Outcome........20

Endogenous Changes in Melatonin Receptor Levels after Traumatic Brain Injury in Rats .........................22
  Osier N, Pugh B, Pham L, Savarese A, Alexander S

Sublingual Microvascular Flow Parameters Can Predict Post-resuscitation Microvascular Response and May Predict Intestinal Regional Perfusion........................................................................................................................................24

Multi-parameter Flow Cytometric Analysis of PBMC-derived Monocyte Response to Danger Signals ..........26
  Podd B, Carcillo J

Improved Lifespan in Drosophila Surviving Sepsis through Reversal of the Warburg Effect ....................27
  Reddy MA, Stelmach MJ, Kwon J, Cambriel AIF, Kaynar AM, Bakalov V

HEALTH SERVICES AND EDUCATIONAL RESEARCH

Impact of a Physician-Targeted Pay-for-Performance Program on Use of Spontaneous Breathing Trials in Mechanically Ventilated Patients ..................................................................................................................................29
  Barbash IJ, Seymour CW, Gunn SR, Kahn JM

Prospective Evaluation of the Pediatric Rothman Index as a Measure of Pediatric Inpatient Acuity ..........31

Comparing How Intensivists and Palliative Care Physicians Discuss Patient Values and Preferences in Simulated Family Conferences........................................................................................................................................32
  Scheunemann LP, Rajagopal PS, Khalil R, Arnold RM, White DB

Barriers and Facilitators to the Conduct of ICU Interdisciplinary Family Meetings: Findings from a Qualitative Exploration..........................................................................................................................34
  Seaman JB, Arnold RM, Rak K, Nilsen ML, Argenas A, Shields A, White DB
The Effect of Clinical Trial Results on the Use of Neuromuscular Blockade for Severe ARDS

Siedsma MP, Le TQ, Kahn JM, Seymour CW

Sentiment Mining of Letters of Recommendations (LOR) for Residency Applications: A Preliminary Work on Automated Categorization

Torbati ME, Coy K, Beaman ST, Forte P, Metro DG, Hwa R, Kaynar AM

QUALITY IMPROVEMENT AND PATIENT SAFETY

Evaluation of an Automated Pupillometer during Routine Neurological Assessments in the Acute Care of the Severe Traumatic Brain Injury Patient

Anderson M, Alexander S, Puccio A, Shutter LA

A Daily Checklist to Improve Communication between the Critical Care Team and Patients’ Families in the Trauma Intensive Care Unit

Baptist T, Thangudu P, Day T, Gunn SR

A WINning Technique: The Wire-in-needle Feasibility Study

Becker TK, Betcher JA, Dooley-Hash SL, Fung CM, Soyk CC, Barton DF, Theyyunni NR

Evaluation and Descriptive Analysis of Stroke Code Team

Chelluri J, Murugan R, Chelluri L, Spiering K

A Quality Improvement Project to Ensure Appropriate Cleaning Practices of Ultrasound Machines after Clinical Use

Freyer A, Schott C

Low Tidal Volume Ventilation Troubleshooting

Javed J, Day T, Padmanabhan R, Donadee C, Gunn SR

Phenobarbital Taper for Prophylaxis and Treatment of Alcohol Withdrawal

Paolini SL, Malaiyandi D, Molyneaux BJ
Oral Presentations

External Validation of a Prehospital Critical Illness Score: A Multi-center Cohort Study [Clinical Science]

Daniel R Kievlan, MD¹; Christian Martin-Gill, MD²; Jeremy M. Kahn, MD, MS¹,³; Clifton W. Callaway, MD, PhD²; Donald M. Yealy, MD²; Derek C. Angus, MD, MPH¹,³; Christopher W. Seymour, MD, MSc¹,²,³

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Objectives: Identification of critically ill patients during prehospital care could facilitate early treatment and aid in the regionalization of critical care. Tools to consistently identify those in the field with or at higher risk of developing critical illness do not exist. We sought to validate a prehospital critical illness risk score that uses objective clinical variables in a contemporary cohort of geographically and temporally distinct prehospital encounters.

Methods: We linked prehospital encounters at 21 emergency medical services (EMS) agencies to inpatient electronic health records (EHR) at nine hospitals in southwestern Pennsylvania from 2010 to 2012. The primary outcome was critical illness during hospitalization, defined as an intensive care unit (ICU) stay with delivery of organ support (mechanical ventilation or vasopressor use). We calculated the prehospital risk score using demographics and first vital signs from eligible EMS encounters, and tested the association between score variables and critical illness using multivariable logistic regression. Discrimination was assessed using the area under the receiver operating characteristic (AUROC) curve and calibration determined by plotting observed versus expected events across score values.

Results: Among 42,550 non-trauma, non-cardiac arrest adult EMS patients, 1,926 (4.5%) developed critical illness during hospitalization. We observed moderate discrimination of the prehospital critical illness risk score (AUROC=0.73; 95% CI, 0.72 – 0.74) and adequate calibration based on observed versus expected plots. At a score threshold of 2, sensitivity was 0.63 (95%CI, 0.61 – 0.75), specificity was 0.73 (95% CI, 0.72 – 0.73), negative predictive value was 0.98 (95% CI, 0.98 – 0.98), and positive predictive value was 0.10 (95%CI, 0.09 – 0.10). The risk score performance was greater with alternative definitions of critical illness, including in-hospital mortality (AUROC=0.77; 95%CI, 0.75 – 0.78).

Conclusions: In an external validation cohort, a prehospital risk score using objective clinical data had moderate discrimination for critical illness during hospitalization.
Figure 1. Calibration curve showing the expected rate of critical illness compared to the observed rate (with 95% CI) for each risk score value.
Aquaporin-4 Antagonist AER-271 Trends to Lower ICP without Altering Edema in Combined TBI and Hemorrhagic Shock in Mice [Translational Science]

Jessica S. Wallisch, MD1,4; Ruchira M. Jha, MD1,4; Vincent Vagni4; Keri Feldman4; C. Edward Dixon, PhD3,4; George Farr, PhD5; Patrick M. Kochanek, MD1,2,4

Departments of 1Critical Care Medicine, 2Pediatrics, 3Neurological Surgery, Children’s Hospital of Pittsburgh of UPMC, 4Safar Center for Resuscitation Research, 5Aeromics, LLC, Cleveland, OH

Objectives: Secondary insults after traumatic brain injury (TBI) such as hemorrhagic shock (HS) increase the need for fluid resuscitation and exacerbate brain edema. The aquaporin (AQP) channel mediates cerebral edema and is a potential therapeutic target. Hypothesis: use of a selective AQP-4 antagonist (AER-271) will reduce brain edema and intracranial pressure (ICP) in a mouse model of TBI+HS.

Methods: We used cortical impact+HS (mean arterial pressure [MAP] 25-27 mmHg for 35 min) model followed by a 90min resuscitation with lactated ringer’s targeting MAP= 70mmHg in C57BL/6 mice. Monitoring included temperature, heart rate, MAP, ICP, and cerebral perfusion pressure (CPP). Mice (n=12) were randomized to receive study drug AER-271 (5 mg/kg Aeromics) vs vehicle via IP bolus at the beginning of resuscitation and at 60min and were evaluated for cerebral edema by %brain water (%BW, wet-dry weight) immediately after resuscitation. Another group (n=20) were randomized to receive AER-271 (10mg/kg IP followed by SQ infusion pump) vs vehicle at the end of resuscitation and underwent wet-dry weight at 24h.

Results: In the acute setting there was a trend toward reduced ICP during resuscitation with AER-271 (15.68±1.04 vs 11.95±1.64 mmHg, vehicle vs AER, p=0.08); however, AER-271 treated mice exhibited a reduction in MAP (63.00±1.34 vs 50.67±3.29 mmHg, p<0.05), without difference in CPP (42.00±8.28 vs 34.62±7.02 mmHg, p=0.24). There were no differences in fluid required or %BW in injured (80.79±0.11 vs 80.81±0.13, NS) or non-injured (79.38±0.09 vs 79.41±0.10, NS) hemispheres between groups immediately following resuscitation. By 24h, contralateral %BW had returned to naïve levels in both groups but treatment with AER-271 did not mitigate edema in the ipsilateral hemisphere (80.50±0.16 and 80.71±0.25 vs 78.56±0.08, p<0.0001).

Conclusions: AER-271 treatment showed a trend toward reduced ICP but surprisingly this did not result from a reduction in brain edema either acutely or at 24h. Differential effects of AQP4 on contusional swelling vs cytotoxic and vasogenic edema in our model may underlie these findings.

Funding: US DoD, W81XWH-14-2-0018; KL2TR000146
Can a Program-specific Smartphone Application Be Useful to Fellows in a Critical Care Training Program? [Health Services and Education Research]

Tim Baptist, MD; Chris Brackney, DO
Department of Critical Care Medicine, University of Pittsburgh School of Medicine

Statement of Need: Fellows in our adult critical care training program rotate through ten intensive care units in five hospitals. They have expressed difficulty adapting to a new intensive care unit (ICU) each month, as clinical protocols, phone numbers, and codes to call rooms are not easily accessible. We hypothesized that a program specific smartphone application may enable fellows to more efficiently access this information.

Methods: A fellowship specific smartphone web application was created containing 9 clinical sections and 2 main non-clinical sections consisting of codes to call rooms and more than 100 phone numbers. Adobe Muse and Business Catalyst software were used to build and host the application respectively. The clinical sections were reviewed by faculty and consisted of information gathered from existing curricula. Only information that could aid in patient management at the point of care was included. The application was distributed to 30 critical care fellows, 18 advanced practice providers, and the 10-15 residents rotating through the ICUs each month.

Results: 83% (15/18) of fellows admitted to saving the application on their smartphones. On a 5 point Likert scale, 56% (10/18) of fellows “agreed” or “strongly agreed” that the clinical sections were useful. 94% (17/18) “agreed” or “strongly agreed” that the non-clinical sections were useful. Usage data was analyzed with Google Analytics for 10 weeks. 8.2 +/- 5.3 sessions were generated by 5.8 +/- 3.5 users per day.

Conclusions: Usage data and feedback received suggest that 6 months after its introduction, our smartphone application has become an integral part of the program. The addition of more clinical protocols and specific management plans requested by fellows may improve the application’s clinical utility. Fellows found the non-clinical sections such as phone numbers and codes to call rooms to be the most useful. The consolidation of such information in a smartphone application may prove a useful aid to trainees in other programs involving rotations in multiple hospitals and units.

