AAP Section on Critical Care
Scientific & Educational Program
Abstract & Poster Presentations

AAP National Conference & Exhibition
October 27-28, 2013
Orlando, FL
Section on Critical Care Program - Day 1
Scientific Abstract Presentations and Improving Quality of Pediatric Care in the PICU

Session Description/Objectives:
This session will enable physicians, physician trainees, nurses, and other healthcare professionals to present original research in both oral/platform and poster presentation formats. The attendee will become conversant in new research in the field of pediatric critical care.

Moderator & Program Chair: Brad Poss, MD, MMM, FAAP

8:00 – 9:30 am
Oral Abstract Session I
Moderators: Donald D. Vernon, MD, FAAP & Jana A. Stockwell, MD, FAAP
1. 8:00 am #20512 Jun Sasaki
Heart Rate Variability in Patients with Diabetic Ketoacidosis in a Pediatric Intensive Care Unit
2. 8:15 am #19242 Nikoleta Kolovos
Reduction in Morbidity and Mortality after Implementation of a Rapid Response Team at a Children's Hospital
3. 8:30 am #20968 Roxanne Arcinue
Acute Kidney Injury in ELBW Infants: Prevalence and Associated Risk Factors
4. 8:45 am #22276 Heather A. Hanley
Identifying Potential Kidney Donors among Newborns Undergoing Circulatory Determination of Death
5. 9:00 am #22043 Michelle Schimelpfenig
Healthcare Costs, Resource Use, and Mortality Rates for Sepsis in Teaching versus Non-Teaching Hospitals
6. 9:15 am #20998 Paul H. Dahm – 2012 SOCC Small Project Grant Recipient
Improving Continuity of Care of Pediatric Sepsis Patients from Emergency Department Arrival through Pediatric Intensive Care Unit Admission

9:30 – 10:45 am
Poster Walk Rounds and Break

Group I
Moderators: Edward E. Conway Jr, MD, MS, FAAP & Luke A. Zabrocki, MD, FAAP

• #19121 Shari Toomey
Implementation of the Neotech RAM Cannula in the Pediatric Intensive Care Unit
• #20644 Elizabeth E. Foglia
Training Level and Associated Outcomes of Neonatal Intubation: Analysis of the National Emergency Airway Registry for Children (NEAR4KIDS) At a Referral Neonatal Intensive Care Unit
• #21061 Kimberly Zimmamack
Interdisciplinary Process Improvement to Reduce PICU Admission and Urgent Interventions Using High Flow Nasal Cannula on an Acute Care Unit in Infants with Bronchiolitis
• #20912 Thomas M. Yohannan
  Use of a Protocol Based Approach for Prevention of Pulmonary Hypertensive Crises Shortens Duration of Mechanical Ventilation in Postoperative Pediatric Cardiac Patients

• #21519 Alan Fujii
  Evaluation of a Novel Non-Invasive Respiratory Volume Monitor in Neonates

• #21973 Tara M. Ulmer
  Insulin Titration during the Treatment of Diabetic Ketoacidosis

**Group II**
*Moderators: Donald D. Vernon, MD, FAAP & Mary W. Lieh-Lai, MD, FAAP*

• #21246 John Alexander
  Intravenous Morphine Infusion in Neonates after Cardiac Surgery Is Not Associated With Extubation Failure

• #22785 Madhuradhar Chegondi
  Heart Rate Variability in Children with Submersion Injury: A Case Series

• #20025 Jason M. Kane
  No Relationship between Surgical Volume and Hospital Mortality in Congenital Diaphragmatic Hernia

• #21611 Sigrid Bairdain
  Venous Thromboembolism in Long-Gap Esophageal Atresia Patients

• #22912 Tolulope Oyetunji
  Variations in the Cost of Extra-Corporeal Membrane Oxygenation in Children

• #22970 Antonio G. Cabrera
  Anticoagulation Therapy Trends in Children Supported By Ventricular Assist Devices: A Multi-Institutional Study

**Group III**
*Moderators: Richard B. Mink, MD, MACM, FAAP & Richard A. Salerno, MD, MS, FAAP*

• #21649 Andrew Smith
  Pediatric Palliative Care in High Cost Patients

• #21807 Adam Szadkowski
  Early Identification of Critically Ill Pediatric Patients At An Academic Medical Center

• #21873 Mark Marinello
  The Potential Impact of a Validated Clinical Prediction Rule for Pediatric Abusive Head Trauma (AHT)

• #21975 Christina Bethell
  When Complex Care Goes Complementary: Closing the Loop on Integrating Care for Children with Special Health Care Needs

• #22714 Aparna Roy
  Adverse Drug Events in Hospitalized Children: Estimates from the Nationwide Inpatient Sample 2003-2010
10:45 – 12:15 pm  Oral Abstract Session II
Moderators: John P. Straumanis, MD, FAAP & Carley L. Riley, MD, MPP, FAAP

1.  10:45 am  #21843  Lea C. Moody
    Physician Documentation of Pressure Ulcers in a PICU: An Error of Omission?

2.  11:00 am  #22212  Jennifer C. Munoz Pareja
    Cardiovascular Implications in Non-Accidental Head Injury - Is the Cerebral Injury
    Exacerbated By Neurogenic Myocardial Stunning?

3.  11:15 am  #21176  Karthi Nallasamy
    Low Dose (0.05U/KG/H) Versus Standard Dose (0.1U/KG/H) Insulin Infusion in Pediatric
    Diabetic Ketoacidosis - A Randomized Controlled Study

4.  11:30 am  #20700  Christina L. Cifra
    The Morbidity and Mortality Conference in Pediatric Intensive Care Units in the United
    States

5.  11:45 am  #22812  Xiomara Garcia
    Catheter Associated Blood Stream Infections in Intracardiac Lines

6.  12:00 pm  #20180  Jennifer L. York – 2012 Small Project Grant Recipient
    Blood Conservation in a Pediatric Intensive Care Unit: Documenting Need, Development,
    and Implementation

12:15 – 12:30 pm  Abstract Awards
12:30 – 1:30 pm  Lunch (on your own)

SECTION ON CRITICAL CARE EDUCATIONAL SESSION CONTINUED
SUNDAY, OCTOBER 27, 2013

Session Description/Objectives:
This session will update attendees on rapidly evolving quality of care issues in the PICU with a focus on assisting
the clinician in planning for and assessing implementation strategies. The three lectures will be followed by a panel
discussion. The objectives of this program are: 1) Improve awareness of recent data on patient safety related to
transitions of care and medication errors; 2) Assist the learner in developing patient safety initiatives on potential
patient care errors at their own institution; 3) Understand the benefits, limitations, and requirements for
electronic health records in the PICU.

Moderator & Program Chair:  Brad Poss, MD, MMM, FAAP

Improving Quality of Care in the PICU: Hot Topics

1:30 – 2:20 pm  Transitions of Care: Don’t Drop the Baton!
    Kshitij Mistry, MD

2:20 – 3:10 pm  Medication Errors: The P's and Q's!
    Gitte Larsen, MD, MPH, FAAP

3:10 – 3:30 pm  Break

3:30 – 4:20 pm  Electronic Health Records: Is There an App for That?
    David Stockwell, MD, MBA, FAAP
4:20 – 4:30 pm **SOCC Update**
Edward Conway Jr, MD, MS, FAAP

4:30 – 5:00 pm **SOCC Distinguished Career Award**
Recipient: Vinay Nadkarni, MD, MS, FAAP

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**MONDAY, OCTOBER 28, 2013**
HYATT REGENCY ORLANDO – FORMERLY THE PEABODY HOTEL
8:30 AM – 12:00 PM (H3022)
REGENCY BALLROOM – FORMERLY THE GRAND BALLROOM

**Section on Critical Care Program - Day 2**
*Rescue Me: How to Avoid or Manage Common Situations*

**JOINT PROGRAM WITH SECTION ON HOSPITAL MEDICINE**

**Session Description/Objectives:**
This session will update attendees on common situations that can lead to quality of care issues in the hospitalized pediatric patient and discuss strategies and programs to prevent common adverse events. The three lectures will be followed by a panel discussion. Objectives of the program are: 1) Increase the awareness of pediatric inpatient providers (intensivists and hospitalists) regarding recent data on pediatric rapid response systems; 2) Increase recognition of common adverse sedation events and provide strategies for management; 3) Assist the learner in developing improved patient safety initiatives at their own institution; 4) Understand the risk management strategies that need to be implemented with adverse patient events.

**Moderator & Program Chair:** Brad Poss, MD, MMM, FAAP

8:30 – 9:20 am  **Perhaps a Rapid Response Activation Should Have Been Called**
Christopher Maloney, MD, PhD, FAAP

9:20 – 10:10 am  **Your Patient Appears a Tad Too Sedated**
Douglas Carlson, MD, FAAP

10:10 – 10:30 am  Break

10:30 – 11:20 am  **Risk Management Strategies**
John Straumanis, MD, FAAP

11:20 – 12:00 pm  Panel Discussion and Wrap-up

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Use the AAP National Conference & Exhibition Event Planner to Search by Topic for other Critical Care Sessions:

HEART RATE VARIABILITY IN PATIENTS WITH DIABETIC KETOACIDOSIS IN A PEDIATRIC INTENSIVE CARE UNIT
Jun Sasaki, MD, Madhuradhar Chegondi, MD, Jared Leichner, Yinchen Song, Wei-Chiang Lin, PhD and Balagangadhar Totapally, MD, (1)Miami Children’s Hospital, Miami, FL, (2)Florida International University, Miami, FL

Special Equipment Needs: Physician In-Training Award

Purpose: Heart rate variability (HRV) is the variation of beat to beat interval over a period of time and is thought to be related to autonomic balance and to reflect cardiac condition. This simple and non-invasive technique has potential to be used as one of the monitoring tool in a critical care setting. Long standing diabetes is known to affect autonomic control and HRV. The utility of monitoring HRV in children admitted with diabetic ketoacidosis (DKA) is not known. This study evaluates various HRV indices in children with DKA at the beginning and the end of a pediatric intensive care unit (PICU) stay.

Methods: We exported electrocardiography (ECG) signals from a central monitor to a computer, then these data were analyzed in both time and frequency domains. We have used the recordings during the first hour of PICU stay and compared with that of the last hour of PICU stay. Each hour data was split in to 12 five-minute segments. The data calculated in time domain were R-to-R (NN) intervals and the standard deviation of the NN intervals for each five minutes. Mean and SD (SDANN) of NN means in 12 segments were compared. The data in frequency domain were analyzed with the Lomb periodogram for power at low-frequency band (LF: 0.04-0.15Hz) and high-frequency band (HF: 0.15-0.4 Hz). Mean LF/HF ratio was calculated. Changes from admission to discharge in mean RR interval, SDANN, and LF/HF ratio were analyzed with a paired t-test.

Results: Thirteen children (4 male and 9 female), aged 14.39 ± 4.44 years (mean ± SD) with an average duration of diabetes of 7.7 ± 4.67 years (3 children with new onset) and with a diagnosis of DKA were studied during their stays in our PICU. The LF/HF increased during DKA therapy from admission to discharge. (1.13 ± 0.92 to 1.80 ± 1.48; p<0.02) There were no differences in the mean of NN intervals (597 milliseconds vs 623 milliseconds) and SDANN (20.5 milliseconds vs 27.1 milliseconds). An example of frequency distribution derived from one of our patients is showed in Figure1.

Conclusion: This is the first study to evaluate HRV during recovery from an episode of DKA in children. There were no changes in time domain variables of HRV during the study period, however frequency domain analysis showed improvement in sympathovagal balance as seen by increase in LF/HF ratio during DKA recovery. Whether the improvement in sympathovagal balance is due to improvement in hemodynamic status or related to improvement in some other aspects of DKA (acidosis, encephalopathy, etc) needs further study.
REDUCTION IN MORBIDITY AND MORTALITY AFTER IMPLEMENTATION OF A RAPID RESPONSE TEAM AT A CHILDREN’S HOSPITAL

Nikoleta Kolovos, MD\textsuperscript{1}, Mary E Hartman, MD MPH\textsuperscript{1}, Rebecca Doerhoff, RN MSN\textsuperscript{2}, Catherine Reese, RN MSN\textsuperscript{2}, Soumojit Ghosh, BS\textsuperscript{3} and Allan Doctor, MD\textsuperscript{1}, (1)Pediatrics, Washington University School of Medicine, St. Louis, MO, (2)Patient Safety, Saint Louis Children Hospital, Saint Louis, MO, (3)St. Louis Children’s Hospital, Saint Louis, MO, (4)Washington University School of Medicine, Saint Louis, MO

Purpose: The use of Rapid Response Teams (RRTs) were recommended in 2004 by the Institute for Healthcare Improvement as one of six strategies in the “100,000 Lives Campaign”, designed to decrease preventable hospital deaths. Reduction in hospital deaths has been documented in children but the effects of RRTs are unknown on outcomes besides mortality. We hypothesized that implementation of an RRT would result in earlier detection of decompensating patients; this would be associated not only with decreased mortality, but also shorter Intensive Care Unit (ICU) length of stay (LOS) and lower admission severity of illness.