ONLINE URL: http://ccguide.businesscatalyst.com (please access through smartphone web browser)
Outcomes of the Implementation of a Daily ICU Checklist during Rounds in a Resource Poor ICU Setting [Quality Improvement and Patient Safety]

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1Department of Critical Care Medicine, UPMC, Pittsburgh, 2Fellow

Background: Checklists are simple, cognitive tools that can help organize and complete tasks. In the ICU, checklists have definitively been shown to decrease infection rates, hospital and ICU length of stay, and costs, amongst other indices. Having completed the preliminary work that showed non-standardized delivery of care, low compliance rates with evidence-based practice guidelines, and poor patient outcomes, the need to develop a simple, cost effective intervention to address these deficiencies was identified in an ICU with limited resources.

Methods: An experimental, non-controlled before and after study was conducted in the ICU of a 300-bed general hospital in rural Haiti. The ICU had a capacity for 3 adult and pediatric patients at a time (primarily because of ICU nursing shortages) and lacked access to several capacities such as certain monitoring equipment, bedside procedures, laboratory, microbiologic and radiologic investigations. Data for the baseline period was collected via retrospective chart review of the preceding 10 weeks prior to intervention. Education (for physicians and nurses) and implementation of the daily ICU rounding checklist was done over a 1-week period. The check-list was filled during rounds by physicians. Data for the post-intervention period was then collected retrospectively after 10 weeks. All adult patients with an ICU stay greater than 24 hours were included in the analysis.

Results: There were 27 patients admitted to the ICU during the pre-intervention period and 29 patients during the post-intervention period. Average age was 45 and 40 in the pre- and post-intervention groups respectively. Compliance with many of the checklist indices improved over time (Table 1). Average length of stay increased from 3.89 days in the pre-intervention group to 4.76 days in the post intervention group. There was a notable (50%) reduction in ICU mortality from 48% in the pre-intervention period to 24% in the post intervention period. It could be inferred that the intervention contributed to a decrease in mortality at the expense of increasing LOS.
Table 1.

Compliance with checklist indices over time (pre-intervention vs post-intervention)

<table>
<thead>
<tr>
<th></th>
<th>Pre-intervention (%)</th>
<th>Post-intervention (%)</th>
<th>Absolute change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low TV ventilation (6-8cc/kg IBW)</td>
<td>4.2</td>
<td>98.8</td>
<td>94.6</td>
</tr>
<tr>
<td>Sedation holiday</td>
<td>45.2</td>
<td>95.2</td>
<td>50.0</td>
</tr>
<tr>
<td>Spontaneous breathing trial</td>
<td>15.6</td>
<td>60.7</td>
<td>45.1</td>
</tr>
<tr>
<td>HOB 30° elevated</td>
<td>51</td>
<td>100</td>
<td>49.0</td>
</tr>
<tr>
<td>Oral care</td>
<td>32</td>
<td>100</td>
<td>68.0</td>
</tr>
<tr>
<td>Stress ulcer prophylaxis</td>
<td>96.7</td>
<td>100</td>
<td>3.3</td>
</tr>
<tr>
<td>VTE prophylaxis</td>
<td>49.1</td>
<td>90</td>
<td>40.9</td>
</tr>
<tr>
<td>Nutrition</td>
<td>44.3</td>
<td>74.6</td>
<td>30.3</td>
</tr>
<tr>
<td>Foley catheter utilization rate</td>
<td>99</td>
<td>77</td>
<td>22.0</td>
</tr>
<tr>
<td>Medication list reviewed</td>
<td>52.8</td>
<td>94.9</td>
<td>42.1</td>
</tr>
<tr>
<td>Mobilization</td>
<td>3.8</td>
<td>2.9</td>
<td>0.9</td>
</tr>
</tbody>
</table>

**Conclusion:** This project has shown that a simple and cost effective method, such as the implementation of daily rounding checklists, can improve patient outcomes in a resource-poor ICU. We admit that there are a few confounders for the results of this study such as the lack of a severity of illness comparison. Further well-structured research is needed to confirm the findings of this simple QI project.
Mortality and Acute Neurologic Events in the Cardiac Intensive Care Unit

Jamie Bell, MD1; Yuliya Domnina, MD; Ricardo Munoz, MD; Ashok Panigrahy, MD; Shareen Milligan; Tracy Baust; Nancy Beluk, BS; Michael J. Bell, MD; Joan Sanchez-de-Toledo, MD, PhD

1Department of Critical Care Medicine, Children’s Hospital of Pittsburgh of UPMC, Pediatric Critical Care Fellow

Introduction: Mortality in patients suffering from congenital heart disease has improved greatly in the past few decades. Focus has now shifted to improving neurologic morbidity in these patients. We sought to identify the current incidence of neurologic related mortality and the spectrum of acute neurologic events in a pediatric cardiac intensive care unit.

Methods: This was a retrospective chart review including all medical and surgical patients admitted to a pediatric CICU between January 2011 and January 2015. Our primary outcome was to identify mortality associated with acute neurologic events (ANE). Secondary outcomes were to identify the incidence of these events, morbidity as shown by hospital and ICU length of stay, and any pre-disposing risk factors. There were 4 types of recorded acute neurologic events (ANEs): intracranial hemorrhage, cerebral infarct, acute grey/white matter changes in the brain, and electrographic seizures.

Results: We identified 1,574 admissions to our pediatric CICU during our study interval with 135 of these having an ANE (8.6%). Of the 135 admissions that had an ANE, mortality was 16.3% compared to the patients who did not have ANE (1.5%). The most common event was intracranial hemorrhage (38.3%) followed by white/grey matter changes (27.1%), cerebral infarct (25.7%) and seizures (9%).

Patients with an ANE had a longer hospital LOS (41.4 ± 3.9 mean days) compared to those that did not have ANE (13.2 ± 4.7 mean days p<0.001). Those patients also had a longer CICU LOS (21.5 ± 1.9 mean days) compared to the non-ANE group (5.9 ± 0.2 mean days p<0.0001).

On multivariate analysis any ECMO use (OR 17 p=<0.001), cardiac arrest (OR 4.6 p=<0.001), and history of prematurity (OR 2.8 p=<0.001) were independently association with ANE.

Conclusion: ANE is associated with an increase in mortality and morbidity in the pediatric CICU. ECMO use and cardiac arrest were independently associated with ANE. This is a population who might benefit from improved surveillance to identify and treat these events. More studies are needed to determine best screening modalities, treatment protocols, and how to prevent long-term morbidity in ANE survivors.
Prediction of Severe Acute Kidney Injury (AKI) by Novel Biomarkers in Patients with Sepsis

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¹Center for Critical Care Nephrology, CRISMA, Department of Critical Care Medicine, University of Pittsburgh, ²CRISMA Center, Department of Critical Care Medicine, University of Pittsburgh

Introduction: Acute kidney injury (AKI) is associated with both short- and long-term adverse outcomes in patients with sepsis. Early detection of AKI may improve therapeutic intervention, but the ability of AKI biomarkers to detect and/or predict AKI in this setting is still not well defined. The aim of this study is to analyze the performance of urinary AKI biomarkers to predict severe AKI.

Methods: We analyzed data from septic patients enrolled in ProCESS trial, for which biomarkers at baseline and at 6 hour were available. The primary endpoint is the development of severe AKI (KDIGO stage 2-3) within 12 and 24 hours after enrollment (excluding patients with AKI at baseline). Urine kidney injury molecule 1 (KIM-1), urine collagen IV, urine tissue inhibitor metalloproteinase-2 (TIMP-2) and urine IGF-binding protein 7 (IGFBP-7) were measured and biomarker performance was assessed using the area under the receiver operating characteristic curve (AUROC).

Results: Severe AKI at 12 hours occurred in 5 patients, while 24 patients had AKI at 24 hours. Baseline TIMP-2 was significantly superior to other baseline biomarkers in predicting severe AKI at 12 (AUROC= 0.86) and 24 hours (AUROC=0.70) (Table 1). A combination of TIMP-2 and KIM-1 did not significantly improve the ability of TIMP-2 alone to predict severe AKI at 12 (AUROC=0.85, p-value=0.41) and 24 hours (AUROC= 0.71, respectively, p-value=0.72), as well as for the product [TIMP-2]*[IGFBP-7](AUROC=0.79 at 12h, 0.69 at 24h). When considering urinary biomarkers at 6 hour, KIM-1 had the best performance for the prediction of severe AKI at 12 (AUROC=0.81) and 24 hours (AUROC=0.78). Moreover, 6 hour-KIM-1 values performed better than 6-hour-[TIMP-2]*[IGFBP-7] in predicting severe AKI at 12 (AUROC=0.81 vs 0.65) and 24 hours (AUROC=0.78 vs 0.58), while no significant differences were found when considered a combination of KIM-1 and Urine Collagen IV both at 12h (AUROC=0.81, p-value=0.69) and 24h (AUROC=0.79, p-value=0.57).

Conclusions: This study shows that urinary biomarkers, such as baseline TIMP-2 and 6-hour-KIM-1, had a good diagnostic performance in predicting severe AKI in patients with sepsis.

Table 1. Comparison between AKI biomarkers in predicting severe AKI at 12 and 24h

<table>
<thead>
<tr>
<th>Biomarker (Log2 Form)</th>
<th>N (events)</th>
<th>AIC</th>
<th>P-Value</th>
<th>H-L</th>
<th>AUROC (1-CV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KIM-1</td>
<td>61 (5)</td>
<td>36.249</td>
<td>0.1359</td>
<td>0.1753</td>
<td>0.6821 (0.5714)</td>
</tr>
<tr>
<td>Biomarker (Log2 Form)</td>
<td>N (events)</td>
<td>AIC</td>
<td>P-Value</td>
<td>H-L</td>
<td>AUROC (1-CV)</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------</td>
<td>------</td>
<td>---------</td>
<td>---------</td>
<td>--------------</td>
</tr>
<tr>
<td>KIM-1</td>
<td>150 (24)</td>
<td>131.103</td>
<td>0.0280</td>
<td>0.6051</td>
<td>0.6543 (0.6157)</td>
</tr>
<tr>
<td>Urine Collagen IV</td>
<td>150 (24)</td>
<td>135.444</td>
<td>0.4988</td>
<td>0.3221</td>
<td>0.5483 (0.4011)</td>
</tr>
<tr>
<td>TIMP-2</td>
<td>150 (24)</td>
<td>127.299</td>
<td>0.0041</td>
<td>0.6402</td>
<td>0.7019 (0.6541)</td>
</tr>
<tr>
<td>IGFBP-7</td>
<td>150 (24)</td>
<td>131.071</td>
<td>0.0317</td>
<td>0.1853</td>
<td>0.6397 (0.5972)</td>
</tr>
<tr>
<td>TIMP-2 * IGFBP-7</td>
<td>150 (24)</td>
<td>128.240</td>
<td>0.0073</td>
<td>0.3279</td>
<td>0.6883 (0.6528)</td>
</tr>
<tr>
<td>TIMP-2, KIM-1</td>
<td>150 (24)</td>
<td>128.982</td>
<td>(0.0411, 0.5731)</td>
<td>0.4482</td>
<td>0.7067 (0.6498)</td>
</tr>
<tr>
<td>Hour 6 KIM-1</td>
<td>135 (22)</td>
<td>108.851</td>
<td>0.0002</td>
<td>0.4451</td>
<td>0.7838 (0.7627)</td>
</tr>
<tr>
<td>Hour 6 Urine Collagen IV</td>
<td>135 (22)</td>
<td>118.536</td>
<td>0.0221</td>
<td>0.4483</td>
<td>0.6691 (0.6275)</td>
</tr>
<tr>
<td>Hour 6 TIMP-2</td>
<td>135 (22)</td>
<td>121.851</td>
<td>0.1319</td>
<td>0.7332</td>
<td>0.5632 (0.4610)</td>
</tr>
<tr>
<td>Hour 6 IGFBP-7</td>
<td>135 (22)</td>
<td>122.144</td>
<td>0.1701</td>
<td>0.7227</td>
<td>0.5794 (0.4988)</td>
</tr>
<tr>
<td>Hour 6 TIMP-2 * IGFBP-7</td>
<td>135 (22)</td>
<td>121.860</td>
<td>0.1379</td>
<td>0.8180</td>
<td>0.5774 (0.5000)</td>
</tr>
<tr>
<td>Hour 6 Ur Coll. IV, KIM-1</td>
<td>135 (22)</td>
<td>110.286</td>
<td>(0.0018, 0.4146)</td>
<td>0.5167</td>
<td>0.7932 (0.7526)</td>
</tr>
</tbody>
</table>
The Burden of New Health Conditions in Elderly Severe Sepsis Survivors
Florian B. Mayr, MD, MPH; Walter Linde-Zwirble; Derek C. Angus, MD, MPH; Lisa A. Weissfeld, PhD; Sachin Yende, MD, MS

1Fellow, Critical Care Medicine, CRISMA Center, Department of Critical Care Medicine, University of Pittsburgh, Pittsburgh, PA

Objectives: To determine whether severe sepsis survivors are at increased risk of new health conditions and whether these conditions increase one-year mortality.

Methods: Matched-cohort analyses of 12,392 Medicare beneficiaries. We matched each severe sepsis patient to three controls (general population, hospitalized and infection controls) using propensity scores and incidence density sampling. Outcomes were diagnosis of a new health condition (cardiovascular disease, atrial and ventricular fibrillation, dialysis, cancer, diabetes, dementia, and infections) over one year and one-year mortality.

Results: New health conditions were common among severe sepsis survivors (76.4% had at least one condition). The most common conditions were infections (45.2%) and cardiovascular disease (35.1%). Severe sepsis survivors had a 1.5 fold, 1.1-fold, and 1.1-fold increased risk of diagnosis of at least one condition compared to general population, hospitalized, and infection controls, respectively (P <0.0001 for all comparisons). Among severe sepsis survivors, one-year mortality was high (26.4%). Severe sepsis survivors who were diagnosed with a new condition had a 1.3-fold increased risk for death compared to those without these diagnoses (P = 0.009). New health conditions accounted for 19% of deaths among severe sepsis patients.

Conclusion: Elderly severe sepsis survivors were at high risk for diagnosis of a new health condition and these conditions may explain increased long-term mortality.
Early Nutritional Support is Associated with Favorable Outcome in Pediatric Traumatic Brain Injury

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Departments of Critical Care Medicine1 and Epidemiology2, University of Pittsburgh and Neurological Surgery3, Barrow Neurological Institute and Phoenix Children’s, Phoenix AZ

The first author is a fellow in Pediatric Critical Care Medicine; the second author is her mentor.

Abstract: The impact of nutritional support on outcome after severe traumatic brain injury (TBI) is well recognized and nutritional support is addressed in the pediatric guidelines. Early initiation of nutrition (≤48h) is associated with survival in adults with severe TBI. However, it has not been systematically evaluated in children.

Hypothesis: Timing of nutritional support is associated with outcome in children with severe TBI. The Cool Kids Trial (NCT 00222742) tested the hypothesis that early (<6h), therapeutic hypothermia (32-33°C, 48h) would reduce mortality in children with severe TBI. Data were also collected on the timing of initiation of nutritional support for up to 7d as well as other variables. We defined nutrition initiation as the start of enteral or parenteral support and stratified it based on time after injury (<48h, 48-<72h, ≥ 72h or never). Outcomes were also stratified (mortality and Glasgow Outcomes Scale-Extended for Pediatrics [GOS-E Peds; 1-4, 5-7, 8] at 6 mo and mixed-effects models defined the relationship between nutrition and outcome. Children (n=90, 77 randomized, 13 run-in) were enrolled (mean GCS= 5.8); the mortality rate was 13.3%. 57.8% of subjects received hypothermia. Initiation of nutritional support varied widely (<48h-35.5%; 48-<72h-40%; ≥ 72h-18.9%, never–5.6%). Nutrition initiation was associated with mortality (p=0.01) and 6 mo GOS-E Peds (p<0.05). Patients never receiving nutrition in the study period exhibited increased mortality (<48h, p<0.05; 48-<72h, p<0.05) and worse GOS-E Peds (<48h, p<0.05; 48-<72h, p<0.05) vs other groups. Initiation of nutritional support early after TBI was associated with decreased mortality and favorable outcome in this secondary analysis. While this provides a rationale to initiate nutritional support early after TBI, definitive studies that control for important co-variates (severity of injury, clinical site, calories delivered, parenteral/enteral routes and other factors) are needed to provide definitive evidence on the optimization of the timing of nutritional support after severe TBI in children.
Safety and Efficacy of Warfarin Reversal with Four-Factor Prothrombin Complex Concentrate for Subtherapeutic INR in Intracerebral Hemorrhage

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Objectives: The use of vitamin K antagonists (VKA) is an independent risk factor for the development of intracerebral hemorrhage (ICH). Four-factor prothrombin complex concentrate (4F-PCC) is recommended for urgent reversal of anticoagulation in this setting. The safety and efficacy of 4F-PCC in ICH with subtherapeutic levels of anticoagulation is yet to be determined.

Methods: This was a retrospective, observational study of 4F-PCC administration data from September 2013 to July 2015. Patients with spontaneous or traumatic ICH with initial INR 1.4 to 1.9 were compared to those with INR 2 to 3.9. A Fisher’s Exact test was used to compare the difference between the two groups in the effectiveness of 4F-PCC in reversing the INR to ≤ 1.3 and in the occurrence of thrombotic events within seven days of administration.

Results: A total of 131 patients with a presenting INR between 1.4 and 3.9 received 4F-PCC during the study period. Twenty-three of 29 patients (79%) in the INR < 2 group achieved an INR reduction to ≤ 1.3 after 4F-PCC administration compared to 47 of 92 patients (51%) in the INR 2 to 4 group, p = 0.03. There was no difference in thrombotic complications within seven days after administration (6.7% in INR 1.4 to 1.9 group, 10% in INR 2 to 3.9 group, p = 0.73).

Conclusion: The use of 4F-PCC in patients with INR between 1.4 and 1.9 results in an effective reduction in INR with similar thrombotic risks compared to patients presenting with an INR of 2 to 3.9.
Renal Recovery at Hospital Discharge is Associated with 1-year Mortality in Patients with Sepsis-induced Acute Kidney Injury

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² The Center for Critical Care Nephrology. Department of Critical Care Medicine, University of Pittsburgh School of Medicine, and University of Pittsburgh Medical Center, Pittsburgh, PA.

Objectives: To examine factors associated with renal recovery at hospital discharge and whether renal recovery is associated with 1-year mortality in patients with sepsis-induced acute kidney injury (AKI).

Methods: We used the Genetic and Inflammatory Markers of Sepsis [GenIMS] study, a multicenter prospective inception cohort of adults hospitalized with community-acquired pneumonia. AKI was classified using the maximum Risk, Injury, Failure, Loss and End-stage (RIFLE) criteria. Complete recovery was defined as alive at discharge with return of serum creatinine (SCr) to within 150% of baseline or less. Partial recovery was defined as alive at discharge with improvement in at least one RIFLE stage without return of SCr to ≤150% of baseline. Non-recovery was defined as no improvement in RIFLE stage, death or renal replacement therapy (RRT) at discharge. We used multivariable linear regression to identify factors independently affecting renal recovery. Kaplan-Meier curves and multivariable Cox models were built to examine the association between renal recovery and 1 year survival.

Results: Of 1836 patients, 621 (34%) developed AKI. 287 (46%) had complete recovery, 71 (11%) had partial recovery and 263 (43%) had no recovery. Factors associated with partial and/or non-recovery included older age (OR =1.03, 95% CI:1.00-1.05, p=0.03), absence of AKI on admission (OR 0.27, 95%CI:0.11-0.69, p=0.02), lower AKI severity (OR 0.32, 95%CI:0.19-0.55, p<0.001) and absence of ICU admission (OR 3.2, 95%CI, 1.94-5.35, p<0.001). In the unadjusted analysis, complete recovery was associated with similar survival after 1 year compared with no AKI (Figure). Non-recovery was associated with higher mortality at 1 year (adjusted HR 1.79, 95%CI, 1.59-1.99, p<0.001), independent of age, Charlson comorbidity index, severity of AKI, ICU admission, need for mechanical ventilation or presence of severe sepsis on day 1.