Methods: We constructed a database of all non-Newborn Intensive Care Unit (NICU) admissions to St. Louis Children’s hospital that included patient demographics (age, race, gender, admitting diagnosis and severity of illness), hospitalization characteristics (operative procedures, ICU care, hospital/ICU length of stay), resource use (mechanical ventilation, invasive monitoring, radiographic imaging) and outcome (in-hospital mortality data). The NICU was excluded from analysis because their LOS, resource use, and mortality were unrelated to the presence or absence of a hospital RRT. We divided the dataset into 2 groups for comparison: the 52-month period before implementation (January 1, 2004-April 30, 2008) and the 49-month following implementation (June 1, 2008-June 31, 2012). Summary statistics were generated using the t-test comparison of
**Results:** The pre-RRT dataset included data from 54,764 admissions, distributed across 10 separate hospital units, and accounted for over 345,000 patient days. The post-RRT dataset was slightly smaller, comprised of 44,210 admissions accounting for just over 330,000 patient days. Hospital-wide deployment of our RRT was associated with a significant decrease in hospital-wide mortality (68 deaths per month pre-RRT vs. 42 post-RRT, p<0.001), a significant decrease in ICU LOS (5.8 days pre-RRT vs. 4.7 days post-RRT, p=0.01), and a significantly lower severity of illness at the time of ICU admission, as measured by the Pediatric Risk of Mortality –Ill score (3.2 pre-RRT vs. 2.3 post-RRT, p <0.001).

**Conclusion:** Implementation of a Rapid Response Team at St. Louis Children’s Hospital resulted in statistically significant reductions in hospital-wide mortality, ICU length of stay, and lower severity of illness at the time of ICU admission. Future research is needed to understand indications and timing of RRT deployment.

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**8:30 AM – 20968**

**ACUTE KIDNEY INJURY IN ELBW INFANTS: PREVALENCE AND ASSOCIATED RISK FACTORS**

*Roxanne Arcinue, MD, Center for Fetal and Neonatal Medicine, Division of Neonatal Medicine, Children’s Hospital Los Angeles, Keck School of Medicine, University of Southern California, Los Angeles, CA, Anton Bazarov, Northeast Ohio Medical University, Rootstown, OH and Mohammed Elkhward, MD, Children’s Hospital Medical Center Akron, Akron, OH*

**Special Equipment Needs:** Physician In-Training Award

**Introduction:** The advancement of neonatology over the past 20 years has allowed a greater number of extremely low birthweight (ELBW) infants to survive. However, these advancements have contributed to the increased incidence of acute kidney injury (AKI) seen in this population. AKI has been documented to occur in as many as 24% of infants admitted to the NICU. Understanding the risk factors for AKI in this population of ELBW infants is imperative for the successful survival of these infants since the morbidity and mortality rates from this disease are increasing.

**Purpose:** 1) To determine the prevalence of AKI in ELBW infants; 2) to compare the mortality rate of ELBW infants with and without AKI; and 3) to identify the associated risk factors of AKI in ELBW infants.

**Methods:** A retrospective chart review of all ELBW infants with AKI (creatinine level > 1.6 mg/dL) admitted to Children’s Hospital Medical Center Akron (CHMCA) NICU between 1998 and 2008 was conducted. Case-controls were matched for birthweight, gestational age (± 2 weeks), and date of birth (within 6 months between the 2 groups). SPSS v17.0 software, Student’s t test, X² test, and Mann-Whitney U test were used for statistical analyses. A p value of ≤ 0.05 was considered statistically significant.

**Results:** The prevalence rate of AKI in ELBW infants admitted to CHMCA NICU from 1998 to 2008 was 26%. The mortality rate of ELBW infants with AKI was 54%, compared to 20% in those ELBW infants without AKI. AKI was associated with the presence of the following: placental abruption/bleeding (OR 2.3 [1.3-3.9]), grade III or IV intraventricular hemorrhage (OR 3.4 [1.5-7.7]), patent ductus arteriosus (OR 2.2 [1.1-4.1]), positive culture/s (OR 2.4 [1.3-4.4]); and use of steroid (OR 2.3 [1.3-4.0]), furosemide (OR 4.3 [1.9-10.1]), hydrochlorothiazide (OR 7.0 [2.6-19.0]), vancomycin (OR 2.5 [1.2-5.0]), clindamycin (OR 2.7 [1.4-5.1]), amphotericin (OR 2.8 [1.5-5.0]), and cefotaxime (OR 2.4 [1.3-4.3]). Use of CPAP was found to be less associated with AKI (OR 0.4 [0.2-0.8]). Stepwise multivariate logistic regression analysis illustrated that the two most prominent variables associated with AKI were presence of positive culture/s (OR 2.1 [1.1-3.9]) and use of furosemide (OR 4.9 [1.9-13.0]); while use of CPAP showed less association with AKI (OR 0.3 [0.1-0.5]).

**Conclusion:** Presence of AKI in ELBW infants was most strongly associated with positive culture/s and use of furosemide. Presence of placental abruption/bleeding, grade III or IV IV intraventricular hemorrhage, patent ductus arteriosus, and use of steroid, hydrochlorothiazide, vancomycin, clindamycin, amphotericin, and cefotaxime were also associated with AKI. Conversely, use of CPAP was less associated with AKI.
IDENTIFYING POTENTIAL KIDNEY DONORS AMONG NEWBORNS UNDERGOING CIRCULATORY DETERMINATION OF DEATH
Heather A. Hanley, MD, Sunhwa Kim, MD, Erin Willey, MD, Dana Castleberry, RN CPTC and Mudit Mathur, MD, (1)Pediatric Critical Care, Loma Linda University Children's Hospital, Loma Linda, CA, (2)Division of Neonatology, Loma Linda University Children's Hospital, Loma Linda, CA, (3)OneLegacy, Los Angeles, CA

Special Equipment Needs: Physician In-Training Award

Purpose: The Organ Procurement and Transplantation Network database currently lists 95,500 patients awaiting kidney transplants and an additional 35,000 patients are added each year. The demand for donor kidneys far outweighs supply, resulting in approximately 5,000 wait-list deaths each year. En-bloc kidney transplantation techniques allow the utilization of younger donors with weights as little as 1.8 kg and broaden the donor pool. Since brain death is uncommon in newborns, we sought to identify the potential for kidney donation among newborns undergoing circulatory determination of death (DCDD).

Methods: We reviewed all discharges from our 84-bed NICU between November 2002 and October 2012 to record the total number of deaths. The mode of death among potential organ donors (weight ≥ 1.8kg) was categorized into 4 groups: Died despite cardiopulmonary resuscitation (CPR), Do not resuscitate (DNR) status, Brain death, or Withdrawal of life support. Patients undergoing withdrawal of life support were then evaluated for DCDD potential. Patients were excluded as potential kidney donors in the presence of a tumor, systemic infection, HIV, renal replacement therapy requirement, urine output < 0.5ml/kg/hr, or serum creatinine level >1.5mg/dL. We evaluated the number of potential donors based on time of death < 60 minutes as well as <120 minutes after withdrawal of life support as these warm ischemia time (WIT) thresholds are commonly used by US-based abdominal transplant surgeons to determine DCDD donor suitability. We applied a donation consent rate of 70% (consistent with the contemporaneous consent rate in our PICU) to project the number of potential newborn kidney donors.

Results: There were 11201 discharges during the study period. Of the 609 deaths, 359 babies weighed more than 1.8 kg at the time of death. Fifty-five (15%) died despite CPR, 145 (40.6%) died with a DNR order in place, and 159 (44.3%) died after planned withdrawal of life support. No brain deaths occurred. Of the 159 patients who underwent withdrawal, the exact time of withdrawal could not be determined for two patients, and 94 had at least one exclusion criteria. Of the remaining, the warm ischemia time was < 120 minutes in 63 and < 60 minutes in 45 patients. These newborns could have been potential en-bloc kidney donors depending on acceptance threshold for WIT in the receiving transplant center. Using our average consent rate, this would yield 3.1-4.4 newborn DCDD donors per year.

Conclusion: A neonatal DCDD kidney program at our institution could provide 3-4 paired kidneys for en-bloc transplantation each year. Extrapolating these data to 22 similar NICUs in California and then across the nation suggests that implementing a national DCDD kidney donation program in NICUs could add a new source of donors and increase the number of kidneys available for transplantation.

HEALTHCARE COSTS, RESOURCE USE, AND MORTALITY RATES FOR SEPSIS IN TEACHING VERSUS NON-TEACHING HOSPITALS
Michelle Schimelpfenig, DO, Jean M. Kelchen, MD, Jacqueline Berner, MD and Benson Hsu, MD, MBA, FAAP, Sanford School of Medicine, University of South Dakota, Sioux Falls, SD

Purpose: With the changing healthcare landscape in the US, teaching hospitals face increasing pressure to provide not only medical education but also cost effective care. For pediatric patients, the diagnosis of sepsis has carried a high mortality and morbidity along with annual costs greater than $2 billion dollars. To evaluate for cost effective care, our study investigated the financial, resource use, and mortality impact of teaching hospital status on pediatric patients admitted with a diagnosis of sepsis.

Methods: We conducted a retrospective study of hospitalized children with the diagnosis of sepsis. The Agency for Healthcare Research and Quality (AHRQ) 2009 Kids’ Inpatient Database (KID) provided the data for analysis. The data set consisted of 7,370,203 weighted discharges in 4,121 hospitals over 44 states. Diagnosis of sepsis was characterized based on an All Patient Refined Diagnosis-Related Groups (APR-DRG) of 720: Septicemia & Disseminated Infections. APR-DRG validated severity classes segmented the illness severity. Teaching hospital status was determined based on the Accreditation Council for Graduate Medical Education (ACGME) approved residency training, presence in the Council of Teaching Hospitals (COTH), or a ratio of full-time equivalent interns and residents to beds of 0.25 or higher. Statistical analysis was conducted using STATA 11.2. Institutional Review Board approval obtained prior to research study.
Results: There were 11,893 patients discharged with an APR-DRG of 720, 5,085 in non-teaching hospitals and 6,808 in teaching hospitals. In comparing non-teaching versus teaching hospitals, patients were on average 8.28 versus 7.23 years old and 54.25% versus 49.08% female (both p values < 0.00). Non-teaching hospital patients (versus teaching hospital patients) had a mortality rate of 1.63% versus 4.66%, average length of stay of 4.86 versus 8.13 days, average number of procedures of 0.89 versus 2.04, and average total hospitalization charges of $29,829 versus $65,639 (all p values < 0.00). When examining the highest severity of illness class (discharges=2,626 with 592 in non-teaching versus 2,034 in teaching), those in non-teaching hospitals had a mortality rate of 12.50% versus 14.01% (p value=0.35), average length of stay of 10.91 versus 14.19 days, average number of procedures of 3.31 versus 4.30, and average total hospitalization charges of $113,384 versus $143,999 (all p values < 0.00).

Conclusion: Our study demonstrated that teaching hospitals, in caring for pediatric inpatients diagnosed with sepsis, had overall higher charges, length of stay, procedures performed, and mortality rates. Even when accounting for a higher level of severity, these trends mostly remain. Our findings were contrary to previous studies attributing higher costs and resource utilization in teaching hospitals but having similar clinical outcomes. Thus, our study suggested that teaching hospitals, when compared to non-teaching hospitals, provide care for sepsis at greater costs and resources without an improvement in mortality rates.