Conclusions: Non-recovery from AKI at hospital discharge is associated with mortality at 1 year. Complete recovery seems to be associated with favorable survival at 1 year. Further studies are needed to delineate the effect of reversible AKI on longer term outcomes.
1-year mortality by renal recovery

![Graph showing mortality over time for different categories of renal recovery and no AKI.](image)

Number at risk

<table>
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<th>Category</th>
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<td>Complete</td>
<td>267</td>
</tr>
<tr>
<td>Partial</td>
<td>71</td>
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<tr>
<td>Non-recovery</td>
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<tr>
<td>Partial</td>
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<tr>
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<tr>
<td>No AKI</td>
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<td>Partial</td>
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<td>Complete</td>
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<tr>
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<td>141</td>
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</tbody>
</table>

Adapted from Murugan, R et. al.; Clin J Am Soc Nep 2012
A Zebrafish Model of Acute Kidney Injury Associated with Systemic Infection Induced by Intravascular Bacteria Injection

Liyan Cui, MD, PhD; Xiaoyan Wen, MD, MS; Seth Morrisroe, BS; Lauren Brilli, BS; Xiukai Chen, MD, PhD; Neil Hukriede, PhD; David Emlet, PhD; John A. Kellum, MD

1Visiting Scholar, Center for Critical Care Nephrology, Department Critical Care Medicine, University of Pittsburgh

Sepsis associated Acute Kidney Injury is a serious complication in critically ill patients and contributes to high mortality. To date, the underlying mechanisms responsible for kidney injury in sepsis remain poorly understood, and treatments are still limited to supportive methods. The zebrafish is an economically attractive multicellular organism that provides unique visual access to the microscopic structure with cell-cell interactions. Both the embryonic and adult zebrafish show conserved components in both immune responses and functional nephrons with mammals, making this model promising for studying mechanisms and screening for treatment options. An acute nephrotoxic kidney injury model has been developed using gentamycin, but inflammation-associated AKI is more clinically relevant and yet no model in the zebrafish has been reported. E. tadar is a lethal pathogen in zebrafish characterized by striking cytokine excretion and high mortality.

Objectives: To establish a zebrafish model of acute kidney injury associated with systemic infection.

Methods: We compared inflammatory findings of both bacteria injections into 3 days post-fertilization (dpf) zebrafish embryos as well as infection mediated kidney damage.

Results: We show dose-dependent mortalities for both E. coli and E. tadar intravascular injections, with E. tadar significantly higher than E. coli treated animals. We found remarkably decreased fluorescent dextran uptake and loss of tubule brush boarder in E. tadar treated larvae as early as 6-24 hours post injection, compared to E. coli treated ones as well as normal controls. Nephron-specific kidney injury molecular-1 (KIM-1) functions as a phagocyte receptor and mediates uptake of dead cells and tissue debris. Immunofluorescence staining of KIM-1 appears at late time points post injection in both groups, compared to no expressions in control groups. Prolonged expression of KIM-1 in mammalian kidneys predicts AKI and maladaptive repair.

Conclusions: These analyses have provided new insights for further understanding the physiological and molecular mechanisms that lead to kidney injury in the setting of infection and system inflammation.
Genetic Variants in Hyperferritinemic Sepsis
Kate Kernan, MD, Fellow, PCCM; Rahil Sethi, Lina Gonzalez, MD; Uma Chandran, PhD, MSIS; Janette Lamb, PhD and Mentor: Joseph Carcillo, MD

Objective: Our research focuses on identifying gene variants that predispose to septic shock and elevated ferritin levels. We are particularly interested in understanding variants found in genes associated with immunologic disorders, including primary immunodeficiencies and complex immunologic phenotypes such as hemophagocytic lymphohistiocytosis, macrophage activation syndrome, atypical hemolytic-uremic syndrome, thrombotic thrombocytopenic purpura, periodic fever syndromes, autoimmune lymphoproliferative syndrome and hemochromatosis.

Methods: Using the Ion Torrent platform we have next generation sequenced six pediatric patients with hyperferritenemic sepsis. Non-synonymous coding variants were identified, and after applying internal quality filtering, we selected a subset of variants found in genes related to the aforementioned disease states for further analysis. Of that subset, we further filtered the results for variants found in the general population at a frequency less than 0.05 and those whose frequency in pediatric hyperferritenemic sepsis patients differs significantly than in population studies of previously reported human genome sequences (NHLBI ESP6500, and the 1000 genomes project) (P<0.05).

Results: Among the first 6 pediatric patients sequenced, one individual was found to harbor a novel variant of a homozygous frameshift deletion in XIAP, X-linked inhibitor of apoptosis protein. This protein stops apoptotic cell death and is known to be associated with an X-linked lymphoproliferative disorder.

Conclusions: Next generation sequencing may identify novel variants in immunologically active genes that contribute to the phenotypic expression of pediatric sepsis.
AMPK Activation Rescues Energy Depletion during Sepsis-induced AKI and May Improve Outcome

Seth Morrisroe; David R. Emlet, PhD; Jacob Volpe; Yujie Ma, MD; Kui Jin, MD; Michael R. Pinsky, MD; Brian S. Zuckerbraun, MD; John A. Kellum, MD; Hernando Gomez, MD

Center for Critical Care Nephrology, Department of Critical Care Medicine

Purpose: The role of energy regulatory pathways in the protection from sepsis-induced acute kidney injury (AKI) is uncertain. We have previously shown that AMP-activated protein kinase (AMPK), a master regulator of energy balance, is activated early after cecal ligation and puncture (CLP), and its exogenous activation with AICAR limits sepsis-induced AKI and inflammation. Here we tested the hypotheses that activation of AMPK with AICAR limits both ATP depletion, and inflammation, and improves clinical status and survival.

Methods: H1: 15 C57BL/6 wild type, 12-20 week old, 30-35g mice were subjected to CLP (n=12) or sham surgery (n=3), and sacrificed after 8 h to measure renal tissue ATP. Human proximal tubular epithelial cells (HK2) were exposed to LPS+HMGB1 (sepsis mix or SM) for 6 and 24 hours, and were treated with AICAR 500nM, Compound C (20μM), or vehicle. Outcomes included MCP-1, intracellular ATP levels and activation of AMPK. H2: Mice subjected to CLP (n=18) or sham surgery (n=9) were randomly assigned to pretreatment with AICAR (100 mg/kg intraperitoneal (IP), 24h before), Compound C (AMPK inhibitor, 30mg/kg IP) or vehicle (control). Functional status was assessed using a 6-item clinical severity score (score range 0-3) daily for 7 days.

Results: Sepsis was associated with a decline in ATP in renal tissue and HK2 cells. (Figure 1A, B). AMPK activation limited the decline in renal ATP (Fig 1A,B) and was associated with a trend towards improved mortality. AMPK inhibition with compound C was associated with worse clinical score (Fig 1C), survival (7 day mortality CLP 83.3%, AICAR 50%, Compound C 100%) and higher inflammation (Figure 1D).

Conclusion: AMPK activation limits ATP depletion in the kidney, and was associated with decreased clinical severity score and a trend towards improved survival. Inhibition with compound C resulted in increased inflammation. These data suggest that immune modulation and energy conservation may play a role in the protective effects of AMPK activation during sepsis.
Objectives: The role of the melatonergic system after traumatic brain injury (TBI) remains unknown; this study explores changes in endogenous melatonin receptors after TBI in rats.

Methods: Young adult rats were randomly assigned to receive TBI or sham and were euthanized at either 6 hr post-operatively (n=12) or 24 hr post-operatively (n=13). TBI induced using pneumatic controlled cortical impact (CCI) or sham surgery. Following sacrifice and removal of the brain from the cranial vault, the ipsilateral hippocampus and frontal cortex were dissected out and flash frozen in liquid nitrogen until processed for histological analysis. Tissue was homogenized using lysis buffer in combination with a sonicator; whole cell lysates were collected and subjected to BCA assay to determine the desired loading volume to achieve the desired mass of total protein. Western blot analysis and semi-dry transfer were completed and membranes were washed, blocked, and incubated in primary antibodies (MT1, MT2, and actin) before rewashing and incubating in corresponding secondary antibodies. Membranes were imaged using a digital imaging system (BioRad) and chemiluminescent solution. The bands were semi-quantified using ImageJ and normalized to beta-actin levels. Group differences were assessed via independent samples t-test. The criteria for statistical significance are as follows: p<0.05* and p<0.001**.

Results: Group means and SEM are graphed by protein, brain region, and time-point (Figure 1). In the hippocampus, MT1 was downregulated at 24 hr post-TBI (p<0.0005**) with a trend toward significance at 6 hr (p=0.064); similarly, downregulation of hippocampal MT2 was evident at 6 hr (p=0.011*) and 24 hr (p<0.0005**) post-TBI. In the frontal cortex, there was no significant difference in MT1 or MT2 levels between sham and CCI groups at 6 hr; however, 24 hr post-TBI cortical MT1 (p=0.001**) and MT2 (p=0.0004**) were downregulated.

Conclusions: In this study, reduction of both endogenous melatonin receptors (MT1; MT2) was downregulated after TBI. Additional research characterizing this system is necessary, as these changes may be related to prognosis or response to therapy.
Figure 1. Western blot results by protein of interest, time-point, and brain region.
Sublingual Microvascular Flow Parameters Can Predict Post-resuscitation Microvascular Response and May Predict Intestinal Regional Perfusion

Mia Pauley*; Camila Corzo, MD; Brett Curtis*; Lisa Gordon; Bridget Deasy; Michael Pinsky, MD; Brian Zuckerbraun, MD; Hernando Gomez, MD

Level of Training of first three authors: *Undergraduate student and MD, Cardiopulmonary Physiology Laboratory

Background: The purpose of fluid resuscitation following traumatic hemorrhagic shock (THS) is to optimize microvascular flow and maintain tissue perfusion. However, macrohemodynamic parameters fail to predict the regional microvascular flow response in disease states such as THS. Thus we hypothesize that in hemorrhaged animals predicted to respond to fluids by macrohemodynamic parameters: H1: pre-resuscitation microvascular parameters can differentiate those that will respond to fluids by improving microvascular flow, from those that will not; and H2: that animals that respond to fluids by improving microvascular flow, will also improve tissue perfusion as measured by lactate:pyruvate ratio.

Methods: Twenty one Yorkshire-Durock pigs were bled to 30 mmHg mean arterial pressure (MAP) and maintained by repetitive bleeding for 90 minutes or until cardiovascular collapse occurred (MAP < 30 mmHg for 10 min or, <20 mmHg for 10 s). Animals were resuscitated with Hextend in equal parts to shed volume. Microvascular perfusion was evaluated using the sidestream dark field videomicroscopy, and quantified by calculating the proportion of perfused vessels (PPV), microvascular flow index (MFI) score and the heterogeneity index (HI = max flow – minimum flow/total average flow), prior to resuscitation (R0), and at the end of resuscitation (EH). Microvascular fluid responsiveness was defined as an increase in MFI > 10% after fluid resuscitation. Intestinal perfusion responsiveness was defined as L:P ratio < 20. Means were compared with t-test or non-parametric tests if appropriate, and the area under the receiver operating characteristic (ROC) curve was used to evaluate MFI as a predictor of microvascular fluid responsiveness.

Results: MFI and PPV at R0 predicted fluid microvascular responders as shown in figure 1A. A change in MFI of more than 50% after fluid resuscitation was the only marker that displayed a trend towards prediction of regional perfusion response as measured by the intestinal Lactate:Pyruvate ratio.
**Figure 1.** A. Microvascular Flow Index (MFI) and Proportion of Perfused vessels (PPV) as predictors of a change of more than 10% in post-resuscitation MFI. B. Microvascular fluid responsiveness (defined as a change in MFI > 10% post-resuscitation) as a predictor of post-resuscitation intestinal Lactate:Pyruvate ratio. C. ROC curve of change in post-resuscitation MFI as a predictor of post-resuscitation L:P ratio.
Multi-parameter Flow Cytometric Analysis of PBMC-derived Monocyte Response to Danger Signals

Bradley Podd, MD, PhD; and Joseph Carcillo, MD
Division of Pediatric Critical Care Medicine, Department of Critical Care Medicine, Children's Hospital of Pittsburgh and University of Pittsburgh School of Medicine

Background: Most children who die of sepsis do so with a multiple organ dysfunction syndrome (MODS), which can be associated with hyperferritinemic macrophage activation syndrome (MAS). In a proof of feasibility study, we tested the hypothesis that heavy-chain ferritin (HCF) can activate monocytes ex vivo. Our overall goal is to develop personalized medicine approaches to severe sepsis care by: 1) relating immune phenotype to clinical phenotype, 2) monitoring response to conventional or immunomodulatory therapy, and 3) manipulating and analyzing cells ex vivo.

Methods: We have used multicolor multiparameter flow cytometry of PBMC as a tool to analyze innate immune phenotypes. In this proof of feasibility experiment, whole blood PBMCs from a healthy donor were isolated and incubated with pathologic concentrations of LPS (recognized by TLR4), CPG DNA (recognized by TLR9) or HCF (recognized by TfR1, possibly others).

Results: CD40 expression was analyzed among CD14+ cells. Incubation with HCF resulted in increased frequency of CD40 expression (35%) compared to controls (2%) or CPG DNA (24.1%), but was less frequent than after exposure to LPS (45%). By contrast, incubation with CPG resulted in higher frequency of expression of the marker CD16 among CD14+ cells (46%) as compared to LPS (11%) or HCF (11%), but was less than observed among control (69%).

Conclusions: This study indicates that multicolor multiparameter flow cytometry of isolated PBMC is a feasible approach to measure ex vivo immune response to stimuli. Distinct patterns of innate immune cell activation, as measured by CD40 expression, and differentiation, as measured CD16 expression, were observed with co-incubation with various pathogen associated molecular patterns (CPG or LPS) or HCF. HCF may act as damage associated molecular pattern / cytokine in innate immune activation. Further study is required to understand 1) effect of HCF source on activation, 2) signaling pathways involved in response to HCF, 3) effect of HCF on innate cell cytokine production, and 4) effect of anti-inflammatory therapy on HCF response.
Improved Lifespan in Drosophila Surviving Sepsis through Reversal of the Warburg Effect

Mereddy Avantika Reddy*; Michael J. Stelmach*; Jennifer Kwon*; Amélie I. F. Cambriel; A. Murat Kaynar, MD, MPH; Veli Bakalov, MD

*Co-first authors / University of Pittsburgh Undergraduate Students, Department of Critical Care Medicine

**Objectives:** Multiple organ failure, wasting, increased morbidity, and mortality following acute illness complicates the health span of patients surviving sepsis [1]. The theory for the increased morbidity and mortality among sepsis survivors is sustained inflammation, which was triggered by the initial insult and sustained by mechanisms that are poorly understood. [2,3]. The balance at the cellular energetic levels between oxidative phosphorylation and aerobic glycolysis has recently been suggested to be one of the determinants driving acute as well as sustained inflammation [4, 5].

We hypothesized that reversal of the aerobic glycolysis into oxidative phosphorylation (reversal of Warburg effect) decreases sustained inflammation and associated mortality and morbidity. We therefore tested our hypothesis by inducing starvation as well as using agents (Metformin, 2-Deoxyglucose (DG), and dichloroacetate (DCA)) to force the cellular metabolic flux out of aerobic glycolysis into oxidative phosphorylation in a survival model of sepsis in *Drosophila melanogaster*.

**Methods:** We used wild-type (WT) *Drosophila melanogaster* 4–5 days of age (unmanipulated). We infected *Drosophila* with *Staphylococcus aureus* (infected without treatment) or pricked with aseptic needles (sham). A group of flies were treated with oral linezolid following infection (infected with antibiotics).

To test our hypothesis, we starved flies for 6 hours before the induction of sepsis. In separate experiments to force metabolism into oxidative phosphorylation, we treated flies with Metformin, 2DG, DCA for 1 week after infection. We harvested the flies over the 7-day course to evaluate bacterial burden, inflammatory and metabolic pathway gene expression patterns, and metabolic reserve. We also followed the lifespan of the flies.

**Results:** Our results showed that when treated with antibiotics, flies had improved survival compared to infected without treatment flies in the early phase of sepsis up to 1 week (81 %, \( p = 0.001 \)). Sepsis survivors treated with antibiotics had significantly lower glucose stores along with increased level of lactate comparing to sham flies \( (p = 0.001) \). (**Figure 1A**). Lifespan of infected with antibiotics flies was significantly shorter than that of sham controls \( (p = 0.001) \) (**Figure 1B**).

In the group of sepsis survivors, starvation 6 hours before infection demonstrated significantly better survival 1 week after infection and longer life-span. Flies pretreated with Metformin, DCA, and DG also demonstrated similar improvement in survival 1 week after infection (**Figure 1C**).

**Conclusions:** In summary, using *Drosophila* sepsis model, we successfully reversed mortality in sepsis surviving flies by promoting oxidative phosphorylation following sepsis instead of traditional interventions on immune system or microorganisms.
References:


Figure 1
Health Services and Educational Research

Impact of a Physician-Targeted Pay-for-Performance Program on Use of Spontaneous Breathing Trials in Mechanically Ventilated Patients
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Fellow, Division of Pulmonary, Allergy and Critical Care Medicine
Postdoctoral Research Fellow, CRISMA Center, Department of Critical Care Medicine
T32 Postdoctoral Scholar, University of Pittsburgh

Statement of Need: Pay-for-performance is an increasingly common quality improvement strategy despite the absence of robust supporting evidence.

Methods: We analyzed data from six months before and two years after the 2012 initiation of a physician-targeted pay-for-performance program in three academic hospitals within an integrated health system. Under the program, approximately 5% of each intensivist’s annual income was tied to unit-wide performance on three quality metrics, including SBT completion rate for eligible patients. We compared processes of care and patient outcomes before and after introduction of the program. We used Poisson regression to examine the proportion of mechanically ventilated patient-days deemed eligible for an SBT and daily SBT attempt rates for eligible patients. We used multivariate regression to examine risk-adjusted duration of mechanical ventilation (DMV), ICU length of stay (LOS), and in-hospital mortality among mechanically ventilated patients. To account for differences in baseline SBT rates across hospitals we performed the analysis separately for each of the three sites.

Results: The cohort included 7,292 mechanically ventilated patients with 75,621 ventilator days. Baseline SBT rates were 97.3% in hospital A, 16.3% in hospital B, and 76.8% in hospital C. In hospital A, there was no change in SBT rates, DMV, or mortality across time periods, although there was a small decrease in SBT eligibility and ICU LOS (Table). In hospitals B and C there was an increase in daily SBT completion rates coincident with a decrease in the number of mechanically ventilated patients deemed eligible for SBT. There were mixed changes in patient outcomes, with a small decrease in DMV and ICU LOS in hospital C, but no statistically significant change in hospital B.

Conclusions: In hospitals with low baseline compliance, physician-targeted financial incentives were associated with increased SBT rates driven in part by increased exclusion rates, without consistent improvements in outcome. This pattern suggests that financial incentives may affect documentation without necessarily improving clinical outcomes, and that the impact of similar incentives is likely to vary based on contextual factors.

Table 1:
Table: Changes in Processes and Outcomes of Care

<table>
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<th>Post-Intervention Year 2 vs. Baseline</th>
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<td>Hospital A</td>
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<td>95% CI</td>
<td>p-value</td>
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<td>SBT Completion</td>
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<td>[0.97 – 1.05]</td>
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<td>[0.91 – 0.98]</td>
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<td>In-Hospital Mortality</td>
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<td>ICU Length of Stay</td>
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<td>[-0.17 – -0.01]</td>
<td>0.02</td>
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</tbody>
</table>

| Hospital B | IRR        | 95% CI         | p-value |
|------------|--------------------------------------|---|---|---|
| SBT Completion | 5.72      | [3.87 – 8.46]  | <0.001 |
| SBT Eligibility | 0.51      | [0.42 – 0.62]  | <0.001 |
| In-Hospital Mortality | 1.11      | [0.39 – 3.16]  | 0.20   |
| Duration of Mechanical Ventilation | 0.20      | [-0.09 – 0.48]  | 0.17 |
| ICU Length of Stay | 0.22      | [-0.13 – 0.56]  | 0.22 |

| Hospital C | IRR        | 95% CI         | p-value |
|------------|--------------------------------------|---|---|---|
| SBT Completion | 1.23      | [1.15 – 1.31]  | <0.001 |
| SBT Eligibility | 0.78      | [0.74 – 0.83]  | <0.001 |
| In-Hospital Mortality | 0.85      | [0.63 – 1.13]  | 0.27   |
| Duration of Mechanical Ventilation | -0.18     | [-0.28 – -0.09]  | <0.001 |
| ICU Length of Stay | -0.15     | [-0.26 – -0.03]  | 0.01 |

The post-intervention year 2 is compared with the pre-intervention period using Poisson regression for SBT data, logistic regression for mortality, and linear regression for duration of mechanical ventilation and ICU LOS. SBT = Spontaneous Breathing Trials; IRR = Incidence Rate Ratio.
Prospective Evaluation of the Pediatric Rothman Index as a Measure of Pediatric Inpatient Acuity

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The increasing acuity of hospitalized patients necessitates new methods of clinical surveillance to ensure patient safety. Previous retrospective analysis demonstrated the potential utility of the pediatric Rothman Index (pRI), a composite acuity score integrated in the electronic medical record (EMR), for predicting clinical deterioration in hospitalized pediatric patients. This study represents a prospective evaluation of the pRI as a tool for timely detection and electronic notification of patient deterioration.

Previous retrospective analysis guided the selection of pRI thresholds of 30 and 40 to trigger silent acuity alerts for hospitalized, acute care, pediatric patients at our tertiary Children’s Hospital. In this IRB-approved study, data were collected prospectively from Apr-Jul 2015. Demographic and clinical data were recorded. Lead time between triggered alerts and transfer to an intensive care unit (ICU) was calculated. Medical emergency response team deployment (Condition A or C) during the study period was examined for overlap with pRI-triggered alerts.