9:15 AM – 20998
IMPROVING CONTINUITY OF CARE OF PEDIATRIC SEPSIS PATIENTS FROM EMERGENCY DEPARTMENT ARRIVAL THROUGH PEDIATRIC INTENSIVE CARE UNIT ADMISSION
Paul H Dahm, MD1, Robert Lapus, MD2, Ijeoma Akunyili, MD1, Anita Hicks, RN2 and Christian Erikson, MD1, (1)University of Texas Health Science Center, Houston, TX, (2)Children’s Memorial Hermann Hospital, Houston, TX

Special Equipment Needs: Physician In-Training Award

Purpose: About one-third of pediatric patients with sepsis are admitted to Pediatric Intensive Care Unit (PICU) through Pediatric Emergency Department (ED). Rapid initiation of early goal directed therapy (EGDT), antimicrobial administration and early advanced critical care improves mortality and decrease organ dysfunction. Effective implementation of these goals remains a challenge. A retrospective chart review of our cases suggested that although EGDT was begun in the pediatric ED, there were significant delays in care interventions and transfers to PICU. Specifically three main areas of concerns were 1) delay in recognition, 2) lack of efficient communication between medical staff and care units, and 3) lack of a transfer protocol. Our purpose was to develop a sepsis recognition tool and improve intervention processes along with increasing collaboration between the ED and the PICU to improve outcomes and quality of care.

Methods: A multidisciplinary sepsis task force was formed consisting of physicians from the ED, general pediatrics, and PICU, along with the administrative, nursing and respiratory staff, and pharmacy. A collaborative plan of data collection, intervention protocols and analysis were developed for this quality improvement project. Over the summer of 2012, multiple lectures, sepsis fairs, and repeated educational events were held to introduce the sepsis protocol to physicians and hospital staff. Educational and protocol posters were prepared and placed in the key areas. The division between pre and post sepsis protocol introduction corresponded with world sepsis day (September 13, 2012).

Results: Between March 2012 and March 2013, 22 patients were identified with sepsis initially seen in the ED and subsequently transferred to the PICU. A total of 9 patients were identified prior to introduction, while 13 were identified post protocol, with no major differences in demographics between the groups. Time to triage remained virtually unchanged (0.37 vs. 0.31 hours, p=0.66). Time spent in the ED decreased by 1.6 hours from 5.5 to 3.9 hours (p=0.27). Times to initial lab draws (2.2 vs. 1.3 hours, p=0.37), first fluid boluses (3.6 vs. 2.2 hours, p=0.34), and first antibiotics (3.4 to 2.3 hours, p=0.24) all decreased by approximately one hour.

Conclusions: We found improvements in time spent in the ED, initial lab draws, first fluid boluses and first antibiotics. Although not statistically significant, they are clinically relevant. During the study period we also had the introduction of new computerized provider order entry, a large turnover in ED staff, and changes in attending coverage of the ED. We dealt with these confounders’ by repeated educational events. We demonstrated that, with continued reinforcement in education, implementation of this protocol can lead to improved patient outcomes utilizing minimum additional resources or personnel.
PHYSICIAN DOCUMENTATION OF PRESSURE ULCERS IN A PICU: AN ERROR OF OMISSION?
Lea C Moody, BS1, Christine Schindler, PhD, CPNP2, Sven R Olson, BS2 and Matthew C. Scanlon, MD, CPPS2, (1)Medical College of Wisconsin, Milwaukee, WI, (2)Pediatrics, Medical College of Wisconsin, Milwaukee, WI

Special Equipment Needs: Physician In-Training Award

Purpose: Pressure ulcers are a common, serious, and expensive preventable injury that occurs in Pediatric Intensive Care Units (PICU). Historically, pressure ulcers are viewed as a “nursing” problem. However, physician decisions regarding medication use, nutrition and patient activity may influence the development of ulcers. Despite the potential for physicians to influence both the prevalence and treatment of pressure ulcers, there is no pediatric literature on physician documentation of pressure ulcers. The purpose of this study was to measure physician documentation of pressure ulcers as a proxy for awareness of ulcer existence.

Methods: We performed a retrospective chart review of 33 patients who were admitted to a PICU from 3/2009- 2/2010 and were known to have pressure ulcers through nursing documentation. Approval was obtained from the Institutional Review Board prior to initiation of study. Information about the date, location and stage of ulcer was obtained from a previously approved study. For each admission known to be associated with a pressure ulcer, the chart was reviewed for: 1) evidence of physician documentation in either problem list or progress notes, 2) hospital ICD-9 coding of any pressure ulcers including present on admission status, 3) type of care team in PICU, and 4) any additional notations of skin findings. Physician documentation was reviewed two days prior through five days after previously identified nursing documentation.

Results: The 33 patients had a total of 97 pressure ulcers identified by bedside nurses. Of these, physicians documented a total of 6 (6%) pressure ulcers, physicians documented non-specific skin findings suggestive of the pressure ulcers for another 11 (11%), and hospital abstractors coded 18 (19%) pressure ulcers. For 10 of the known pressure ulcers, physicians documented normal skin findings. Documentation did not vary by provider team type.

Conclusion: The infrequent documentation by physicians of pressure ulcers (6- 17%) suggests a lack of awareness of or attention to pressure ulcers. This in turn, suggests there may be inadequate attention to prevention and treatment by PICU providers. Possible explanations for the lack of documentation may include inadequate physician education regarding pressure ulcers, physician attitudes of pressure ulcers as a nursing problem, or inadequate communication between the bedside nurses and PICU providers. Additionally, hospital coding underestimates the prevalence of these injuries. The combination of inaccurate coding and infrequent physician documentation of pressure ulcers suggests an underestimation of the scope and magnitude of this hospital acquired condition.
CARDIOVASCULAR IMPLICATIONS IN NON-ACCIDENTAL HEAD INJURY - IS THE CEREBRAL INJURY EXACERBATED BY NEUROGENIC MYOCARDIAL STUNNING?

Jennifer C. Munoz Pareja, MD, Declan McGuone, MD, Kristen Saliga, BS, Carter Dodge, MD, Colin Smith, BS, Beth Costine, PhD and Ann-Christine Duhaime, MD, (1)Massachusetts General Hospital, Boston, MA, (2)Massachusetts General Hospital, Boston, MA, (3)Dartmouth Hitchcock Medical Center, Lebanon, NH

Special Equipment Needs: Physician In-Training Award

Purpose: Over 1,000 deaths are caused by non-accidental head injury (NAHI) each year in the US, and 60-70% of survivors experience significant neurologic deficits. Subdural hematoma (SDH) in children with NAHI is often associated with marked cerebral edema, progressing to hemispheric infarction. This infarction pattern encompasses both the anterior and posterior cerebral circulations with relatively sparing of the basal ganglia, cerebellum, and brainstem. In its most severe form it has been described as "big black brain" because of the appearance on CT scan in which the entire hemisphere appears hypodense. We have hypothesized that while immature subjects resist injury from any single insult, combination of insults overwhelm compensation and lead to profound injury. To further investigate this pathophysiologic response of the immature brain, our group uses an immature large animal model to further understand and potentially design interventions to treat this condition.

We describe here cardiac effects of combination insults typical for subjects with the severe form of infantile SDH.

Methods: 21-day-old male piglets (N = 20) received direct mechanical brain injuries, paralleling those frequently seen in children with severe NAHI: cortical impact, autologous SDH, and elevated intracranial pressure via ipsilateral intracranial balloon inflation. Following brain injuries piglets were randomly assigned to receive either seizures (3 mg/kg bicuculline) (n=5), apnea and hypoventilation (n = 5), apnea and hypoventilation and seizures (n = 5), or sham surgery (n = 5). Animals were sacrificed 8-12 h after direct brain injuries or sham surgery and the heart and brains collected. Blood gases and concentrations of catecholamines, cortisol, troponin I and lactate were measured before and after injuries, after additional insults, and at sacrifice. Cardiac output was measured non-invasively via electrical velocimetry and echocardiography was used to determine the ejection fraction (EF) before injuries, after injuries, after additional insults, and at sacrifice. Brains were evaluated for evidence of hypoxic ischemic damage characterized by red cell change. Ventricular myocardium was assessed for contraction band necrosis and acute inflammation.

Results: To date, 5 of 20 subjects have been completed. Animals subjected to the combination of seizures and episodes of apnea and hypoventilation had evidence of neurogenic stunned myocardium. Cardiac output post-insult, especially when seizures were present, doubled relative to baseline, while echocardiography post-insult showed partial left ventricular wall motion abnormalities and moderate decrease in EF. Subjects demonstrated dramatically decreased peripheral perfusion. In 2 subjects, the cortex showed unilateral widespread acute hypoxic ischemic neuronal damage i.e. 'red cell change', more prominent towards the depths of cortical sulci. These changes mimic unilateral "big black brain" in children. Cardiac histology and concentrations of hormones and biomarkers are currently being analyzed.

Conclusion: A stunned myocardium after SDH may exacerbate neurological ischemia, and therapeutics that provide cardiac support can possibly ameliorate neurological damage sustained after NAHI.

LOW-DOSE (0.05U/KG/H) VERSUS STANDARD DOSE (0.1U/KG/H) INSULIN INFUSION IN PEDIATRIC DIABETIC KETOACIDOSIS: A RANDOMIZED CONTROLLED STUDY

Karthi Nallasamy, MD, Jayashree Muralidharan, M.D and Sunit Singhi, M.D, PGIMER, Chandigarh, India

Special Equipment Needs: Physician In-Training Award

Background: The recommended standard dose (0.1U/kg/h) of insulin in current DKA guidelines is not based on strong clinical evidence. Physiological dose-effect studies showed that even lower doses (0.03 and 0.05 U/kg/h) could adequately normalize the raised ketones. Recent retrospective studies observed a dose of 0.05U/kg/h to be as effective as standard dose in correcting acidosis. Given the possible association of rapid glucose fall following start of insulin and risk for cerebral edema, lower insulin doses may potentially be safer. Furthermore, using low dose could minimize therapy related complications like hypokalemia and hypoglycemia.

Purpose: Primary: To compare the rate of fall in blood glucose (BG) till it reaches to ≤ 250mg/dl with low(0.05U/kg/h) and standard dose (0.1U/kg/h) insulin in pediatric DKA. Secondary: To compare the rate of resolution of acidosis, incidences of cerebral edema, hypokalemia and hypoglycemia in the above groups.
**Methods:** Design: Open-labeled Randomized Controlled Trial Setting: Pediatric ER and ICU of a tertiary care teaching hospital

Subjects: Consecutive children ≤12 years with DKA between July 2011 and December 2012

Interventions: Fifty children were randomized to receive either low dose (n=25) or standard dose (n=25) insulin. A uniform fluid correction (6.5%) over 36 hours with additional initial bolus to correct shock was administered in both groups. Dextrose was added to rehydrating fluid (NS or N/2 saline) when BG fell to ≤ 250mg/dl. BG was monitored every hourly. Electrolytes and blood gases were measured at 4 hourly intervals.

**Outcomes:** Rate of fall in BG till ≤ 250mg/dl, rate of resolution of acidosis, incidences of cerebral edema, hypokalemia and hypoglycemia

**Results:** Mean (SD) age of study population (n=50) was 6.9 (3.7) years. New onset TIDM presenting as DKA was seen in 29 (58%). Two thirds (n=34; 68%) had severe DKA at enrollment. Baseline clinical and biochemical (pH, HCO3, BG) variables were comparable between both groups. The time taken for BG to reach ≤ 250mg/dl in low vs. standard dose group (6.0 vs 6.2 hours) and mean±SD rate of BG fall till ≤250mg/dL (45.7±18 vs 51.4±24 mg/dL/h) were also similar. However the first hour BG fall was significantly higher in standard as compared to low dose (63.2 vs 39.1mg/dL; p=0.01), with 4(16%) children in the former compared to none in the latter showing a BG fall >100mg/dL. Duration for resolution of acidosis (low vs. standard dose: 16.5 vs 17.2 hours; p=0.73) and rate of resolution of acidosis were similar in both. Incidence of hypokalemia was significantly higher with standard dose (48% vs 20%; p = 0.04); the difference being more in malnourished (88% vs. 28%; p=0.02). Five(20%) and 1(4%) with standard and low dose infusion (p=0.08) respectively developed hypoglycemia. One child in standard dose group developed cerebral edema and there were no deaths.

**Conclusion:** Low dose is as effective as standard dose insulin in children with DKA. However it may be preferred in malnourished children and in situations warranting a gentler fall in BG.