During the study period, the cohort (n=68) triggered 107 alerts (1.2/day). The median age of the cohort was 14 y (interquartile range 7 y 9 mo – 18 y) and 57% were male. 14 patients (20.5%) who triggered an acuity alert required ICU care, with a median lead time of 15 h 12 min. Compared to patients who did not trigger an alert but were transferred to the ICU, patients triggering alerts were older (median age 14 y versus 5 y; P < 0.001), less likely to experience critical deterioration (8.8% versus 41.3%; P < 0.001), and less likely to trigger emergency response team activation (1.5% versus 13.0%; P = 0.008). Patients triggering alerts were more likely to be transferred to the ICU than patients not triggering an alert, relative risk 5.8.

Acuity alerts generated using the EMR-integrated pRI provided early identification of a cohort of patients who ultimately required ICU-level care or critical intervention(s). Further refinement of pRI alerts may better highlight inpatient pediatric acuity and guide timelier interventions.
Comparing How Intensivists and Palliative Care Physicians Discuss Patient Values and Preferences in Simulated Family Conferences

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Primary affiliation of first author: Fellow (Post-doctoral scholar), Division of Pulmonary, Allergy, and Critical Care Medicine, University of Pittsburgh

Objective: To compare how intensivists and palliative care physicians discuss an incapacitated patient’s values and preferences in simulated ICU family conferences, and test whether these communication skills are associated with patient-centeredness of care.

Methods: Using high-fidelity simulation, physicians from critical care (n=36) and palliative care (n=14) conducted audiorecorded ICU family conferences for a 78 yo woman on day 12 of mechanical ventilation for ARDS as if she were their patient in clinical practice. Actresses portraying the patient’s daughter completed the Patient-Centeredness of Care Scale (PCCS). Coders analyzed transcripts for physicians’ statements: 1) identifying the patient’s values and preferences; 2) applying her values and preferences by: a) discussing what they mean in light of her prognosis and treatment options; b) asking the surrogate’s substituted judgment about what she would want; or c) recommending treatment based on them. We compared intensivists’ and palliative care physicians’ use of these communication skills with Fischer’s exact test and t-tests, and tested their association to PCCS with linear regression.

Results: Compared to intensivists, palliative care physicians asked significantly more questions identifying the patient’s values and preferences (mean 13.7 v 20.6, p=0.04), made significantly more statements about what they mean in light of the prognosis or treatment options (mean 1.1 v 2.6, p=0.005), and more often recommended treatment based on the patient’s values and preferences (14% v 43%, p=0.05). Both asked for a similar number of substituted judgments (mean 2.0 v 2.1, p=0.94). Linear regression showed a highly significant association between these 4 skills and PCCS (F<0.005).

Conclusions: Compared to intensivists, palliative care physicians asked more about the patient’s values and preferences, discussed more about what they mean in light of the prognosis or treatment options, and more often recommended treatment based on them. These skills were associated with greater patient-centeredness of care. Data are needed to test whether these communication skills lead to more patient-centered care in actual practice.
### Table. Physician identification and application of the standardized patient’s values and preferences

<table>
<thead>
<tr>
<th>Communication Skill</th>
<th>ICU Physicians (n=36)</th>
<th>Palliative Care Physicians (n=14)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identified the patient’s values and preferences</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>N (%)</td>
<td>36 (100%)</td>
<td>14 (100%)</td>
<td></td>
</tr>
<tr>
<td>Mean (SD) statements/conference</td>
<td>13.7 (1.7)</td>
<td>20.6 (2.8)</td>
<td>0.04</td>
</tr>
<tr>
<td>Applied the patient’s values and preferences</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussed values and preferences in light of the prognosis or treatment options</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N (%)</td>
<td>22 (61%)</td>
<td>11 (79%)</td>
<td>0.32</td>
</tr>
<tr>
<td>Mean (SD) statements/conference</td>
<td>1.14 (0.22)</td>
<td>2.57 (0.57)</td>
<td>0.005</td>
</tr>
<tr>
<td>Asked for a substituted judgment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N (%)</td>
<td>30 (83%)</td>
<td>11 (79%)</td>
<td>0.70</td>
</tr>
<tr>
<td>Mean (SD) statements/conference</td>
<td>2.03 (0.31)</td>
<td>2.07 (0.45)</td>
<td>0.94</td>
</tr>
<tr>
<td>Made a recommendation based on patient values and preferences</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N (%)</td>
<td>5 (14%)</td>
<td>6 (43%)</td>
<td>0.05</td>
</tr>
<tr>
<td>Mean (SD) statements/conference</td>
<td>0.17 (0.45)</td>
<td>0.43 (0.51)</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Funding: Dr. Scheunemann was funded by NIH T32HL007820-16A1, NIH T32HL007563-27, and NIA F32 AG047806-01A1. Dr. Arnold was supported by the Jewish Healthcare Foundation and the Arthur Vining Davies Foundation. Dr. White was supported by NIH R01HL094553, R01 AG045176, and R01 NR014663.
**Barriers and Facilitators to the Conduct of ICU Interdisciplinary Family Meetings: Findings from a Qualitative Exploration**

Jennifer B. Seaman, PhD, RN¹; Robert Arnold MD²; Kimberly Rak, PhD, MPH, MA; Marci L. Nilsen, PhD, RN³; Amanda Argenas, MA¹; Anne-Marie Shields, MSN; Douglas B. White, MD, MAS¹

¹University of Pittsburgh School of Medicine, Department of Critical Care Medicine, ²University of Pittsburgh School of Medicine, Department of Internal Medicine; UPMC Palliative and Supportive Institute, ³University of Pittsburgh School of Nursing, Department of Acute and Tertiary Care

*Level of training and primary affiliation of first author: Postdoctoral Critical Care Research Scholar; University of Pittsburgh, School of Medicine, Department of Critical Care Medicine, CRISMA Center*

**Introduction:** Conduct of timely interdisciplinary family meetings in the ICU has been shown to improve patient and family-centered outcomes and has been incorporated into recommendations for best practice. Yet, adherence to these recommendations is poor. The purpose of this study is to use an implementation science approach to understand barriers and facilitators related to the conduct of timely family meetings from the perspectives of ICU clinicians and to elicit clinicians’ ideas for interventions to ensure timely family meetings.

**Methods:** We are conducting in-depth, semi-structured phone interviews with clinicians from among a national sample of ICUs to elicit perceived barriers and facilitators related to the conduct of timely family meetings. Using the AHA database we are purposively sampling to recruit participants in diverse clinical roles from a range of practice settings, with the goal of enrolling ≥2 clinicians from each ICU. We are performing constant comparative content analysis to generate a matrix of themes; data from future interviews will be integrated into the matrix, ceasing enrollment with thematic saturation.

**Results:** To date, 11 participants in diverse nursing roles have completed the study. Emergent themes are about beliefs, practices, barriers and facilitators related to family meetings. Participants universally ascribe high value to family meetings, endorsing them as uniquely able to simultaneously achieve intra and inter group communication, and to provide family support. Participants do not, however, cite unit-based protocols for holding meetings, but instead describe predominantly reactive motivations for their conduct. Clinicians identified buy-in at all levels, preemptive scheduling of family meetings, compliance monitoring, and clinician education as key components to a proposed intervention to ensure timely family meetings (Table 1).

**Conclusions:** Findings suggest that establishing structured care processes in support of proactive family meetings is needed. Modifiable barriers suggest targets for intervention, and identified facilitators can be leveraged in intervention design. Next steps include a larger survey to validate these finding across a larger sample.
<table>
<thead>
<tr>
<th>Theme</th>
<th>Exemplar Quote</th>
</tr>
</thead>
</table>
| Value of interdisciplinary family meetings | “It gets us all on the same page.”  
“There’s just an acknowledgement that these conversations have to happen, in order for people to transition.”  
“The family…it just makes them understand better how to make choices and gives them support.”                                                                                                                   |
| **Barriers**                               |                                                                                                                                                                                                                                                                                                                                                     |
| **Patient-Family Level**                  |                                                                                                                                                                                                                                                                                                                                                     |
| Conflicted or avoidant families           | “So those barriers sometimes are the family and it’s not just this case, but the families—some want the meeting, some don’t want the meeting, they’re mad if you have the meeting.”  
“The other thing are families that are having a really hard time...It’s either a chronic disease that they’ve never really come to grips with...or a sudden disease that they’re having a really hard time with. Sometimes families will hide...You literally cannot get in touch with the family members, and that makes it nearly impossible.” |
| **Clinician-level**                       |                                                                                                                                                                                                                                                                                                                                                     |
| Perceived clinician discomfort with conducting meetings and with end-of-life conversations | “Some of the hospitalists don’t like to talk about end-of-life care...they want to go the whole nine yards for everybody, all the time.”  
“Physicians are driven by their comfort level.”                                                                                                                                                                                                                               |
<p>| Belief that attending family meetings is not a nursing priority | “Sometimes it can be very difficult to pull away from the bedside because they have this task, and that task...and they don’t always see the ICU family meeting as valuable...”                                                                                                                                                                      |
| <strong>Unit-level</strong>                            |                                                                                                                                                                                                                                                                                                                                                     |
| Holding a meeting only when a decision is needed | “Usually if they’ve been on the vent five days or six days, and we don’t see an end to it, or they might need a trach and a PEG and a long-term care facility—that type of thing—“                                                                                                                                                       |
| <strong>Institutional-level</strong>                   |                                                                                                                                                                                                                                                                                                                                                     |
| Lack of administrative support            | “Unfortunately, our VPMA [vice president for medical affairs] is one of our least engaged people with family conferences... when we are in need of support, he’s the one I have to call and he usually supports whatever the other doctor wants to do. And then I end up having to go over him to the president or the vice president or the CNO.” |
| <strong>Facilitators</strong>                          |                                                                                                                                                                                                                                                                                                                                                     |</p>
<table>
<thead>
<tr>
<th><strong>Unit-level</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Including families in daily rounds</td>
<td>“…if we’re not having to give them all of the information, all at once in a family meeting, if they’ve kind of been prepped along the way...sometimes the family meeting is a culmination of every day, having conversations with this family, so then they feel empowered to actually make a decision when the actual family meeting happens.”</td>
</tr>
<tr>
<td>A clear process and a responsible party for setting up meetings.</td>
<td>“Our case manager does a really good job of knowing when doctors have clinic hours and things like that, so she’s able to manipulate time very well, which is nice.”</td>
</tr>
<tr>
<td>Closed Unit</td>
<td>“Our hospitalist is here...and social services is here”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Institutional-level</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative Support</td>
<td>“My director—she’s super supportive...yes, ’cause if you need to spend that time you need to know that somebody’s not going to be wondering, you know, where you were, or what was going on, because they do take time.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Future Interventions</strong></th>
<th></th>
</tr>
</thead>
</table>
| Multidisciplinary buy-in | “I think it’s the bedside nurses... if they don’t have buy-in, if they don’t place a value on this, then they can really drag their heels in the process.”  
“I think it’s physician buy-in I think that’s probably the hardest thing...nurses suggest it, but then doctors kinda shoot it down and unless they want to buy into it, we’re not gonna get that meeting that early.”  
“The team effort is so important.” |
| Preemptive scheduling of a family meeting upon admission to ICU | “So I feel like it would almost need to be...just a given... with patient admission.” |
The Effect of Clinical Trial Results on the Use of Neuromuscular Blockade for Severe ARDS

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Objectives: The 2010 ACURASYS trial suggested that neuromuscular blockade (NMB) agents can lower mortality in severe acute respiratory distress syndrome (ARDS). The effects of publication of this trial on NMB use in severe ARDS are unknown.

Methods: We performed a retrospective cohort study using the electronic health record of 12 hospitals in the UPMC Health System from 2010 to 2012. Eligible patients included all mechanically ventilated adults with severe ARDS (P:F ratio <150) secondary to sepsis. The primary outcomes were receipt of any NMB and receipt of a continuous NMB infusion while intubated in the ICU. We compared these outcomes before and after the publication of the ACURASYS trial in September 2010 using multivariable logistic regression, treating time as a linear spline to account for temporal trends that may be independent of ACURASYS publication.

Results: The final cohort included 4,986 patients, of whom 1333 (27%) received any NMB and 306 (6%) received a NMB infusion. Patients who received any NMB had greater severity of illness (mean SOFA score: 9.2 vs 7.9, p<0.01), and worse oxygenation (mean P:F ratio: 83 vs. 97, p<0.01). After adjusting for these and other clinical factors, we found significant differences in utilization trends before and after publication of the ACURASYS trial for any NMB use but not NMB infusions. Examining any NMB use, adjusted use in the pre-publication period was stable over time while adjusted use in the post-publication period increased over time (p=0.018 comparing slopes, see Figure). Examining use of NMB infusions, adjusted use was stable over time both before and after publication of ACURASYS (p=0.75 comparing slopes).

Conclusions: The publication of the ACURASYS trial was associated with an increase in the use of NMB for patients with severe ARDS, although this finding was limited to intermittent dosing rather than NMB infusions. These findings suggest a modest impact of the ACURASYS trial in terms of clinicians overall approach to neuromuscular blockade but continued clinical equipoise regarding NMB infusions for severe ARDS.
**Pre-publication OR=0.98 (95%CI: 0.96, 1.006), versus post-publication OR=1.02 (95%CI: 1.00, 1.05), p=0.02.**
Sentiment Mining of Letters of Recommendations (LOR) for Residency Applications: A Preliminary Work on Automated Categorization

Mahbaneh E. Torbati, MS¹; Kathleen Coy, MD; Shawn T. Beaman, MD; Patrick Forte, MD; David G. Metro, MD; Rebecca Hwa PhD; A. Murat Kaynar, MD, MPH

¹Graduate Student, Department of Computer Sciences, University of Pittsburgh

Objectives: There has been a recent increase of interest in the automation of opinion extraction from text. As educators, we also face the increasing number of applications for our programs and expect to continue this rise in the future. In the last academic year, our program received in excess of 700 applications. We present preliminary work on the possible use of automation in extracting sentiment from standardized medical school LORs for residency applicants. Our hypothesis is that automated text mining of LORs results in similar interpretation of the sentiment, when compared to interpretation by established educators.

Methods: We obtained IRB approval for our work, following de-identification of the LORs, we selected 10 positive and 10 negative LORs to be interpreted by 4 educators. All the educators developed an annotated lexicon of 5 positive and 5 negative sentiments as interpreted during their reading of the LORs. We then used the reliability of interpretation between educators using Kendall's W for Agreement between Ranks with the null hypothesis that there is no agreement among the educators.

Results: There was good agreement between educators in interpreting the LORs and extracted similar terms (words, phrases) to build the lexicon for the next step of the work. The Kendall was $W = 0.8839$ with a $\chi^2=31.8214$, $df=9$, and $p=0.0002$. When we build the word cloud, phrases such as “magna cum laude”, “excelled”, “sincere” were repeated frequently (Figure 1).

Conclusion: We established the first step towards an automated interpretation support of LORs by confirming the coherence among educators interpreting text. The next step is to use this lexicon towards sentiment mining of LORs. Standardized LORs from medical schools during the time of residency application is an important variable in the decision making for residency acceptance. An automated approach in extracting sentiment from the LORs would be a great asset for the educators in making residency decisions.
Figure 1: Positive sentiment word cloud
Quality Improvement and Patient Safety

Evaluation of an Automated Pupillometer during Routine Neurological Assessments in the Acute Care of the Severe Traumatic Brain Injury Patient

Maighdlin Anderson, MSN, University of Pittsburgh School of Nursing (DNP Student); Sheila Alexander, PhD; Ava Puccio, PhD; Lori Shutter, MD

Objectives: The purposes of this project are to evaluate staff satisfaction with the pupillometer when incorporated into the existing Neuro-Trauma intensive care unit (NTICU) evidence-based protocol for regular pupil assessments during management of severe traumatic brain injury (TBI), and evaluate the use of pupillometer values as markers of intracranial pressure. The aims are to:

- Evaluate nursing, medical and neurosurgical staff satisfaction with the pupillometer and understanding of the NPi as it relates to pupillary assessment in patients with severe TBI.
- Evaluate the relationship between pupillary function as measured manually and automatically with the recorded intracranial pressures (ICP) for each patient treated with the protocol during the twelve-month period.

Methods: During this twelve month longitudinal quality improvement project, clinical staff (nursing, critical care and neurosurgery) in the NTICU were trained on use of the pupillometer and the aims of the project. Nurses caring for severe TBI patients completed a standard pupil exam using a penlight and then used the automated pupillometer to measure pupil size and the Neurological Pupil Index (NPi) every 2 hours. When abnormal results were obtained, both the manual and automated findings were reported to Neurosurgery and critical care providers. All pupillary data, ICP values and vital signs were recorded in the patient flow-sheet. Short surveys evaluating knowledge, practical use of the data from the pupillometer and satisfaction with the new device as an acute care adjunct were administered every 3 months via handouts. Correlation between NPi and ICP will be evaluated with least squares regression analysis to determine correlations over time.

Results: We are presenting results from 42 completed staff surveys and 16 TBI patients. Staff are positive about their ability to use and understand the device and think that it augments patient care and critical decision making. No significant relationship between abnormal NPi values and intracranial hypertension has been measured yet, though data from 4 patients suggests that the pupillometer may be useful in early identification of possible optic neuropathy in trauma patients. Additional analysis will be done on prior to presentation.

Conclusions: These results will increase understanding of the feasibility, practicality and possible efficacy of the pupillometer as a tool for decision making in acute TBI patients.
A Daily Checklist to Improve Communication between the Critical Care Team and Patients’ Families in the Trauma Intensive Care Unit
Tim Baptist, MD; Pavan Thangudu, MD; Tina Day, CRNP; Scott Gun, MD
Fellow, Department of Critical Care Medicine, University of Pittsburgh School of Medicine

Statement of Need: Effective communication between physicians and patients’ families in the intensive care unit improves family satisfaction and aids in clinical decision making. As part of a multifaceted approach to improve the family experience in the trauma intensive care unit, we sought to encourage daily communication between critical care physicians and patients’ families by utilizing a checklist.

Methods: Each day, attending intensivists were asked to complete a checklist that documented the method by which a family update occurred. If effective communication did not occur with the patient, and if the family was not updated at the bedside, the checklist prompted the physician to call the family at home. When an update did not occur, the reason why was documented.

Results: 101 checklists were completed over 175 days. The average patient census was 20. Compliance rates for completed checklists varied considerably among individual attendings (range 0 – 100%). On days that checklists were completed, 83% of patients and/or their families were successfully updated—67% received a bedside update, while 16% received an update by phone. On average, 3.24 phone calls were made daily. The remaining 13% of families were not updated for the following reasons: could not reach by phone but voicemail left (36%), could not reach by phone due to no answer (15%), no family listed (10%), lack of time (8%), transferred from ICU (7%), in operating room (4%), incorrect number listed (4%), prisoner (4%), other reason (4%), and no reason given (11%).

Conclusions: When effective communication with the patient was not possible, and the family was not updated at bedside, the checklist successfully prompted the physician to call the family at home. When no communication occurred, the reasons provided were reasonable. Only a minority of updates were not completed due to lack of time. Future directions include interviewing attending physicians to discover families’ perceptions of daily phone updates, and improving the number of updates made by encouraging fellow involvement.
A WINning Technique: The Wire-in-needle Feasibility Study
Torben K. Becker, MD, PhD; Joseph A. Betcher, MD; Suzanne L. Dooley-Hash, MD; Christopher M. Fung, MD; Cody C. Soyk, MD; David F. Barton, MD; Nik R. Theyyunni, MD
Fellow, Department of Critical Care Medicine, UPMC

Objectives: Ultrasound guidance has been shown to reduce complications associated with central venous catheter (CVC) placement. However, the procedure can remain challenging, particularly in volume-depleted patients. The wire-in-needle (WIN) technique has the potential to improve procedural safety: A needle is “preloaded” with a guidewire that is advanced towards the tip of needle. The vein is then cannulated using real-time ultrasound guidance with the transducer in the longitudinal orientation. The benefits of this technique include improved needle visualization, avoiding loss of access to the target vessel when switching from the syringe to the guidewire and no risk of inadvertent placement of a CVC into an artery as the wire is being observed as it is advanced into the vein. We assessed the feasibility and safety of the WIN technique.

Methods: Medical students, emergency medicine residents and faculty participated. After a brief lecture on the WIN technique, they practiced on a vascular access manikin. They then demonstrated both the traditional short axis and the WIN technique to an expert sonographer, who assessed their performance with both techniques. Participants then completed a survey on their current ultrasound use for CVC placement, and their assessment of the WIN technique.

Results: 60 clinicians participated. No significant differences in the number of needle redirections, cannulation attempts, arterial punctures or overall dexterity with the procedure was found. The WIN technique was faster (45.9 vs. 61.5 sec, p = 0.0005) and more participants explicitly confirmed the position of the wire in the vein (75% vs 95%, p = 0.002). Greater than 90% of study participants met the three pre-defined safety aspects of the WIN technique. 85% of the participants reported occasional difficulties with the traditional approach. The WIN technique was rated as easy to learn (8.29 on the VAS).