**11:30 AM – 20700**

**THE MORBIDITY AND MORTALITY CONFERENCE IN PEDIATRIC INTENSIVE CARE UNITS IN THE UNITED STATES**

*Christina L. Cifra, MD, Johns Hopkins Hospital, Baltimore, MD, Melania Bembea, MD, MPH, Johns Hopkins School of Medicine, Baltimore, MD and Marlene Miller, MD, MSc, Pediatrics, Johns Hopkins Children’s Center, Baltimore, MD*

**Special Equipment Needs:** Physician In-Training Award

**Purpose:** The Morbidity and Mortality Conference (MMC) is a powerful yet under-leveraged tool for advancing patient safety. However, many MMCs across specialties are still conducted with significant heterogeneity. Our objective was to determine how well MMCs in Pediatric Intensive Care Units (PICUs) across the United States are utilized for patient safety and quality improvement, by measuring how many conform to the three elements of medical incident analysis (MIA). We hypothesized that a significant number of MMCs do not conform to all three elements.

**Methods:** A survey instrument was developed based on the MMC model created by Aboumatar, et al, which collected information on respondents’ perceptions of their PICU MMC and its adherence to the three elements of MIA: 1) eliciting input from all involved caregivers, 2) using a structured framework to investigate contributing factors, and 3) assigning responsibility for improvement and follow-up. The survey was piloted in the authors' home institution PICU, reviewed and revised before administration. Survey respondents were PICU staff who regularly attend the MMC. They were recruited by e-mail from a list compiled by cross-referencing 5 publicly available databases and all available PICU websites. Descriptive statistical analysis was performed, calculating proportions for categorical variables.

**Results:** There were 276 respondents to the survey, of which 156/276 (56.5%) identified their PICUs. 78 PICUs were identified from 34 states, of which 38/78 (48.7%) PICUs had 1 respondent, 25/78 (32.1%) had 2 and 15/78 (19.2%) had 3 or more. 116/154 (75.3%) of respondents who self-identified were attending physicians, and 25/154 (16.2%) were fellows. Of the 78 PICUs, 48/78 (61.5%) had fellowship programs. The table illustrates responses relating to MMC conformity to elements of MIA. Column A shows the proportion of PICUs with >1 respondent whose respondents have differing answers per query (intra-PICU disagreement). Column B shows the proportion of PICUs (both with only 1 and >1 respondents) whose respondents answered in the majority (>50%) that their MMC did possess that specific element of MIA.
Elements of Medical Incident Analysis | A | B
---|---|---
Elicits input from all involved caregivers | 26/40 (65%) | 32/62 (51.6%) |
Uses a structured framework to investigate contributing factors | 14/39 (35.9%) | 40/58 (70%) |
Assigns responsibility for improvement and follow-up | 24/40 (60%) | 44/64 (68.8%) |

Note: Denominators differ per cell due to non-response to some questions.

Conclusion: There was marked disagreement within PICUs in perceptions regarding whether their MMC possessed elements of MIA, which may itself be revealing a lack of MMC structure and consistency. Disagreement was most marked when asked about eliciting input from all involved caregivers. Majority of PICUs however had respondents who believed that their MMC possessed at least one of the essential elements.

11:45 AM – 22812
CATHETER ASSOCIATED BLOOD STREAM INFECTIONS IN INTRACARDIAC LINES
Xiomara Garcia¹, Sherry Pye², Christopher J. Swearingen, PhD³, Parthak Prodhan, MBBS⁴ and Adnan Bhutta, MBBS⁵, (1)Pediatric Cardiology, Arkansas Children’s Hospital, University of Arkansas for Medical Sciences, Little Rock, AR, (2)Pediatric Cardiology, UAMS, Little Rock, AR, (3)Pediatrics--Biostatistics, University of Arkansas for Medical Sciences, Arkansas Children’s Hospital, Little Rock, AR

Purpose: Catheter associated blood stream infections (CABSI) are an important cause of morbidity and mortality in pediatric cardiac intensive care units. Infection rates are known to vary by catheter type, number of lumens, location and duration. Recently, alteplase use has also been noted to be associated with increased CABSI rates. However, the rates of CABSI are not known for intra-cardiac (RA) lines and the risk factors for CABSI in these lines are not known. We therefore undertook this study to estimate CABSI rates for RA lines in comparison with various other catheter types and locations of placement and to understand the effect of use of alteplase on CABSI rates RA lines.

Methods: After obtaining approval from the Institutional Review Board, a retrospective review of all patients undergoing cardiac surgery at Arkansas Children’s Hospital between January 1, 2006 to December 31st 2011, was performed. Demographic data, clinical features and outcomes were summarized on a per-patient level. Type, location and duration of all centrally placed catheters as well as associated complications were recorded. Central lines used in our unit include peripherally inserted central catheters or PICC lines (made of silastic) and antibiotic coated double or triple lumen lines (made of polyurethane) placed in internal jugular (IJ), femoral (Fem) or intracardiac (RA) lines. All analysis was completed using Stata v12.1 (College Station, TX).

Results: A total of 2714 lines were used in 1249 patients. Data on line duration, alteplase use and percentage of lines developing CABSI are shown in Table 1. Disease severity as assessed by Risk Adjusted classification for Congenital Heart Surgery (RACHS) score (p<0.001), year of placement (p<0.001), and line type adjusted for alteplase use are significantly associated with risk of any bloodstream infection. Overall, IJ and RA lines had least risk of infection while PICC lines had the highest. However, while PICC lines had higher risk than CVL lines for infection without alteplase use, that risk was mitigated and reversed with the use of alteplase (Figure 1).

Conclusions: RA lines have lower rates of CABSI compared to PICC and Fem CVL’s. Alteplase use is a predictor of increased CABS rates in all types of catheters except PICC lines.
Table 1. Clinical Features and Outcomes of each Line Catheterization by Line Type

<table>
<thead>
<tr>
<th></th>
<th>RA</th>
<th>CVL-IJ</th>
<th>CVL-FEM</th>
<th>PICC</th>
<th>Total</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>730</td>
<td>894</td>
<td>706</td>
<td>309</td>
<td>2639</td>
<td></td>
</tr>
<tr>
<td>Alteplase Use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.007</td>
</tr>
<tr>
<td>No</td>
<td>221 (30.3%)</td>
<td>395 (44.3%)</td>
<td>229 (32.5%)</td>
<td>57 (18.4%)</td>
<td>902 (34.2%)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>508 (69.7%)</td>
<td>497 (55.7%)</td>
<td>475 (67.5%)</td>
<td>252 (61.6%)</td>
<td>1732 (65.8%)</td>
<td></td>
</tr>
<tr>
<td>Line Duration (days)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>20.8 (23.5)</td>
<td>8.1 (12.6)</td>
<td>12.3 (15.5)</td>
<td>24.8 (29.3)</td>
<td>14.7 (20.2)</td>
<td></td>
</tr>
<tr>
<td>Median [Min, Max]</td>
<td>13 [1, 176]</td>
<td>5 [0, 168]</td>
<td>8 [0, 242]</td>
<td>16 [0, 262]</td>
<td>6 [0, 262]</td>
<td></td>
</tr>
<tr>
<td>Any Bloodstream Infection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.017</td>
</tr>
<tr>
<td>No</td>
<td>576 (78.9%)</td>
<td>794 (99.8%)</td>
<td>548 (77.6%)</td>
<td>213 (68.9%)</td>
<td>2131 (81.8%)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>154 (21.1%)</td>
<td>100 (11.2%)</td>
<td>158 (22.4%)</td>
<td>96 (31.1%)</td>
<td>508 (19.3%)</td>
<td></td>
</tr>
</tbody>
</table>

*Generalized estimating equation regression reported. Otherwise, random effects logistic regression reported.

Figure 1. Cumulative Incidence of Bloodstream Infection
BLOOD CONSERVATION IN A PEDIATRIC INTENSIVE CARE UNIT: DOCUMENTING NEED, DEVELOPMENT, AND IMPLEMENTATION
Jennifer L York, BA, MD1, Julie A. Hoerr, RN, MSN, PCCNP2, Enola K. Practor, BA, MSSW, Ph.D3, Jessica Richards, RN, BSN, CCRN, MSN4, Rose Hansen, RN, BSN5, Jeanine Allen, RN, BSN6, Sarah M. Brown, Ph.D7, Jennifer Jaffe, MPH, CCRP8, Allan Doctor, MD9, and Philip C. Spinella, MD, FCCM10, (1)Washington University School of Medicine, St. Louis, MO, (2)St. Louis Children's Hospital, St. Louis, MO, (3)Washington University, St. Louis, MO, (4)St. Louis Children's Hospital and Washington University School of Medicine, St. Louis, MO

Purpose: Critically ill children require repeated phlebotomy, increasing their risk for anemia and red blood cell (RBC) transfusions. Upon admission to the Pediatric Intensive Care Unit (PICU), 33% of children are anemic and 41% more become anemic during their stay (Bateman et al., 2008). RBC transfusions have been associated with adverse outcomes to include increased organ failure in children, therefore processes that reduce exposure to RBCs via a Blood Conservation (BC) Program may improve outcomes. This study documents the need for a BC Program in a Pediatric Intensive Care Unit (PICU) and subsequently describes the development and implementation of BC interventions.

Methods: This single center, prospective observational study included detailed characterization of all blood removed from 112 PICU patients, as well as an anonymous survey and focus groups with PICU nurses to assess BC culture and identify barriers to change. Using an Adapted Conceptual Model of Implementation, a multidisciplinary team developed four specific BC interventions with tailored implementation strategies.

Results: We analyzed 112 patients with a mean PICU length of stay of 5.4 days. The median (IQR) of total blood withdrawn during the PICU admission was 12.5 (4 – 46.15) ml per patient. Blood overdraw was defined as the volume of blood removed in excess of minimal requirements for laboratory processing for any combination of tests. Blood overdraw was identified in 87% of samples with a median overdraw of 0.7 (0.2 - 0.8) ml per sample. 32% (36/112) of patients in our cohort were transfused RBCs. These patients had a median of 0.64 (0.53 – 0.89) ml blood per kg patient per day sampled for laboratory procedures and an average hemoglobin drop of 3.9 ± 1.9 g/dL from admission to time of transfusion. 98% of PICU staff nurses completed a blood practices survey and 82% attended focus groups on the topic. These revealed that size, sites available, amount required for processing, and current practice are the most common factors influencing total amount of blood drawn and wasted. Focus Groups identified concerns with current practice and requested change. Based on this, four BC interventions were developed and implemented: 1) closed-loop venous blood sampling devices; 2) bedside blood volume reference cards; 3) micro-sampling blood tubes; and 4) blood culture volume policy standardization.

Conclusion: These results indicated that blood overdraw is common in critically ill children, may result in increased risk of RBC transfusions, and supported the need for a BC Program. A post-implementation study is in progress to assess intervention effectiveness on blood overdraw, anemia and RBC transfusions. A repeat BC cultural assessment survey will be conducted, targeting acceptance and adoption of the BC Program. If the interventions are found to be effective, they may be more broadly implemented, further improving patient outcomes.
(19121) Implementation of the Neotech RAM Cannula In The Pediatric Intensive Care Unit

Shari Toomey, MBA, RRT-NPS, Carilion Clinic Children's Hospital, VA

Purpose: Patients with broncholitis, Respiratory Syncytial Virus (RSV), and apnea require all levels of respiratory support, from nasal cannula to intubation. As patient’s respiratory status deteriorates the options available are Non-invasive Positive Pressure Ventilation (NIPPV) or intubation. Non-invasive ventilation interfaces presently on the market are uncomfortable and ill fitting, which lead to non-compliance of usage, ineffective ventilation, and poor outcomes. Intubation can lead to further complications from airway trauma, infection, and increased lung damage. The RAM Cannula is a versatile interface for the neonatal and pediatric population. By adopting the use of the RAM Cannula for new management of patients meeting the inclusion criteria the goal was to decrease the overall intubated days and length of stay (LOS) of our PICU patients.

Methods: This prospective study was compared to a retrospective review of patients in 2010-2011, looking at ventilator days and LOS of patients meeting the inclusion criteria. Target population: Patients ≤ 8 months of age, diagnosis of broncholitis, RSV, or apnea, requiring non-invasive ventilation or intubation. Per guidelines patients meeting inclusion criteria would be placed on the RAM Cannula and receive continued support based on clinical assessment. A data collection form followed the patient throughout admission until discharge.

Results: In 2010, 7 pediatric patients ≤ 8 months of age were admitted to the PICU with a diagnosis of broncholitis, RSV and apnea for a total of 10 ventilator days. In 2011, 16 patients ≤ 8 months of age meeting inclusion criteria were admitted, for a total of 17 ventilator days. In 2012, 31 patients ≤ 8 months of age meeting inclusion criteria were admitted, for a total of 7 ventilator days. In 2010, LOS for patient’s ≤ 8months of age was 5.7 days. In 2011, LOS for patient’s ≤ 8 months of age was 4.6 days. In 2012, LOS for patient’s ≤ 8 months of age was 4.1 days. In 2010, 14% of PICU patients meeting inclusion criteria were intubated. In 2011, 25% of PICU patients meeting inclusion criteria were intubated. In 2012, 7% of PICU patients meeting inclusion criteria were intubated and 35% received non-invasive ventilation via the RAM Cannula. The 7% that were intubated were extubated and placed on the RAM Cannula and did not require re-intubation.

Conclusion: Implementation of the RAM Cannula guidelines resulted in a decrease in ventilator days, decrease in rate of endotracheal intubation, and LOS. RAM Cannula guidelines allow our PICU to standardize care and provide a comfortable interface for our patients. We will continue to monitor our outcomes as we continue to address the expansion of our usage of the RAM Cannula in a broader patient population

(20644) Training Level and Associated Outcomes of Neonatal Intubation: Analysis of the National Emergency Airway Registry for Children (NEAR4KIDS) at a Referral Neonatal Intensive Care Unit

Elizabeth E. Foglia, MD MA, Anne Ades, MD, Natalie Napolitano, MPH, RRT-NPS, FAARC, Jessica Leffelman, BS, Vinay M. Nadkarni, MS, MD, FAAP, FCCM, FAHA and Akira Nishisaki, MD, Children’s Hospital of Philadelphia, Philadelphia, PA

Special Equipment Needs: Physician In-Training Award

Purpose: Tracheal intubation is a life saving intervention in the care of critically ill neonates. Current Accreditation Council for Graduate Medical Education (ACGME) program requirements state that pediatric residents must demonstrate “procedural competence” in neonatal intubation. However, as training work hours have reduced, pediatric trainees have fewer opportunities to perform invasive procedures. Little is known about the current association between training level and success
rates and safety of neonatal intubation. Training level is significantly associated with success of intubation and the incidence of tracheal associated adverse events (TIAE) in the pediatric intensive care unit and emergency department settings. We hypothesize that training level is significantly associated with success rates and incidence of TIAE in the neonatal intensive care unit (NICU) setting.

**Methods:** A prospective observational cohort study was performed between from 9/1/11-1/31/13 to evaluate tracheal intubations performed in a large referral NICU and a referral delivery suite. All data were collected using a standard National Emergency Airway Registry for Children reporting system. Outcome measures included first attempt success, overall success, TIAE, and significant oxygen desaturations (defined as encounters with initial saturation ≥90% and lowest saturation<80%). Data were analyzed to identify a potential association between training level of first provider and: (1) TIAE using Fisher’s Exact test, (2) oxygen desaturations using χ² test, (3) median decrease in oxygen saturation during the encounter using the Kruskal-Wallis test.

**Results:** There were 205 primary oral intubation encounters involving pediatric residents, NICU fellows, or NICU attending physicians. First and overall attempt success rates were as follows: residents (23%, 31%), fellows (40%, 70%), and attendings (63%, 90%). TIAE occurred in 25% of encounters, and oxygen desaturations occurred in 37% of encounters. Adverse events and oxygen desaturations were more likely to occur when less experienced providers attempted the first intubation (Table 1).

**Conclusion:** Success rates of tracheal intubation are low in pediatric resident providers and improve stepwise with increasing levels of training. TIAE and significant desaturations are most likely to occur when pediatric residents attempt the first intubation. NICU fellow performance is superior to pediatric residents with respect to success rates, TIAE, and oxygen desaturations, although TIAE are more common when initial providers are NICU fellows, compared with NICU attendings. Future studies should focus on ways to improve the safety of tracheal intubation with medical trainee participation.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Pediatric Resident N=48</th>
<th>NICU Fellow N=130</th>
<th>NICU Attending N=27</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIAE</td>
<td>16 (33%)</td>
<td>32 (25%)</td>
<td>3 (11%)</td>
<td>0.1</td>
</tr>
<tr>
<td>Oxygen Desaturation</td>
<td>28 (58%)</td>
<td>38 (29%)</td>
<td>9 (33%)</td>
<td>0.002</td>
</tr>
<tr>
<td>Median Change in Oxygen Saturation</td>
<td>30% (IQ Range 13, 49)</td>
<td>13% (IQ Range 2, 30)</td>
<td>20% (IQ Range 7, 31)</td>
<td>0.005</td>
</tr>
</tbody>
</table>

**Table 1: Differences in outcomes, based on initial provider**

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**(21061) Interdisciplinary Process Improvement to Reduce PICU Admission and Urgent Interventions Using High Flow Nasal Cannula on an Acute Care Unit in Infants With Bronchiolitis**

*Kimberly Zimmamck, MS, RN,1 Christina Pano, BA, RRT-NPS,1 Patricia S Lye, MD,1 Michael T. Meyer, M.D.1 and Rainer Gedeit, MD.1, (1)Children’s Hospital of Wisconsin, Milwaukee, WI, (2)Medical College of Wisconsin, Milwaukee, WI*

**Purpose:** To evaluate the implementation of an evidence based care plan that uses high flow high humidity nasal cannula oxygen (HFNC) on an acute care unit to decrease the need for PICU admissions and urgent interventions.

**Introduction:** Guaranteeing high quality outcomes and reducing costs are at the forefront of healthcare as hospitals try to define the value of care delivery. Utilization of PICU beds is expensive, but often necessary for infants with bronchiolitis due to their severity of illness and need for advanced respiratory support. Use of HFNC has been shown to reduce work of breathing and improve oxygenation in infants with bronchiolitis. At our institution, the use of HFNC requires admission to the PICU due to an increased need for close monitoring and higher staffing ratios. In order to evaluate the safety of HFNC in acute care for infants with bronchiolitis, an interdisciplinary team developed a care plan for use of HFNC aimed at reducing PICU utilization.

**Methods:** An interdisciplinary group developed an evidence based plan of care for use of HFNC in infants with bronchiolitis on an acute care unit. Criteria were developed, including use of the Bedside Pediatric Early Warning System (BedsidePEWS), for initiating and maintaining HFNC and for considering transfer to the PICU. All health care providers caring for patients on the unit were educated in the use of HFNC and the plan of care for these patients. Weekly meetings were held to develop rapid cycle improvements. Data were collected on patient age, outcome (remained on floor or transferred to PICU), duration of HFNC use on the acute care unit and the need for urgent intervention (Code Blue or RRT evaluation). We compared urgent intervention data for the unit from the same time period in the prior year.
Results: Twenty two patients were treated with HFNC. Eight remained on the unit and 14 transferred to PICU. No HFNC patients required urgent intervention. Patients requiring transfer to the PICU received HFNC for an average of 9.8 hours prior to transfer. Patients remaining on the floor received HFNC for an average of 51.9 hours. Total time on HFNC on the unit for all patients was 552.25 hours, (23 fewer PICU days). When comparing data for the entire unit (includes patients not in this cohort) there was a reduction in urgent interventions. In 2012 there were 16 urgent interventions (14 RRT, 2 Code Blue) and in 2013 there were 3 RRTs and no Code Blues.

Conclusion: An interdisciplinary team utilizing the evidence can quickly and effectively make changes to patient care practices. Initial data suggests that this change improved value by decreasing utilization of PICU resources and preserved or even improved care by decreasing the need for urgent interventions.

(20912) Use of a Protocol Based Approach for Prevention of Pulmonary Hypertensive Crises Shortens Duration of Mechanical Ventilation in Postoperative Pediatric Cardiac Patients

Thomas M. Yohannan, MD1, Juan C Menendez, PhD2, Vivian Lebaroff, RRT3, Curtis Petty, Pharm.D3 and Mayte Figueroa, M.D1, (1)Pediatrics, University of Tennessee Health Sciences Center/ Le Bonheur Children's Hospital, Memphis, TN, (2)University of Tennessee Health Sciences Center, Memphis, TN, (3)Le Bonheur Children's Hospital, Memphis, TN

Special Equipment Needs: Physician In-Training Award

Purpose: Post-operative pulmonary hypertension (PH) complicates 2% of patients undergoing congenital cardiac surgery. The incidence of post-operative pulmonary hypertensive crises (PHC) has been reported at 0.75%. Although mortality from PHC has decreased with earlier surgical correction, many of these patients have prolonged hospitalizations and suffer significant morbidity. Specific congenital heart defects are at high risk for PHC, but it is often difficult to predict which patients will experience a PHC. We developed a protocol for prevention of PHC in the Cardiovascular Intensive Care Unit (CICU) consisting of preemptive use of sedation and inhaled nitric oxide (NO). We hypothesized that the implementation of a standardized PH protocol would reduce length of mechanical ventilation (MV) in postoperative cardiac patients.

Methods: We performed a retrospective review of all post-operative cardiac patients at risk for PHC between January 2009 to October 2012. The IRB approved the study and the need for informed consent was waived. Patients were identified by clinical diagnosis, preoperative cardiac catheterization and echocardiographic data. Patients were divided into two groups: Group A (pre-protocol) and Group B (post-protocol). Both groups were analyzed on the following variables: hours on NO, cost of NO, use of sildenafil, use of sedation, duration of MV, hospital and CICU length of stay (LOS). A two-sample unpaired t-test was used to compare both groups.

Results: Total of 49 patients were included in the study, 23- Group A and 26 -Group B. Median age at surgery in Group A was 3 months (0.07- 24) with a median weight of 4.2 kg (2.1-9.2) and in Group B was 5 months (0.23-24) with a median weight of 5 kg (1.7-14.4). Diagnoses included: Total Anomalous Pulmonary Venous Return (8), Complete atrioventricular canal defect (13), ventricular septal defect (13), Single Ventricle (11), Other (4). Mean duration of mechanical ventilation was shorter in Group B (2.3 days vs. 4.5 days) (p <0.01). There was no significant difference in the use or cost of NO between the 2 groups. There was a tendency toward use of sildenafil in Group B (65.3%) vs. Group A (39%) (p < 0.1). There was no statistically significant difference in the CICU/ hospital LOS or total sedation dose.

Conclusions: The pulmonary hypertension protocol successfully reduced the duration of mechanical ventilation in postoperative cardiac patients in our CICU. Prophylactic use of NO and sedation did not increase NO utilization/costs or cumulative sedation dose. There was a higher tendency to use sildenafil in the Group B possibly reflecting increased awareness of pulmonary hypertension.

(21519) Evaluation of a Novel Non-Invasive Respiratory Volume Monitor in Neonates

Alan Fujii, MD, Julie Silva, RRT and Daniel Gavin, RRT, Boston Medical Center, Boston, MA

Purpose: Monitoring of ventilation in premature infants is challenging, especially as current strategies seek to minimize duration of intubation. A monitor that can provide continuous, non-invasive, accurate measurements of minute ventilation (MV), tidal volume (TV) & respiratory rate (RR) during positive pressure ventilation, non-invasive positive pressure ventilation (NIPPV) & spontaneous ventilation after extubation, in neonates, would be a valuable asset to the neonatologist. Monitoring of respiratory volumes in intubated and non-intubated neonates can help track the effectiveness of therapeutic interventions and
optimize care. A novel non-invasive, continuous Respiratory Volume Monitor (RVM) that calculates MV, TV & RR from thoracic bioimpedance measurements was adapted for use on neonates. The objectives of the study are to develop and test a calibration algorithm for an RVM system (modified ExSpiron, Respiratory Motion, Inc., Waltham MA) based on TV & RR simultaneously measured by a flowmeter (NeoFlow, Drager Medical, Inc. Telford, PA) to assess RVM TV in positive pressure ventilator breaths at different pressures & in negative pressure spontaneous breaths. To evaluate the RVM in neonates after extubation and following the administration of opioids and stimulants to measure trends in MV, TV, and RR.

Methods: Eleven mechanically ventilated infants, 24-40 weeks gestational age; 470-3390g birth weight were studied. RVM data from 4 thoracic electrodes were collected alongside flowmeter data for an average of 68.95 hours (1.3-269.05) & compared for both ventilator driven & spontaneous breaths. Of those, 5 were studied further. All were extubated, 2 babies received 3 caffeine doses & 1 baby received 3 morphine doses. MV, TV & RR were calculated from 30 second data segments preceding (mean:17min, range 2-68 min,) & following (mean:16min, range 2-21 min) extubation or medication.

Results: RVM respiratory flow curves were compared to flowmeter respiratory curves, yielding correlations between 0.89-0.95 (Figure 1). Preliminary analyses, of the subgroup, showed decrease in TV & MV (-45±21%, -61±10%) after morphine in 1 baby & an increase in TV & MV (+85±46%, +107±42%) after caffeine in 2 babies. There was a decrease in TV & MV (-30±6%, -35±4%) after extubation followed by an increase to substantially above pre-extubation baseline (+95±27%, +111±29%) within an hour in 3 babies who remained extubated and a continuing decrease in TV & MV (-65%, -87%) in 1 baby who was reintubated. One baby given caffeine just prior to extubation showed an increase in TV & MV (+37%, +30%) after extubation and further increase (+53%, +56%) an hour later (Figure 2).

Conclusion: The RVM has the capability to provide objective, non-invasive measurements of respiratory parameters during mechanical ventilation, NIPPV and spontaneous respiration. RVM has potential to guide clinical decision making during weaning from mechanical ventilation & need for reintubation as well as quantitate the effects of interventions and potentially drive decisions regarding medications.

Figure 1: Respiratory traces from RVM and flowmeter. Digital traces from the flowmeter, built into the ventilator, were available in 3 of the 11 patients studied. (A) Example traces from all 3 intubated infant patients, demonstrating RVM’s ability to accurately monitor respiratory flow curves. The RVM and flowmeter traces are highly correlated with each other during spontaneous breathing (top and bottom trace, r=0.89 and r=0.95, respectively) and during ventilator-driven breathing (middle two traces, r=0.89 and r=0.91, respectively). This suggests that once the infant is extubated and the flowmeter is removed, the RVM would continue to accurately track respiratory performance. (B) Direct point-by-point comparison of RVM and flowmeter traces. RVM measurements were plotted against volume for all 3 infants for both spontaneous and ventilator breathing trials. Note the highly linear correlation across patients and breathing conditions.
Figure 2: (A) Example respiratory traces demonstrating 3 significant therapeutic interventions: extubation (top), morphine administration (middle), and caffeine administration (bottom). Following extubation (top row) the breathing pattern is initially disrupted and TV and MV decrease, but in the babies who remain extubated, volumes quickly recover and exceed pre-extubation values. Morphine (middle row) leads to substantial decrease in spontaneous breathing and breathing becomes primarily ventilator-driven (large breaths are ventilator breaths, small ones are spontaneous breaths). Caffeine (bottom row) stimulates breathing and leads to a notable increase in TV, MV, and a small increase in RR. (B) Trends in respiratory parameters following extubation. In the 3 infants successfully extubated without caffeine administration prior to extubation (left panel) TV decreased initially and then recovered and exceeded pre-extubation levels. In contrast, in the infant who was re-intubated, the initial decrease in TV was followed by a further decrease within the hour following extubation (middle panel) preceding reintubation. The infant receiving caffeine prior to extubation showed an immediate TV increase followed by an additional increase one hour later (right panel).
**(21973) Insulin Titration during the Treatment of Diabetic Ketoacidosis**

*Tara M Ulmer, MD, Judy R Walker, MD and Hayden L Smith, PhD, Blank Children’s Hospital, Des Moines, IA*

**Purpose:** Diabetic ketoacidosis (DKA) is a relatively common complication of type I diabetes mellitus and remains a major source of morbidity and mortality. Recent literature has brought into question most aspects of classic DKA treatment (e.g., continuous low dose 0.1 units/kg/hr) in pediatric populations. The objective of this study was to analyze the effectiveness of insulin titration treatment of DKA by reviewing time to acidosis resolution, length of pediatric intensive care unit (PICU) stay, average insulin dosing requirement, average amount of intravenous (IV) fluids, and incidence of complications.

**Methods:** A retrospective observational study was conducted on patients admitted to a PICU in a tertiary children’s hospital during January 2005 through December 2010. Eligible patients had an initial diagnosis that included DKA, defined as blood pH level < 7.30. Patients treated for DKA received treatment based on titrating insulin doses. Patient demographic and treatment data were ascertained. Linear regression was performed to determine significant predictors of hours to pH resolution. Pearson correlation coefficients and Wilcoxon rank sum test conducted. Study received Institutional Review Board approval.

**Results:** There were 127 pediatric encounters that had treatment based on insulin titration (Figure 1). Mean patient age was 149 months; sex was equally distributed; and mean weight was 47.8 kg. New onset diabetes was treated in 33% of patients. Mean initial blood pH was 7.10; mean initial blood glucose level was 509.5 mg/dL, while mean HbA1C was 12.0% within the 72% of patients with a documented HbA1C value. Mean Pediatric Risk of Mortality (PRISM) score upon admission was 7.8. Average patient treatment information is presented in Table 1, with mean number of hours to pH ≥7.27 was 9.3; mean IV insulin dose of 0.05 units/kg/hr; and total fluid given throughout treatment 81.4 mL/kg. There were no documented adverse outcomes in the sample. Significant predictors of time to achieve pH ≥ 7.27 were initial pH level, total fluids administered, and whether sodium bicarbonate was given (p-values: <0.05). Select correlations of hours to normal pH presented in Figure 2. Average decrease in PRISM 24-hours after admission was 6.9 (p-value: <0.001).

**Conclusion:** This study presents the successful use of insulin titration based treatment for ketoacidosis in a pediatric patient population. The treatment approach used minimal insulin and hydration over a 24 hour period with no documented adverse events. This report provides data toward future steps in examining various evidence-based medicine approaches suitable for treatment strategies in DKA patients.

<table>
<thead>
<tr>
<th>Table 1. Treatment Information (n=127)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treatment variable</strong></td>
</tr>
<tr>
<td>Bicarbonate Administered</td>
</tr>
<tr>
<td>Mean Normal Saline Bolus (mL/kg)</td>
</tr>
<tr>
<td>Mean Unit Insulin (units/kg/hr)</td>
</tr>
<tr>
<td>Mean Total Fluid (mL/kg)</td>
</tr>
<tr>
<td>Mean hours to pH normal</td>
</tr>
<tr>
<td>Mean PICU days</td>
</tr>
<tr>
<td>Disposition Floor</td>
</tr>
<tr>
<td>Home</td>
</tr>
<tr>
<td>Values presented in means(SD: standard deviations) and counts[percentages]</td>
</tr>
</tbody>
</table>
2567 Admissions to Pediatric Intensive Care Unit (2005-2012)

139 Encounters with Diabetic Ketoacidosis Diagnosis

11 Encounters Excluded

9 Encounters not Treated on Protocol

2 Encounters Incomplete Medical Records

Study Sample 127 Encounters Included

Figure 1. Patient population and sample

Figure 2. Correlations between hours to normal pH and select study variables: A) \( r = -0.55; \) p-value: < 0.0001; B) \( r = 0.05; \) p-value: 0.6011; C) \( r = 0.26; \) p-value: 0.0034; D) \( r = 0.21; \) p-value 0.0182
(21246) Intravenous Morphine Infusion in Neonates after Cardiac Surgery Is Not Associated with Extubation Failure

Mayte Figueroa, M.D.1, John Alexander, MD1, Juan C Menendez, PhD2, Michelle Grandberry, RN BSN2 and Christopher J. Knott-Craig, MD2. (1)Pediatrics, University of Tennessee Health Sciences Center/ Le Bonheur Children’s Hospital, Memphis, TN, (2)Le Bonheur Children’s Hospital, Memphis, TN

Purpose: The purpose of this study was to report our experience with the use of low dose morphine infusion in neonates after cardiac surgery through the post-extubation period. Studies have shown that the use of analgesia minimizes the hormonal response to cardiac surgery. There is also evidence that agitation and inadequate sedation are associated with adverse short and longer-term outcomes. However, compared to adults, neonates and infants have been reported to be at increased risk of respiratory depression after morphine. There is limited data on the safety and efficacy of low dose morphine infusion in the postoperative pediatric cardiac surgical patient.

Methods: We performed a single center retrospective observational study in a pediatric CICU at a tertiary academic children’s hospital during the period of November 2008 to July 2012. The IRB approved the study and the need for informed consent was waived. The study included all infants three months of age or less who underwent cardiac bypass surgery. Subjects excluded from the study were infants who required an open sternotomy postoperatively, Extracorporeal membrane oxygenation support, were mechanically ventilated for greater than 3 days preoperatively and those who were placed on a fentanyl drip postoperatively. Extubation failure in our study was defined as reintubation within 24 hours after extubation. Clinical outcomes evaluated included the success or failure of extubation, length of mechanical ventilation (MV) and escalation of respiratory support. Statistical analyses included least square fit for comparison of continuous variables and contingency for association containing nominal variables.

Results: Of 75 patients eligible during the study period, extubation failure occurred in 8% (6/75) of the patients. The median age of patients was 15 days (1-70 days) and median weight of patients was 3.4 kg (1.7-5.9 kg). The median cardiopulmonary bypass (CPB) time was 65 min (0-148 min) and median aortic cross clamp time 25 minutes (0-75 min). Median dose of morphine infusion was 6.5 mg/kg/min (2 to 30 mg/kg/min). 71 % of patients remained on a morphine infusion post extubation (53/75). The MV median was 25 hours (4 - 213 hours). Five of six patients who failed extubation were under two weeks of age (mean of 12.8 days). 19% (14/74 patients) required an escalation of respiratory support with 4 of these requiring reintubation (c2 ≤0.05). Morphine infusion dose did not show effect on MV (p>0.05); reintubation did not show association to morphine infusion dose or CPB time (c2>0.05).

Conclusion: This is the first report of the safety of routine use of low dose morphine infusion through the post-extubation period in postoperative pediatric cardiac surgical patients. Our study reveals a reintubation rate lower than what is reported in the literature. In our patients use of low dose morphine infusion was not associated with risk of reintubation.

(22785) Heart Rate Variability in Children with Submersion Injury: A Case Series

Madhuradhar Chegondi, MD1, Jun Sasaki, MD1, Sayed Naqvi, MD1, Jared Leichner2, Yinchen Song2, Wei-Chiang Lin, PhD2 and Balagangadhar Totapally, MD1. (1)Miami Children’s Hospital, Miami, FL, (2)Florida International University, Miami, FL

Special Equipment Needs: Physician In-Training Award

Purpose: Heart rate variability (HRV) is used to prognosticate several conditions in adults and it is thought reflect autonomic balance on the chronotropy of the heart. Submersion can cause serious anoxic injury of the brain this may in tern affect HRV. This study evaluates various HRV indices in three children after submersion injury.
Methods: The study includes three children who were a part of multimodal neuromonitoring in critically ill children funded by the Department of Defense (Award# W81XWH-09-1-0295). These children were admitted with acute brain injury from submersion to PICU and were treated with mechanical ventilation and therapeutic hypothermia. The first child (initial pH 6.8) died after meeting brain death criteria, the second child (initial pH 7.12) had a full recovery, and the third child (initial pH 6.66) survived with severe neurologic dysfunction. Electrocardiography (ECG) signals exported from the central monitor were analyzed in both time and frequency domains. We have used EEG and ECG recordings during the first four hours after recruitment (2-3 days after injury) and last four hours of the monitoring study (3-4 days after recruitment) for analysis. Each hour ECG data were split into 12 five-minute segments (a total of 8 hours of data from each patient). We have calculated the mean NN interval (R-to-R interval) for each of 12 segments. Then, standard deviation of NN means in 12 segments (SDANN) was calculated and used in statistical analysis. The data in frequency domain were analyzed with the Lomb periodogram for power at low-frequency band (LF: 0.04-0.15Hz) and high-frequency band (HF: 0.15-0.4 Hz). Mean LF/HF ratio was calculated. T-test and ANOVA with Tukey-Kramer multiple comparisons were used to analyze the data.

Results: The mean LF/HF ratios for all hours were 0.11, 0.94, and 0.13 for three children respectively. LF/HF ratio in the second child was significantly different from other two children (p<0.05). Child 1 and 3 had isoelectric or burst-suppression in EEG during some hours. Power in LF band (192 vs 817 arbitrary units), LF/HF ratio (0.25 vs 0.68), and SDANN (13 vs 21 msec) were significantly lower during isoelectric or burst-suppression periods compared to active ECG periods (p<0.05). During hypothermia, power in LF band was lower (304 vs 907 au; one way t-test, p<0.05) and a trend towards lower LF/HF ratio compared, to normothermia periods. In general, the power in the HF band was not significantly influenced by EEG activity or hypothermia.

Conclusion: The power in LF band, LF/HF power ratio, and SDANN are lower in children who had a bad outcome, and during the period of isoelectric or burst suppression. Hypothermia may affect HRV. The utility of HRV as a monitoring and prognostic tool in children with anoxic brain injury needs further study.

(20025) No Relationship between Surgical Volume and Hospital Mortality in Congenital Diaphragmatic Hernia

Jake Harbert, BA MSt, Samuel Hohmann, PhD, MSt, Tricia Johnson, PhDSt, Srikumar Pillai, MDSt, Debra Selip, MDSt, Rajneesh Behal, MD, MPHSt and Jason M. Kane, MD, MSt. (1)Rush University Medical Center, Chicago, IL, (2)University HealthSystem Consortium, Chicago, IL

Purpose: Congenital diaphragmatic hernia (CDH) continues to be a significant cause of neonatal morbidity and mortality. Advances in critical care including high frequency oscillatory ventilation, nitric oxide, and ECMO have expanded the range of therapeutic modalities for managing these critically ill infants. However, the mainstay of therapy still requires surgical repair. Recent data suggest that regionalization of CDH cases in tertiary care pediatric hospitals is required to ensure sufficient volume for optimal outcomes. The purpose of the current study was to assess whether a relationship exists between surgical volume and in-patient survival in neonatal patients undergoing repair of CDH at academic medical centers in the United States.

Methods: A retrospective cross-sectional analysis of discharge data from academic medical center members of the University HealthSystem Consortium (UHC) Clinical Database was conducted. UHC is an alliance of 119 academic medical centers and 293 affiliated hospitals representing approximately 90% of the nation's non-profit academic medical centers. Information was abstracted for all patients who underwent surgical repair of the CDH within 30 days of birth from January 1, 2008 through December 31, 2011. Additional risk factors known to affect clinical outcomes were also assessed. Hospitals were categorized as either low volume (less than 6 cases/yr) and high volume (greater than or equal to 6 cases/yr) based on prior published research. Unadjusted mortality rates were compared between low and high volume centers. Chi squared tests were used to compare mortality rates between the two groups. Binary logistic regression analysis was also performed on risk factors of mortality.

Results: 674 CDH cases were identified at 46 distinct facilities, all with ECMO capabilities. Median facility procedure volume was 21 (range 3-57) during the three year period. ECMO was used in 29% of cases. Overall survival rate following surgery was 84%. There were 36 low-volume and 10 high-volume centers performing 308 and 366 surgical repairs, respectively. There was no significant difference in mortality between low and high volume centers (15.9% vs 16.4%, p=0.865). There were no differences in gender, birth weight, facility median procedure volume, or race comparing survivors to non-survivors. In the binary logistic regression model, independent risk factors for mortality included the use of ECMO, the presence of bacteremia, pulmonary hypoplasia, and septic shock (p<0.05).

Conclusion: The surgical volume of an academic medical center is not associated with the clinical outcome of neonatal patients undergoing repair of CDH. These data refute the notion that referral to high volume pediatric centers will necessarily result in
better surgical outcomes. Contrary to published data exclusively from tertiary pediatric hospitals in the United States, there appears to be no relationship between surgical volume and mortality in neonatal patients undergoing repair for CDH at academic medical centers.

(21611) Venous Thromboembolism in Long-Gap Esophageal Atresia Patients

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Special Equipment Needs: Physician In-Training Award

Purpose: To determine the incidence of venous thromboembolic events (VTE) in Long-Gap Esophageal Atresia (LGEA) patients treated at Boston Children's Hospital (BCH) and to identify possible risk factors associated with development of VTE.

Methods: We performed a retrospective analysis of patients with LGEA admitted to BCH from 2005 to 2012. Patients with symptomatic VTE with radiographic confirmation were defined as events. Potential risk factors for the development of VTE were assessed by univariate analysis and multivariate logistic regression, with covariates including age, weight, initial gap length, number of days of pharmacologic paralysis, number of paralytic episodes, number and type of central venous catheters (CVC), and number of invasive procedures.

Results: Forty-four LGEA patients were identified. VTE occurred in 34% (n = 15). Univariate analysis identified total duration of paralysis (median: 42 vs. 21 days, P=.013), cumulative episodes of paralysis (P=.001), cumulative number of CVC (P=.007) and ICU length of stay (P=.027) as significant factors associated with VTE. Multivariate logistic regression identified number of episodes of paralysis as the only significant independent risk factor of increased likelihood of VTE (P<.0001). Specifically, patients having more than two episodes of paralysis had a higher incidence of VTE compared to those with 1 or 2 episodes (10/14 = 71% vs. 5/30 = 17%) and were estimated to be 12 times more likely to develop VTE (odds ratio, 12.5, 95% CI: 3-56, P<.0001) independent of total number of paralysis days (P=.39), number of lines (P=.23), type of lines (P=.28), and number of invasive procedures (P=.85). No thrombosis-related mortality occurred during this study time period.

Conclusion: The incidence of symptomatic VTE was 34% in this small series, significantly higher than the VTE incidence of 0.58% reported for hospitalized children. These data have led to multidiisciplinary and multi-unit discussions regarding thromboprophylaxis and development of a consensus-driven approach.

(22912) Variations in the Cost of Extra-Corporeal Membrane Oxygenation in Children

Tolulope Oyetunji, MD, MPH¹, Augustine Obirieze, MD, MPH², Hope T. Jackson, MD² and Faisal G. Qureshi², (1)Howard University College of Medicine, Washington, DC, (2)Pediatric Surgery, Children's National Medical Center, Washington, DC

Special Equipment Needs: Physician In-Training Award

Purpose: Pediatric ECMO is performed at various types of centers across the United States. Low volume centers have been identified as not only generating higher hospital costs but also having higher mortality rates. Regionalization of care has therefore been recommended to reduce costs and mortality. However, the effect of geographical location on the outcomes and cost has not been evaluated.

Methods: The Kids Inpatient Sample (KID) from 2003-2009 was used to identify patients undergoing ECMO using ICD-CM 9 procedure codes. Patient demographics and hospital characteristics were analyzed. Generalized linear modeling was used to compare the adjusted mean cost for treating patients between US regions (Northeast, South, Midwest, and West) and by NACHRI's Children's Hospital status (Children's Hospital-CH, non-children's Hospital-NCH and Children's Unit in a general Hospital-CUGH) based on the AHRQ HCUP cost-to-charge ratio files. Hospital factors (size, teaching status, and location), patient demographics, length of stay, local wage index, and payer were adjusted for. Relative mean cost (RC) was calculated using the West as the reference.
Results: Adjusted relative costs were estimated for 1575 records, representing an estimated 2633 children. By region, the West, South, Midwest and Northeast represented 31.0%, 35.3%, 24.9% and 8.8% respectively. Children’s Hospital (CH) 45.7% and CH-unit (CUGH) cared for 50.7% of the patients. There were no differences in outcomes between geographical location or my by NACHRI designation. Adjusted mean cost for the Northeast, Midwest, South and West were $167,745, $202,352, $183,641 and $180,476 with no statistically significant difference by relative cost (RC). By NACHRI status however, adjusted mean cost was highest for CH at $227,761 with a 38% reduction in RC (0.62, CI 0.48-0.81) at NCH and a 37% reduction at CUGH. (RC: 0.63, CI0.52-0.78).

Conclusion: Geographical location does not impact outcomes or relative costs of ECMO in patients less than 20 years. However, children’s hospitals have a higher relative cost. Further investigation will be required to understand this difference.

(22970) Anticoagulation Therapy Trends in Children Supported By Ventricular Assist Devices: A Multi-Institutional Study

Brady Moffett, PharmD1, Antonio G. Cabrera, MD2, Jun Teruya, MD DSc3 and Lisa Bomgaars, MD3, (1)Pharmacy, Texas Children’s Hospital, Baylor College of Medicine, Houston, TX, (2)Pediatric Cardiology, Texas Children’s Hospital, Baylor College of Medicine, Houston, TX, (3)Baylor College of Medicine/Texas Children’s Hospital, Houston, TX

Purpose: To describe the trends in anticoagulation therapy in children supported by ventricular assist devices over 10 years.

Methods: Retrospective cohort study of pediatric hospitals from the PHIS (Pediatric Health Information System) database for VAD implantation from 2000-2011. Patient demographics, use of extracorporeal membrane oxygenation, orthotopic heart transplantation, disease states, and medications pertinent to the management of VAD anticoagulation (antiplatelet, anticoagulants, procoagulants, antifibrinolytics) were obtained. Patients were grouped into 3 year time periods to evaluate trends in medication use over time.

Results: 466 patients were identified with a median length of VAD therapy of 21 days (Range 1- 362 days). Overall hospital mortality was 31.9%, 54.5% underwent OHT. Mean length of VAD therapy and use of orthotopic heart transplantation increased, while mortality decreased. Over the time period, there was an increase in the numbers of anticoagulant, procoagulant, antifibrinolytic and antiplatelet agents and the use of oral medications increased more than two fold. Overall, the use of anticoagulant medications (unfractionated heparin, enoxaparin, argatroban, bivalirudin, lepirudin, alteplase, warfarin) occurred in 98.3% of patients. Unfractionated heparin (UFH) was used in 98.3%, and this trend did not differ widely between time periods (p=0.11). Enoxaparin use increased significantly over the 2000-2002 period to 38.6% of patients receiving enoxaparin in the 2009-2011 time period (p<0.01). Warfarin was used in 26.2% of patients, and this did not change significantly over time (p=0.97). Alteplase was used in 31.8% of patients, with a significantly higher percentage of patients receiving alteplase in the 2009-2011 period (41.8%) as compared to the 2000-2002 time period (7.1%) (p<0.01). Antithrombin was used more frequently in the most recent time period (2009-2011, 44.1%) as compared to 2000-2002 (0%, p<0.01). A direct thrombin inhibitor was used rarely (argatroban (0.9%), bivalirudin (0.6%), lepirudin (0.2%).)

The use of unfractionated heparin did not differ between age groups, but infants were more likely to receive enoxaparin, alteplase, and antithrombin. Older patients received warfarin more frequently. (p<0.05)

The use of procoagulant / antifibrinolytic medications increased by 44.5% over the study period (p<0.01). Cryoprecipitate was used frequently in patients (86.3%) and fresh frozen plasma was also used frequently (90.8%). Recombinant factor VIIa was the most frequently used of all of the exogenous coagulation factors (23.2%), with factor VIII (0.2%) and factor IX (4.7%) used less often. Protamine was used in 65.7% of patients and vitamin K in 16.1% of patients. Aminocaproic acid was used in 34.1%, tranexamic acid in 13.3% and aprotinin, was used in 25.1% of patients.

Conclusion: There is wide variability on in-hospital pediatric VAD anticoagulation management with a significant increase in the use of oral agents in recent era.
Pediatric Palliative Care in High Cost Patients

Andrew Smith, MD, Seth Andrews, BS, Chris Maloney, MD PhD, and Susan L. Bratton, MD
(1)University of Utah School of Medicine, Salt Lake City, UT, (2)Primary Children’s Medical Center, Salt Lake City, UT

Special Equipment Needs: Physician In-Training Award

Purpose: Pediatric palliative care (PPC) programs are increasingly available at children’s hospitals to improve care of children with potentially life-limiting conditions. We evaluated PPC utilization among the most costly hospitalized patients and examined factors associated with receipt of PPC and inpatient costs.

Methods: All patients discharged from Primary Children’s Medical Center (PCMC) in 2010 were ranked according to total inpatient cost in 2010. Among the >= 90th % most costly inpatients in 2010, we calculated total inpatient cost for 2010 and 2011 and average cost/day. We identified receipt of PPC during 2010, and compared those who received PPC with those who had no PPC using non parametric tests. For PPC patients, we compared average daily cost prior to and after initial consultation. Data are reported as median values with inter quartile ranges.

Results: The most costly decile in 2010 included 1001 patients; 81(8%) patients received PPC. Of those with PPC, 9 (11%) patients had de-escalation of care, 11(14%) had escalation of care and 61 (75%) were unchanged. Table 1 compares demographic and clinical features among patients with or without PPC. Of patients who died, those children with PPC had a median daily cost of $3976 ($3254-$4931) as compared to $4693 ($3562-$6455) for those with no PPC (p=0.032). Fifty six patients had inpatient hospitalizations in 2010 prior to receiving PPC. For these patients, the median daily cost prior to PPC was $3827 ($2.9-3.9K)) and increased to $4013 ($3.1-5.1K) after PPC consultation (p=0.06).

Conclusion: Among high cost inpatients, patients with PPC differed from those not receiving PPC and were more likely to have multiple complex chronic conditions, be technology dependent, admitted to the PICU, die and be more costly than those with no PPC. However among patients who died, children with PPC were less expensive than those who died with no PPC. Our data suggests that daily cost of care following PPC may be more expensive than care prior to a consultation. Further research is needed to identify factors which explain the increase in cost of care.

<table>
<thead>
<tr>
<th>Factor</th>
<th>No palliative care consultation</th>
<th>Palliative care consultation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age groups</td>
<td>(N=920)(%)</td>
<td>(N=81)(%)</td>
</tr>
<tr>
<td>0-29 days</td>
<td>290 (32)</td>
<td>12 (15)</td>
</tr>
<tr>
<td>30 days-2 years</td>
<td>195 (21)</td>
<td>26 (32)</td>
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<td>2-5 years</td>
<td>122 (13)</td>
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<tr>
<td>6-12 years</td>
<td>143 (15)</td>
<td>15 (19)</td>
</tr>
<tr>
<td>13 or more years</td>
<td>170 (19)</td>
<td>12 (15)</td>
</tr>
<tr>
<td>Boys</td>
<td>515 (56)</td>
<td>26 (44) p=0.045</td>
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<tr>
<td>Complex chronic condition</td>
<td></td>
<td>p &lt;0.001</td>
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<tr>
<td>2 or more</td>
<td>505 (55)</td>
<td>71 (88)</td>
</tr>
<tr>
<td>Died during year</td>
<td>77 (8)</td>
<td>41 (51) p&lt;0.001</td>
</tr>
<tr>
<td>PICU admission in 2010</td>
<td>522(56)</td>
<td>73(90) p=0.001</td>
</tr>
<tr>
<td>NICU admission in 2010</td>
<td>262 (28)</td>
<td>14(17) p=0.04</td>
</tr>
<tr>
<td>Cost in 2010/2011</td>
<td>$103K (64-187K)</td>
<td>$177K (102-281) p&lt;0.001</td>
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<tr>
<td>Daily Cost 2010/2011</td>
<td>$3.4K (2.7-4.5)</td>
<td>$3.8K (3.1-4.7) p&lt;0.001</td>
</tr>
</tbody>
</table>
Early Identification of Critically Ill Pediatric Patients at an Academic Medical Center

Adam Szadkowski, MD, Nabihah Mahmood, MD, Mark Marinello, MD and Jose Munoz, MD, Children’s Hospital of Richmond at VCU, Richmond, VA

Special Equipment Needs: Physician In-Training Award

Purpose: The Pediatric Early Warning Score (PEWS) is a validated tool that has been proven to provide clinicians with significant warning that a patient may be deteriorating. This is especially important in pediatric patients who tend to compensate for prolonged periods prior to respiratory or cardiac arrest. It does not catch all sick children, but it can serve as another piece of information for the care team to use when making an assessment and developing a plan of care. The Children’s Hospital of Richmond at VCU implemented the PEWS system in October 2012. The objective of this research is to analyze the impact of instituting PEWS at our hospital including patient outcomes. The ultimate goal was to determine whether PEWS helps clinicians have better situational awareness of patients who have the potential to decompensate.

Methods: Every PEWS score from every pediatric patient admitted from November 1, 2012 - January 31, 2013 was obtained. According to the hospital algorithm, a score of 6 or greater warrants alerting the rapid response team as well as the resident team. We excluded any patient in the ICU or the PACU. We wanted to evaluate the utility of the hospital algorithm on the general pediatric ward as well as identify barriers to its use. We then analyzed individual charts to determine the outcomes of patients with PEWS of 6 or greater. Of those patients who were moved to a higher level of care (PICU or PICU step down), we examined their need for critical interventions.

Results: There were approximately 50,000 PEWS recorded at VCU between November 1, 2012 and January 31, 2013. There were 166 events of which 50% of the time an MD, RT, or PICU nurse was called to the bedside. Sixteen percent of these cases required a transfer to a higher level of care, while an additional 52% required respiratory support. Fourteen percent required a critical intervention. We also had an increase in rapid response calls from 2.5 per month to 4.6 per month.

Conclusion: Through our analysis, we found that the implementation of PEWS has improved the situational awareness of higher risk pediatric patients. We determined that patients with higher scores were more likely to have an MD notified and to have interventions performed. We postulate that these assessments and interventions likely kept patients out of the PICU, although further studies are necessary. We hope to further improve patient care by making changes to the hospital algorithm so that a physician is notified for all patients with scores of 6 or greater. This will prevent emergent transfers to the PICU. Developing an independent pediatric rapid response team may improve outcomes of higher risk pediatric patients even further.

The Potential Impact of a Validated Clinical Prediction Rule for Pediatric Abusive Head Trauma (AHT)

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Purpose: To estimate the potential clinical impact of a validated AHT clinical prediction rule applied as an AHT screening tool.

Methods: Data were collected on 403 acutely head-injured children less than 3 years of age hospitalized for intensive care at one of our 18 participating PediBIRN sites between 2011 and 2013. We applied our recently derived AHT clinical prediction rule and categorized study patients as high or low risk based on our clinical prediction rule. The diagnostic yields of abuse evaluations in high and low risk patients were calculated. We then applied diagnostic yields observed in equivalent high risk patients to estimate potential diagnostic yields of abuse evaluations in high risk patients not worked up for abuse. Lastly we applied these extrapolations to estimate future AHT screening performance based on our derived AHT clinical prediction rule.

Results: The prevalence of AHT in our study population was 51% (205 of 403). At the time of hospital discharge, clinicians diagnosed AHT in 196 (49%) of 403 study patients. Despite the high prevalence of AHT in this patient population, only 218 (54%) of 403 study patients underwent a complete abuse workup (retinal exam, skeletal survey and liver function tests). Seventy-nine (20%) of 403 underwent no additional evaluations for abuse. Current AHT screening and evaluation practices led to an overall diagnostic yield of 38% (on retinal exam, skeletal survey or abdominal CT scan, if LFTs were elevated). At participating PediBIRN sites, the overall sensitivity and specificity of current AHT screening and evaluation practices were 0.95 and 0.35, respectively. In contrast, our extrapolations suggest that uniform application of our derived AHT clinical prediction rule -- coupled with complete abuse evaluations in all high risk patients -- would have: (1) increased screening sensitivity; (2) targeted 43 additional, high risk patients for abuse evaluation; (3) increased the overall diagnostic yield of abuse evaluations focused on high risk patients.
patients from 38% to 46%; (4) identified 10 additional missed AHT cases; (5) increased screening specificity from 0.35 to 0.44; and (6) spared up to 56 low risk children from a potentially unnecessary abuse workup.

**Conclusions:** At participating PediBIRN sites, intensive care providers elected to forego abuse evaluations in 20% of acutely head-injured patients less than three years of age, despite the prevalence of AHT in this population of approximately 50%. If validated, broad and consistent application of our derived AHT clinical prediction rule as a screening tool has potential to increase AHT screening sensitivity and specificity, decrease the number of unnecessary abuse workups, increase the diagnostic yields of abuse evaluations, and decrease the number of missed AHT cases.

(21975) When Complex Care Goes Complementary: Closing the Loop on Integrating Care for Children With Special Health Care Needs

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**Purpose:** Children with complex health problems, particularly children with special health care needs (CSHCN), have higher medical expenditures, experience more barriers to care and gaps in quality of medical care than other children. Less is known about population-based associations between complementary and alternative medicine (CAM) use and conventional medical care (CMC) experiences for CSHCN. This study assesses patterns of CAM use for CSHCN and associations with conventional medical care utilization, expenditures, access and quality of care.

**Methods:** Data from the most recent available national data on CAM use and CMC expenditures and quality of care among CSHCN are used. This data file links 2007 National Health Interview Survey and 2008 Medical Expenditure Panel Survey data at the child level. Bivariate and logistic and two-part statistical regression analyses were employed.

**Results:** CAM use was more prevalent among CSHCN (AOR 1.89, 24.7%) and children with multiple chronic conditions (2 CC: AOR 2.98, 24.9; 3+ CC, AOR 5.42, 37.9%). CAM use is higher among more complex CSHCN who meet criteria for the Affordable Care Act Diagnostic Condition List (ACA Dx, AOR 4.18, 42.2%) or experience difficulties in daily activities or functioning (AOR 4.19, 36.4%). Regardless of clinical condition group CAM use was found to be significantly higher among children with anxiety/stress (Rate Ratio ranging from 1.44 to 2.67 across DX groups) and children who missed two or more weeks of school (Rate Ratio ranging from 1.58 to 3.26). CSHCN not receiving care within a medical home were more likely to use CAM (27.9% vs. 16.3%, p=0.04). Further, CSHCN CAM users were less likely to meet criteria across nearly all sub-domains of medical home compared to CSHCN non-CAM users (e.g. on shared decision making 66.8% vs. 81.2%). The mean adjusted CMC expenditures for CAM users are significantly higher than for non-CAM users ($2,084 vs. $1,342, p<.0001) and the highest expenditures were reported for CSHCN using CAM who qualify on ACA criteria ($6,462).

**Conclusion:** CAM use is associated with the complexity and intensity of children’s health conditions and service needs, difficulties in accessing and poorer quality of CMC. Children with complex health problems receive multiple forms of conventional, complementary and alternative care, emphasizing the need for well integrated and coordinated pediatric care systems within the context of a medical home.

(22714) Adverse Drug Events in Hospitalized Children: Estimates From the Nationwide Inpatient Sample 2003-2010

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**Special Equipment Needs:** Physician In-Training Award

**Purpose:** Medication errors and Adverse drug events (ADEs) in adults are associated with significant morbidity, mortality, hospital resource utilization, and may be preventable. ADEs are injuries that result from drug use. Longitudinal estimates of
ADEs in pediatric inpatient settings at a national level are lacking. The objective of this study is to provide nationally representative incidence estimates of ADEs among hospitalized children in the United States during the years 2003 to 2010.

**Methods:** The current study is a retrospective analysis of the Nationwide Inpatient Sample (NIS) for the years 2003 to 2010. NIS is the largest all-payer hospital discharge database that is a part of the Healthcare Cost and Utilization Project sponsored by the Agency for Healthcare Research and Quality. All hospitalizations among children (aged <=21 years) that had an external cause of injury code for “Adverse Effects of Medical Drugs” were selected. Drugs causing ADEs, patient characteristics, disposition status following hospitalization, co-morbid burden, and year of hospitalization were all examined. All hospitalizations were categorized into 7 groups based on age. All estimates were projected to the national levels using the discharge weight variable. Simple descriptive statistics were used. All analyses were conducted using SAS Version 9.3 software (SAS institute, Cary, NC).

**Results:** Over 8 years, a total of 62,053,870 pediatric hospitalizations occurred in the United States. Of these, 460,966 (0.74%) experienced an ADEs. Infants comprised the greatest proportion of hospitalized children (38.5 million hospitalizations, 62% of all hospitalizations). Age group: number of ADEs included: Infants( 44,071), Toddlers(64,102), Pre-School(26,640), School age(66,436), Early Adolescents(65,252), Middle adolescents(72,484) and Late adolescents(121,981). Amongst those that experienced an ADEs, a total of 4,140 children died in hospitals. Year of hospitalization, ADEs for that year, and % of total ADEs include: 2003: 43,045(9%); 2004:47,267 (10%); 2005:63,528(14%); 2006:51,660(11%); 2007: 52,405(11%), 2008:66,978 (14%), 2009:62,042(13%); 2010:74,041(16%). Those with an ADEs also had a greater co-morbid burden. Whites (51% without ADE vs. 57% with ADEs), males (46% without ADEs vs. 50% with ADEs), discharged routinely (94% without ADE vs. 85% with ADE) occurred. The individual ADEs incidence rates varied with drug category-Antibiotics (0.14%), Hormones/synthetic agents (0.10%), and primarily systemic agents (0.18%). The overall incidence rate varied based on age with Infants(0.11%), Toddlers(1.67%), Pre-School(2.41%), School age(2.54%), Early Adolescents(2.62%), Middle adolescents(1.84%) and Late adolescents(1.28%)

**Conclusion:** The overall incidence rate of any ADEs was 0.74% of all hospitalizations and the inpatient incidence rates varied by age and agent. A gradual increase in number of ADEs was noted from 2003 to 2010. Those with ADEs had a greater co-morbid burden.