Conclusions: This study demonstrates that the WIN technique can be learned quickly and easily by clinicians with various levels of training. It appears to be as safe as the traditional short axis approach. It has the potential to make CVC placement safer.
Evaluation and Descriptive Analysis of Stroke Code Team
Jayaram Chelluri, MD, MHSA; Raghavan Murugan, MD, MS; Lakshmipathi Chelluri, MD, MPH; Katherine Spiering
Fellow, Critical Care Medicine

Statement of Need: Patients who have a stroke in the hospital have a longer length of stay with a higher degree of morbidity at discharge. In-hospital stroke code teams were developed to promote early diagnosis and treatment. There is limited literature on the efficacy of stroke code teams.

This study is a descriptive analysis of impact of stroke teams on initial management of suspected stroke in patients at Presbyterian and Montefiore. Additionally we will evaluate the time to tPA after the addition of a stroke nurse to the stroke code team.

Methods: We conducted a retrospective chart review of patients who received a stroke code team call. Duplicate records and records with incomplete information were excluded. Charts were reviewed for the following: location and time of code call, stroke provider clinical documentation, discharge diagnosis, and imaging. Outcomes evaluated were: time to intervention (tPA), contraindication to intervention, imaging confirmation of stroke, and ultimate discharge diagnosis.

Results: From 1/2013 to 12/2015, 100 patients were included in our analysis (116 screened). Of 100 patients, 48% were considered high risk on initial exam. 23% of the patients reviewed had a stroke confirmed by imaging. Altered mental status was the most common reason for stroke code calls in low risk patients and with no imaging confirmation of stroke. Interestingly, stroke calls increased significantly from 23 in 2014 to 62 in 2015.

In total, out of 100 patients, 9 received tPA for concern of new ischemic process. After the addition of a nurse to the code team, there was a 54% reduction in time to tPA. The most common contraindications to tPA in those deemed high risk with subsequent imaging confirmation of stroke were recent surgery (21%) or out of window (16%).

Conclusions: This retrospective study indicates that the process of evaluating and intervening on stroke patients can be improved. Possible areas of improvement include but aren’t limited to: early identification and improved resource utilization by reduction of calls for non-focal complaints. Fortunately improvements have been made as seen by the reduction in time to tPA.
A Quality Improvement Project to Ensure Appropriate Cleaning Practices of Ultrasound Machines after Clinical Use
Abhishek Freyer, MD; Christopher Schott, MD, MS, RDMS
Fellow, University of Pittsburgh, Department of Critical Care Medicine

Objectives: Point of care ultrasound (POCUS) is an increasingly common tool used to assist with diagnosis and treatment of patients. Appropriate cleaning of ultrasound (US) machines is important not only to limit potential spread of pathogens from patient to patient, but also to maintain longevity of the machines and transducers.

The purpose of this quality improvement (QI) project is to: 1. Educate physicians on appropriate cleaning practices based on manufacturer recommendations and type of potential pathogens which the machine is exposed to, and 2. To assess which educational materials were most effective in facilitating appropriate cleaning of the US machines.

Methods: Data was collected from Critical Care faculty and fellows using a pre- and post-intervention on-line survey. To use US machines at the VA, participants were required to complete a pre-intervention survey, and to meet with the US director for in-person education on cleaning for each device model. In addition, only the appropriate disinfectants were made readily available and contained on each device, and reference cards were attached to each machine.

Results: The intervention took place over 6 months. During this time, a total of 244 US exams were performed and saved. 13 faculty and fellows completed both pre- and post-intervention on-line surveys. All had rotated at the VA over this time. There was an average score increase of 13.9% on post- vs. pre-test knowledge assessment (p = 0.0422, 95% CI = 0.58%- 27.31%).

Conclusions: Written assessment of knowledge demonstrated statistically significant improvement amongst faculty and fellows that rotated at the VA and completed both pre- and post- test evaluation. Despite the limitations of the study, what is particularly unique about this QI project is that we were able to assess which of the multiple implemented modalities were perceived as most effective. Results are summarized in Table 1, with rank score noting the greatest reported impact from having only appropriate cleaners stocked and reference hanging from each device. Moving forward, we will likely invest resources in these areas to ensure appropriate cleaning practices of POCUS machines.
### Table 1. Subjective Ranking of Intervention Modalities

<table>
<thead>
<tr>
<th>Intervention Description</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>n/a</th>
<th>Total</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Having only the appropriate materials readily available and contained on each device</td>
<td>58.33%</td>
<td>33.33%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>8.33%</td>
<td>0.00%</td>
<td>12</td>
<td>4.33</td>
</tr>
<tr>
<td>Reference cards attached to each machine</td>
<td>25.00%</td>
<td>58.33%</td>
<td>0.00%</td>
<td>8.33%</td>
<td>0.00%</td>
<td>8.33%</td>
<td>12</td>
<td>4.09</td>
</tr>
<tr>
<td>In person in-servicing/instruction on device cleaning</td>
<td>8.33%</td>
<td>0.00%</td>
<td>75.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>8.33%</td>
<td>12</td>
<td>3.09</td>
</tr>
<tr>
<td>Educational on-line surveys (the pre- and post-quizzes)</td>
<td>0.00%</td>
<td>8.33%</td>
<td>16.67%</td>
<td>66.67%</td>
<td>8.33%</td>
<td>0.00%</td>
<td>12</td>
<td>2.25</td>
</tr>
<tr>
<td>Other (write in on next question)</td>
<td>0.00%</td>
<td>0.00%</td>
<td>14.29%</td>
<td>14.29%</td>
<td>42.86%</td>
<td>28.57%</td>
<td>7</td>
<td>1.6</td>
</tr>
</tbody>
</table>
Low Tidal Volume Ventilation Troubleshooting

Jeffrey Javed, MD; Tina Day; Rajagopala Padmanabhan, MD; Chenell Donadee, MD; Scott Gunn, MD

Fellow, Department of Critical Care Medicine

Objectives: Starting in July of 2015 we embarked on a mission to ensure that 100% of the patients admitted to the 6FG Trauma ICU would undergo low tidal volume ventilation, as defined as a tidal volume of less than 8cc per kilogram of ideal body weight, regardless of their admitting diagnosis.

Methods: Starting in July of 2015 we began using an automated report that could be run within Cerner to evaluate the compliance of low tidal volume ventilation within the trauma ICU. In the beginning we were using the automated reports to ensure the accuracy of the reports, which required some trouble shooting with our Cerner support staff, as well as reconfiguring the report generating algorithms to ensure obtaining accurate data. After this we continued to run the data reporting to evaluate our compliance and to determine areas that we could improve. This involved manual chart reviews of the patients that were noted to be out of compliance, greater than 8 cc/kg of ideal body weight. This data was collected for several months in order to determine possible interventions that could take place. The interventions that we identified that could be implemented immediately included notifying the respiratory team, advanced practice practitioners, and the fellows that we would be evaluating the compliance data. Reminders were performed in person and by e mail.

Results: After multiple revisions of the automated Cerner report, we were able to refine the data to ensure that patients were attributed to the correct unit, that they would have more than one tidal volume reported before being considered to be reported in order to prevent patients arriving from the operating room on high tidal volumes, and to prevent capturing data from patients transferred from ICU to ICU. We were also able to capture the appropriate height that was being used as the patients ventilator settings were set. Also we were able to reduce the number of out of compliance patients by ensuring that if a patient's ventilator settings were changed to different modes, that they did not count as additional hits (separate encounter days). Our overall compliance data from July to January was: July 96%, August 98%, September 91%, October 97%, November 95%, December 98%, and January 98%. On the patients that were out of compliance throughout the time period of July to January the following were noted: 6.52% due to MD order, 13.04% due to patient being placed on pressure control or bilevel, 77.17% due to wrong calculation, 2.17% due to error with charting the tidal volume.

Conclusion: The process of achieving a 100% low tidal volume ventilation has been met with multiple challenges and the creation of multiple PDSA (Plan-Do-Study-Act) cycles that has yet to cease. The start of the project led to the first PDSA cycle of creating an accurate tracking tool, which then lead to the ability to study our current low tidal volume practices, which led to the implementation of reminders to the fellows. The goal for future endeavors is to engage in more restricted pressure regulated ventilator modes, as well as further integration into the electronic medical record with real time direct feedback on out of compliance tidal volume settings. This can be achieved with working with Cerner, but due to the length of time that this would have taken, it was not feasible for incorporation into this year. As well it should be noted that the achievement of 100% compliance is likely not a feasible goal, due to errors that can take place into charting and purposeful MD corrections. As there were multiple patients that required hyperventilation due to severe metabolic acidosis with hyperkalemia, or other anticipated events in the trauma ICU would be hyperventilation to lower ICPs (intracranial pressures). Therefore future goals should be set to greater than 90-95% for compliance.
Phenobarbital Taper for Prophylaxis and Treatment of Alcohol Withdrawal
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Statement of need: Protocolized treatments using phenobarbital for alcohol withdrawal syndrome (AWS) are equally as effective and in some cases superior in symptom management to benzodiazepine-based regimens (1-4). As a quaternary hospital center, UPMC has varying practices across its hospitals as well as the ICUs within Presbyterian Hospital. The pharmacy department recently published a summary of our current practices showing a predominance of benzodiazepine or intravenous sedative infusions which were associated with a rate of ICU admission and mechanical ventilation (5). In 2014, the Neurovascular and Neurotrauma ICUs transitioned to using a phenobarbital taper for AWS. The objective of this study was to assess the safety, efficacy and success of implementation of this protocol.

Methods: The medical records of those who were treated with the phenobarbital protocol were reviewed retrospectively for 4/2014-12/2014 and prospectively for 5/2015-9/2015 to assess the adherence to protocol, safety and efficacy, as defined by the prevention of seizures and need to transfer back to the ICU

Results: There were 31 patients treated from 4/2014 to 12/2014 and 12 treated from 5/2015 to 9/2015. There were no adverse events or complications reported in either group. A single patient in whom the protocol was initiated but discontinued early subsequently received 200 mg of diazepam resulting in a transfer back to the ICU for intubation. The success of implementation varied with an improvement in patient selection over time but ongoing deviation from protocol with benzodiazepine use and under-dosing of the highest risk patients. In those who received benzodiazepines, none were for seizures and none received more than 2 mg of Ativan during their admission.

Conclusions: The phenobarbital protocol was a safe and effective mono-therapy for management of AWS in 50% of our patients. In the other 50% it was a safe and effective benzodiazepine-sparing intervention. Protocol adherence was <50% but is anticipated to improve once the formal order set is available.

References: