1. Protocolized management of congenital diaphragmatic hernia improves survival
Authors: Swenson, AW; Barthell, JE; Orton, LC; & Hustead, VA. Children’s Hospital and Clinics of Minnesota, Minneapolis, MN, USA

Background: Congenital Diaphragmatic Hernia (CDH) is a serious diagnosis in neonatal patients requiring a high level of support and often extracorporeal membrane oxygenation (ECMO). In April 2006, we implemented a protocol for management of CDH patients that includes ventilatory management guidelines, specific ECMO criteria, and criteria for timing of surgical repair for both those requiring ECMO and not requiring ECMO, with operative repair while on ECMO for those specific neonates. Following this protocol has led to a significantly increased rate of survival to discharge in all CDH patients as compared to the CDHSG registry benchmark.

Methods: All neonates treated at our institution with CDH born before and after April 2006 are compared to the CDH registry in regard to patient demographics, defect characteristics, and survival to discharge. Summary values were expressed as mean + standard deviation or as percentage if dichotomous. Comparing patient’s characteristics data between the Children’s and the CDH registry data, Chi-square test/Fisher’s test were used for frequencies and two-sample t-test was used to compare the continuous variables. A two tailed P value of less than 0.05 was considered statistically significant. All data analyses and statistical calculations have been performed using R V2.15 data package.

Results: Table 1 shows outcome data comparing Children’s to the CDH registry before protocol initiation. Table 2 shows outcome data for the same groups after protocol initiation. Survival for all CDH patients improved from 64% before protocol initiation to 84% after. Patient demographic profile, and defect characteristics did not change significantly from pre to post protocol initiation. In the post-protocol era, Children’s patients are more likely inborn (69%) compared to registry data (p <0.001), and were more likely to be in the “high risk” category of defect severity (p <0.001). For the 38 Children’s CDH patients who received ECMO, 82% survived to discharge; 34 had repair while on ECMO.

### TABLE 1. Before April 1, 2006

<table>
<thead>
<tr>
<th>Patient characteristics</th>
<th>Children’s</th>
<th>The CDHSG Registry</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>156</td>
<td>3213</td>
<td>--</td>
</tr>
<tr>
<td>Survival to discharge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All CDH, N (%)</td>
<td>100 (64)</td>
<td>2217 (69)</td>
<td>0.20</td>
</tr>
<tr>
<td>Isolated CDH, N (%)</td>
<td>97 (71)</td>
<td>2089 (73)</td>
<td>0.47</td>
</tr>
<tr>
<td>Treated with ECMO, N (%)</td>
<td>32 (21)</td>
<td>1030 (32)</td>
<td>0.72</td>
</tr>
<tr>
<td>Survival if treated w ECMO, (%)</td>
<td>47</td>
<td>(50)</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 2. After April 1, 2006

<table>
<thead>
<tr>
<th>Patient characteristics</th>
<th>Children’s</th>
<th>The CDH Registry</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>88</td>
<td>3045</td>
<td>---</td>
</tr>
<tr>
<td>Survival to discharge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All CDH, N (%)</td>
<td>74 (84)</td>
<td>2111 (69)</td>
<td>0.003</td>
</tr>
<tr>
<td>Isolated CDH, N (%)</td>
<td>67 (88)</td>
<td>1966 (74)</td>
<td>0.02</td>
</tr>
<tr>
<td>Treated with ECMO, N (%)</td>
<td>38 (43)</td>
<td>846 (28)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Survival if treated w ECMO, (%)</td>
<td>82</td>
<td>(47)</td>
<td></td>
</tr>
</tbody>
</table>

Conclusions: After protocol initiation for management and repair of CDH at our institution, survival to discharge was statistically improved as compared to the CDHSG registry benchmark.
2. Stress in parents of medically fragile infants who met palliative care referral criteria and were referred to home health services

Authors: Postier A, Foster L, Osenga K, Grinyer A, Friedrichsdorf S.

Background: Parents caring for children with life-limiting or life-threatening illnesses face increased stress. Little is known about how parents of medically fragile infants experience and cope with stress related to transitioning from intensive hospital care to medical services in the home.

Methods: Parents whose infant was being discharged from the hospital, who met Center to Advance Palliative Care (CAPC) pediatric palliative care (PPC) referral criteria, and who were referred to either a skilled home nursing or formal PPC program through the same institution, were interviewed by phone or in person shortly after discharge and again three months later. Parents completed a structured interview and the Pediatric Inventory for Parents (PIP). Descriptive statistics were run to describe parent and family characteristics, and services received. Paired t-tests and nonparametric within-subjects analyses were run to examine change over time in family characteristics (e.g., change in employment status), services received, and PIP scores.

Results: The 42 parents were mostly female (n=40, 95%), white (n=26, 61%), married (n=35, 83%), and were an average of 30.4 (SD=5.0) years of age. Only six (14%) infants actually received PPC services, and 33 (79%) babies qualified for PPC due to extremely low birth weight alone. Total stress frequency and difficulty scores improved significantly at follow-up, as measured by the PIP (t=2.27, p=0.03 and t=2.92, p<0.01, respectively). Services associated with PPC were desired by the majority of parents, yet few had received those services at follow-up. Few parents indicated they were receiving their own spiritual/emotional services or had regularly scheduled time for themselves at either time point.

Conclusions: Parents of medically fragile infants experienced high stress as they transitioned from the hospital setting to home, but this stress lessened during the first few months after discharge. Despite meeting PPC referral criteria, few infants received this level of care at home.

3. Palliative care program involvement at the end of life for children who died in a pediatric hospital setting

Authors: Postier A, Osenga K, Foster L, Teeple W, Friedrichsdorf S.

Background: An increasing number of US children’s hospitals provide pediatric palliative care (PPC) services, but little is known about their involvement in acute inpatient end-of-life (EOL) care. The primary aims of this study were to describe EOL care for children who died at Children’s Hospitals and Clinics of Minnesota (CHC), and to examine PPC provider involvement and impact.

Methods: A retrospective chart review was conducted for all children aged 0-18 who died as inpatients at CHC between January 1, 2012 and June 30, 2013, and were treated for ≥ 24 hours prior to death.

Results: The 114 children were 2.8 (SD=5.3) years of age on average. Twenty-eight (25%) received a PPC consult during the hospital admission in which they died. Median length of stay was 6.5 days (range 1-423), and the majority (54%) died in a neonatal intensive care unit. The most commonly
prescribed opioids were morphine (67%) and fentanyl (33%), and most commonly prescribed adjunct medication types were benzodiazepines (81%) and glucocorticosteroids (46%). During the last 72 hours of life, children who had a PPC provider consult had fewer diagnostic/invasive procedures in the last 48 hours of life (OR=0.17, 95% CI 0.04, 0.67, p=0.01); received an increase in pain medication (71% vs. 42%, p<0.05); were more likely to have a do-not-resuscitate/allow-natural-death (DNR/AND) order in place (OR=7.02, 95% CI 1.75, 28.14, p=0.006); and were more likely to have received integrative (non-pharmacological) treatments (OR=2.20, 95% CI 0.61, 8.00, p=0.004). Pain assessments were documented significantly more often during the last 12-24 and 24-36 hour periods before death for those that received a PPC consult (RR=1.61, 95% CI 1.22, 2.13; RR=1.44, 95% CI 1.08, 1.93, respectively).

**Conclusions:** The majority of children (75%) who died in the inpatient setting were not referred to the PPC service. Children with a PPC consultation appeared to have better overall EOL care coordination and to be aligned with best PPC practices. Initial findings lay the groundwork for further identification of barriers to timely and consistent referral to PPC for children with serious conditions who die in the hospital setting.

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**4. Reducing tissue plasminogen activator use as a means to maintain central venous line patency**

**Authors:** Andrew Peterson, Stephen Kurachek MD

**Background:** Tissue plasminogen activator (TPA) is used to maintain central venous line (CVL) patency when infusion is sluggish and/or blood withdrawal is no longer possible. The efficacy of TPA for this function is well established. TPA use, however, is associated with the development of CLABSIs, an association likely due to the development of fibrin deposition in the catheter or clot at the catheter tip. TPA, however, exposes the patient to hazard: inadvertent overdose, bleeding and allergic reaction as well as cost. Over one year in the PICUs at CHC-MN, 612 doses of TPA were infused to maintain CVL patency at a cost of $61,000 to the organization and $245,000 in charges to patients.

**Methods:** Our initiative to reduce TPA use has occurred in three phases with each phase lasting 6 months. First (the pre-trial phase), we measured TPA use at a time when the MaxPlus needleless cap was being used in both PICUs at CHC-MN. Second, we refrained from “heparin locking” the needle port and attempted to maintain line patency with a continuous infusion of heparinized saline (2 Units/ml at 3 ml/hr through each unused port). Third, we returned to heparin locking when a neutral displacement cap (MaxZero) was introduced into the PICUs.

**Results:** During the initial phase (heparin lock, MaxPlus) 81.76 doses/1000 CVL days were used over a six month period. During the second phase (continuous heparin infusion) TPA decreased to 64.24 doses/1000 line days over a six month period. That is, TPA use declined by 21.4% with the continuous heparin infusion, a significant change (p value < 0.02). In the first three months of the third phase (MaxZero cap) TPA use has declined to 60.89 doses/1000 CVL days, a 25.53% reduction from our pre-trial data.

**Conclusions:** We have been able to reduce the use of TPA with a continuous heparin infusion through the ports of CVL. Continuous heparin infusion, however, may not be necessary if the preliminary findings of TPA use with a neutral displacement cap are maintained. More study is necessary, however, to develop a means to completely eliminate the use of TPA.
5. Prenatal lung-to-head ratio in infants with congenital diaphragmatic hernia does not predict ECMO or survival

**Authors:** E. Plummer, M. Nowicki, P. Wickham, A. Flood, B. Feltis, W. Block, V. Hustead, E. Bendel-Stenzel. Midwest Fetal Care Center of Children’s Hospital and Clinics of Minnesota and Abbott Northwestern Hospital, Minneapolis, MN, USA

**Background:** Congenital Diaphragmatic Hernia (CDH) is a high mortality birth defect frequently requiring extracorporeal membrane oxygenation (ECMO). In April 2006, we implemented a standardized protocol for management of CDH patients, which includes prenatal measurement of the lung to head ratio (LHR). The goal of this study was to assess the predictive value of LHR for ECMO use and survival in CDH patients at our institution.

**Methods:** Data was collected from 96 infants identified in our CDH database between January 1, 2006 and December 21, 2013. Patients transferred without a prenatal diagnosis or without a prenatal LHR measurement were excluded, leaving a total of 46 patients. Patients were divided into 3 LHR groups: severe (<1), moderate (≥1-1.49), and mild (≥ 1.5). Logistic regression was used to determine the association of LHR category with the need for ECMO and with survival.

**Results:** Overall, 54.3% of patients required ECMO and 84.8% of patients survived. Regression analysis showed no association between LHR and requirement for ECMO or survival. This remained true when controlling for variables associated with poor outcome including intrathoracic herniation of the liver (63% of our patients).

<table>
<thead>
<tr>
<th>LHR severity</th>
<th>Use of ECMO (%)</th>
<th>Survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild (15)</td>
<td>9 (60)</td>
<td>12 (80)</td>
</tr>
<tr>
<td>Moderate (22)</td>
<td>10 (45.5)</td>
<td>19 (86.4)</td>
</tr>
<tr>
<td>Severe (9)</td>
<td>6 (66.7)</td>
<td>8 (88.9)</td>
</tr>
<tr>
<td><strong>TOTAL (46)</strong></td>
<td><strong>25 (54.3)</strong></td>
<td><strong>39 (84.8)</strong></td>
</tr>
</tbody>
</table>

**Conclusions:** In our center, LHR predicts neither the need for ECMO nor survival. Limitation of the LHR includes inability to predict functional parameters such as pulmonary hypertension.

6. Variation in emergency department care for children with asthma

**Authors:** Heather G. Zook, BA¹, Nathaniel R. Payne, MD¹, Susan E. Puumala, PhD², Katherine Burgess, MPH², Anupam B. Kharbanda, MD, MSc³. ¹Children’s Hospitals and Clinics of Minnesota, Minneapolis, MN. ²Sanford Research, Sioux Falls, SD

**Background:** Despite consensus on national guidelines for the management of pediatric asthma, significant variation in Emergency Department (ED) evaluation and treatment exists. Less data is available on the variation in treatment across racial/ethnic groups.

**Objectives:** To assess the variability in ED treatment for asthma patients, evaluate the management of asthma patients among racial/ethnic groups, and compare our data to national benchmarks.

**Methods:** This cross-sectional study analyzed pediatric (< 18 years) visits with a final diagnosis of asthma among 6 EDs in the Upper Midwest between June 2011 and May 2012. We used bivariate
and multivariate analyses to assess the odds of asthma patients receiving steroids or radiology tests. We also analyzed the odds of 30-day ED revisits. To control for asthma severity and compare our data with national benchmarks, we conducted a stratified analysis of asthma patients who received at least 1 albuterol treatment in the ED.

**Results:** The sample included 4452 asthma visits by 2470 patients. After adjusting for demographic and clinical variables, Hispanics and African Americans had significantly higher odds of steroid administration than Whites. African American and American Indian children had lower odds of radiological testing compared to White children. In adjusted analyses, Asians were the only racial/ethnic group with lower odds of 30-day ED revisits than Whites, with no other significant differences detected between racial/ethnic groups. In stratified analyses, our cohort met national benchmarks for steroid administration (79%) and matched previous studies for radiological testing (35%).

**Conclusions:** Racial/ethnic minority groups received steroids at a higher rate than Whites, but were less likely to undergo radiological testing. The management of asthma in our study met national benchmarks for steroid administration and was similar to previous studies for radiological testing.

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**7. Emergency department utilization for American Indian children**

**Authors:** Heather G. Zook, BA¹, Anupam B. Kharbanda, MD, MSc¹, Susan E. Puumala, PhD², Katherine Burgess, MPH², Nathaniel R. Payne, MD¹. ¹Children’s Hospitals and Clinics of Minnesota, Minneapolis, MN. ²Sanford Research, Sioux Falls, SD

**Background:** Previous research suggests that American Indian (AI) patients may visit the Emergency Department (ED) more frequently than other racial/ethnic groups.

**Objectives:** To evaluate the influence of geographic location, socioeconomic status, and chronic disease on AI children’s ED utilization patterns.

**Methods:** This cross-sectional study analyzed pediatric (< 18 years) visits to 6 EDs in the Upper Midwest between June 2011 and May 2012. We used bivariate analyses and mixed effects logistic regression to analyze racial/ethnic differences in frequent (≥ 4 visits in 12 months) ED visits. We also conducted several sensitivity analyses.

**Results:** There were 112,746 ED visits by 74,851 patients. African American (9.5%), Hispanic (9.0%), and AI (6.0%) patients were more likely than Whites (2.6%) to be frequent ED visitors. Even among a subgroup of low income patients (zip code median income ≤ $47,917), AI (Adjusted Odds Ratio [aOR] 1.23, 95% Confidence Interval [CI] 1.02–1.49), African American (aOR 1.70, CI 1.44 – 2.00), and Hispanic (aOR 1.84, CI 1.54 – 2.19) patients had higher odds of frequent ED visits than Whites. Compared to AI children, African American and Hispanic children showed similar odds of frequent ED visits. Chronic disease increased the odds of frequent ED visits, but was no more common among AIs than other racial/ethnic groups. Mental health conditions were seen more commonly among AI patients (4.9%) than all other racial/ethnic groups (0.7% to 1.9%).

**Conclusions:** AI patients had higher odds than Whites of frequent ED visits, but their odds were not higher than those of African Americans or Hispanics. AI patients’ ED utilization was not significantly different from that of other socially disadvantaged groups.
8. Pediatric trauma and the risk of pneumonia

Authors: Henry W. Ortega MD¹, Gretchen Cutler PhD¹, Jill Dreyfus PhD², Andrew Flood PhD², Anupam Kharbanda MD, MSc¹. ¹Department of Pediatric Emergency Medicine, ²Research and Sponsored Programs

Background: Injury is a leading cause of hospitalization in children, and as many as 5% of hospitalized injured children require mechanical ventilation. Despite this, little is known about the complications associated with mechanical ventilation, including pneumonia.

Methods: A retrospective analysis of trauma patients younger than 19 years from the National Trauma Data Bank from 2009-2011. Descriptive statistics were used to examine the patient population. Baseline characteristics were compared between subgroups using t-tests and chi-square tests. Generalized linear models were used to identify risk factors for hospital-acquired pneumonia adjusting for clustering of patients by hospital.

Results: A total of 252,187 patients eligible for analysis, and 1,915 patients were diagnosed with pneumonia. Most patients were male (66.3%), white (54.2%), had no co-morbidities (88.9%), and were not considered severely injured (85.5% with an ISS < 16). The average length of stay was 2.9 days (SD=5.2). Patients who developed pneumonia were older (16-18 years: 61.7% vs. 31.1%, p <0.0001), had a longer length of stay (20.9 vs. 2.8 days, p <0.0001), more intensive care days (13.9 vs. 0.7 days, p <0.0001) and more ventilation days (9.5 vs. 0.3 days, p <0.0001) compared to those who did not develop pneumonia. The rate of pneumonia nearly doubled in patients spending two days on a ventilator (OR=5.52; 95% CI: 3.45-8.84), doubled again for patients spending three days (OR=10.59; 95% CI: 6.38-17.61), and doubled again for patients spending five days (OR=23.72; 95% CI: 13.36-42.15) mechanically ventilated. The presence of two co-morbid conditions was associated with twice the odds of developing pneumonia (OR=2.10; 95% CI 1.47-1.78).

Conclusions: Prolonged mechanical ventilation, increased injury severity, older age, and presence of multiple co-morbid conditions all increase the risk of pneumonia in injured children. Preventive measures should be aggressively used in injured children at high risk for the development of pneumonia.

9. How often do children with displaced or angulated wrist fractures receive prehospital analgesic medication?

Authors: Henry Ortega MD, Ernie Krause BS, Laura Erickson MD, Heidi Vander Velden MS, Sam Reid MD. Emergency Services, Research and Sponsored Programs, Children’s Hospitals and Clinics of Minnesota.

Background: Displaced and angulated wrist fractures are intensely painful injuries commonly suffered by pediatric patients. Prehospital analgesia rates for fractures have been shown to be variable in adult patients, and few studies exist that include pediatric prehospital patients.

Methods: Retrospective review of records of all patients presenting to the emergency departments of Children’s Hospitals and Clinics of Minnesota with a radius, ulna or both bone forearm fractures who experienced a reduction of the fracture on the day of presentation. Descriptive statistics were used to identify the population demographics. Logistic regression analysis was used to further identify predictors (including age, type of EMS service, and other related factors) of administration of analgesic medication.
**Results:** A total of 194 patients met our inclusion criteria. The mean age was 9.4 years (SD 3.6 years). Males (71.1%), English-speaking patients (86.9%), and home EMS calls (86.1%) were the most common patient demographics. Only 40.7% of all patients received prehospital analgesia, with splinting being the most common analgesic measure (43.1%). Intravenous narcotics were used in less than a third of all patients (31.1%). Patients transported from a clinic or urgent care were less likely to receive an analgesia measure than patients transferred from a home (P<0.002). Prehospital duration greater than 30 minutes [RR 4.73, 95% CI 2.05-11.36] and increases in age [RR 1.18, 95% CI 1.06-1.32] were associated with higher analgesia measures. Language and insurance status had no significant effects on analgesia measures.

**Conclusions:** Prehospital analgesia measures for children with deformed extremity fractures were low for all patient demographics. Transfers from a primary care clinic or urgent care, younger children, and shorter EMS times are in particular need for improvements in prehospital analgesia measures.

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**10. The role of gender and age in pediatric sports-related concussion**

**Authors:** Mills, J. 1, Doss, R. 1, Rosenkrantz, M. 1, Koolmo, M. 1, Petronio, J. 1, & Seaton, K. 2. 1Pediatric Concussion Program, Neuroscience Center, Children’s Hospitals & Clinics of Minnesota, St. Paul, MN, United States. 2Children's Emergency Department, Children’s Hospitals & Clinics of Minnesota, St. Paul, MN, United States

**Background:** Concussions continue to be a significant focus of the medical and athletic communities. However, there has been relatively little research dedicated to the pediatric concussion problem. Our understanding of recovery rates in male and female pediatric athletes is minimal. Researchers are beginning to focus on age and sex differences in concussion outcomes while sports specific recovery rates in the pediatric population remains little understood. This study describes gender differences in recovery rates among pediatric athletes. Furthermore, we will present recovery rates in specific sports by gender. Finally, we will describe recovery rates among younger vs. older pediatric athletes.

**Methods:** The data collected for this project was from patients seen in the Concussion Clinic at Children’s Hospitals & Clinics of Minnesota from 2011-2013. All subjects were evaluated/treated in the Concussion Clinic following mild head trauma. We identified 390 patients who suffered a sports-related concussion between the ages of 10 to 18 years old. The sample was 61% male and 39% female. We compared male versus female and young (mean age = 12.5) vs. older (mean age = 16.0) athletes overall recovery rates and then recovery rates by specific sports by gender, which included soccer, hockey, basketball, and softball/baseball. Recovery rate was defined as time in days between date of injury and date of recovery as determined by clinical assessment in the concussion program. Parametric (i.e., independent samples t-tests) statistical analyses was conducted using SPSS. IRB approval was obtained for this project.

**Results:** Group statistics showed a comparable mean age at injury of 13.8 for females and 13.7 for males. Initial injury severity was considered comparable between the females and males with similar loss of consciousness (13.4% vs. 17.4%; n.s.) and disorientation (29.5% vs. 35.4%; n.s.) rates. Furthermore, the two groups presented to the ED for assessment of their injury at very similar rates (66% vs. 64%; n.s.). The females overall took longer to recover than the males though this was not a statistically significant difference (Mean = 55.6 vs. 44.3 days), due to the large variability in recovery rates for both groups (SD = 64.8 and 65.8 for the females and males, respectively). The older patients took somewhat longer to recover (54.4 vs. 46.1 days) but again, this difference was not statistically significant. Comparison of sports-specific recovery rates by gender were as follows; Soccer: female >
male (53.0 vs. 40.6 days, n.s.), Hockey: female > male (49.4 vs. 32.7 days, n.s.), Basketball: female > male (58.6 vs. 45.2 days, n.s.), Softball/Baseball: female < male (23.2 vs. 31.4 days, n.s).

**Conclusions:** This study demonstrated a clear trend for longer recovery from concussion in female pediatric athletes when compared to males. We also showed a trend for older athletes taking longer to recover than younger athletes, which may reflect a greater extent of injury that can accompany physically stronger and more competitive play. Finally, we identified that female basketball players took the longest to recover while within a specific sport, hockey showed the greatest discrepancy in recovery rate between males and females. Further analysis of this information is warranted to understand the factors be they biological, biomechanical, athletic rules-related, and/or culture of sport that explain these differences. Finally, these data will be valuable to help develop better clinical understanding and a more customized treatment plan for these student-athletes.

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**11. Association of poor sleep with behavior and quality of life in children and adolescents with Cystic Fibrosis**

**Authors:** Keith Cavanaugh, Mahrya Johnson, Lisa Read, Andrea Gruber, Jill Dreyfus, Sophie Shogren, John McNamara. Children’s Hospitals and Clinics of MN, Children’s Respiratory and Critical Care Specialists, P.A.

**Background:** While numerous sleep architecture and sleep disruption studies have documented sleep-related problems in adult patients with cystic fibrosis (CF), the identification of such problems in children and adolescents is limited. Better understanding of these problems may create an opportunity to improve comprehensive care. A study of children and adolescents with CF identified symptoms of pain, sleep disturbance, anxiety and depression. Furthermore, sleep disturbances have been shown to affect attention, anxiety, and learning in children demonstrating the need for further investigation.

This study aimed to evaluate sleep habits in children and adolescents with CF. The secondary aim was to identify associations with these sleep habits related to quality of life as well as behavioral and emotional functioning.

**Methods:** This study included 50 children and adolescents with CF between 6-19 years of age. Participants wore a wrist actigraphy device for 14 days which recorded sleep efficiency and wake time after sleep onset (WASO). At enrollment, questionnaires were administered addressing sleep habits (Children’s Sleep Habits Questionnaire [CSHQ]), behavior and emotion (Behavior Assessment System for Children, 2nd Edition [BASQ-2]), and quality of life (Cystic Fibrosis Questionnaire [CFQ-R]). Poor sleep was defined by one or more of the following: 1) ≥10% of the night was wakeful after sleep onset [sleep efficiency of <90%] 2) increased number of WASO minutes 3) CSHQ score ≥41. A linear regression model was used to identify associations between worsening sleep and decreased quality of life and/or more adverse behavioral and emotional functioning, adjusting for gender, history of sinus disease, and mean FEV1%. Antibiotic and steroid use did not affect the results.

**Results:** Approximately eighty percent of the subjects met poor sleep criteria through the sleep efficiency measure and the CSHQ. Each one point higher score on the CSHQ was associated with higher anxiety (0.5±0.1, p=0.002) and somatization (0.8±0.2, p=0.004) scores on the BASC-2, and a higher digestive problem score on the CFQ-R (0.8±0.4, p=0.03). Each one percentage point lower sleep efficiency was associated with higher attention (1.0±0.4, p=0.01) and hyperactivity (1.0±0.4, p=0.02) problem scores on the BASC-2. Each additional WASO minute was associated with higher scores of worsening attitude towards teachers (0.3±0.1, p=0.03) and attention problems (0.5±0.2, p=0.007) subscales on the BASC-2.
Conclusions: This study demonstrated that children and adolescents with CF experience poor sleep. Poor sleep was associated with worsening scores for behavior and emotional functioning. Despite these findings, there were minimal significant associations impacting quality of life by CFQ-R. Additional studies are needed to better understand the co-dependent relationship between behaviors and sleep habits in patients with CF.

12. Optic nerve sheath diameter measurement by ocular sonography in diabetic ketoacidosis and the relationship to cerebral edema

Authors: Kelly R. Bergmann, DO, Donna M. Milner, MD, Constantinos Voulgaropoulos, MD, Molly Raske, MD, Gretchen J. Cutler, PhD, Anupam B. Kharbanda, MD

Background: Ocular sonography has been used to detect increased intracranial pressure and cerebral edema through measurement of the optic nerve sheath diameter (ONSD). This technique may allow for rapid bedside assessment of diabetic ketoacidosis-related cerebral edema (DKA-CE).

Objective: To assess the reliability of ocular sonography for identification of subclinical or clinically apparent DKA-CE.

Methods: This is a prospective validation study of subjects aged 7–18 years divided into three study groups: 1) well-controlled type 1 diabetes (T1DM), 2) T1DM with hyperglycemia and 3) DKA. Well-controlled subjects were enrolled in the endocrinology clinic. Subjects with T1DM with hyperglycemia and DKA were enrolled in the emergency department. Well-controlled T1DM was defined as current hemoglobin A1c ≤8% within 1 week of the clinic visit, no previous episodes of DKA other than at the time of T1DM diagnosis, and no documented hemoglobin A1c >8% other than at the time of T1DM diagnosis. DKA was defined as blood glucose ≥200 mg/dL, pH <7.30 and/or serum bicarbonate <15 mmol/L, and elevated serum or urine ketones. Subjects with hyperglycemia ≥200 mg/dL but not meeting other criteria for DKA were classified as T1DM with hyperglycemia. Exclusion criteria included >10 mL/kg of IV fluids or insulin prior to transfer, type 2 diabetes, Hyperosmolar Hyperglycemic State, or conditions predisposing to increased intracranial or intraocular pressure. Measurement of the ONSD was obtained by ocular sonography according to standard technique. Student’s t-test and X2 were used for continuous or categorical variables, respectively. One-way ANOVA was used to compare the between group difference in optic nerve sheath diameter. Reliability was assessed using the Intraclass Correlation Coefficient (ICC) and percent agreement. We aimed to enroll 36 subjects in each of three groups in order to achieve 80% power to detect an optic nerve sheath diameter of > 0.3 mm.

Results: We have currently enrolled 36 subjects with well-controlled T1DM, 24 with T1DM with hyperglycemia, and 18 subjects with DKA. Age, gender, and time to sonography were similar between groups. No subjects had clinically apparent cerebral edema. Three subjects with DKA were treated with 10 mL/kg of IV fluid prior to arrival. The between group difference in mean ONSD among subjects with well-controlled T1DM (5.2 ± 0.08), T1DM with hyperglycemia (5.0 ± 0.09), and DKA (5.1 ± 0.11) was not significant (p=0.70). Eight subjects were measured twice for reliability, with excellent agreement between sonographers (ICC 0.74; 87.5% agreement).

Conclusions: Ocular sonography may not sufficiently identify subclinical DKA-CE. Given that no subjects in our sample had clinically apparent DKA-CE, further studies should assess the utility of ocular sonography in this setting.
13. The WICU (Well-defined Intensive Care Unit): a unique PICU quality/safety program

Authors: Kelly Kennedy, Julie Herda CPNP, Stephen Kurachek MD. Children’s Hospitals and Clinics of Minnesota, Minneapolis, Minnesota. Children’s Respiratory and Critical Care Specialists, PA, Minneapolis, Minnesota

Background: Historically, little focus had been placed on the identification and character of less serious safety events (LSSEs) and their role in defining best PICU practice. The Well-defined ICU (WICU), was created to capture and capitalize on LSSEs in the context of local PICU practice, ultimately to improve safety and quality.

Objective: To discover if incidents go unrecognized by providers, management, the Safety Learning Report (SLR) system, and the hospital’s Quality and Patient Safety department. If so, we plan to enumerate the incidents by type, level of harm, theme, etc.

Methods: After reviewing the literature regarding how other medical facilities tried to increase awareness and reporting of unplanned events of all types of significance, we decided to forge a new path with a unique quality/safety program (the “WICU”) that utilized the nonjudgmental views of recent college graduates with three goals in mind.

1. Capture LSSE at point of care.
2. Quantify (“define”) the majority of PICU activities.
3. Transform LSSEs into safety/quality projects.

Quality Safety Analysts (QSAs) maintained a daily schedule of incident queries with night PICU staff, huddle, rounds, and chart reviews to capture additional events. Incident Type, Harm Index and Theme Index further categorized each event. QSAs recorded common daily activities (durational interventions) and active procedures (procedural interventions). All information was entered into the WICU Database via iPad. Together, the QSAs and QSO selected specific LSSEs for comprehensive evaluation; project ideas were presented to PICU Leadership.

Results: During the 15-month study period 1,977 LSSEs were recorded in 1,344 PICU patients with 5.28 events/day, and 0.30 events per patient day. There were 4.78 LSSEs for each Safety Learning Report filed. Over 40% of LSSEs required a patient intervention or change in therapy. Examples of data include: durational- 1905 ETT days, procedural- 145 intubations, and composite- 2.96% failed extubation rate.

Example Safety/Quality projects:
1. Assessment and implementation of the AMT Bridle™ Nasal Tube System
2. Blind bronchial lavage procedure created;
3. Consent procurement for PICU bronchoscopy (improved from 43% to 91%).

A total of 84 quality/safety interventions were acted upon during the study period.

Conclusion: There were many previously unrecognized incidents, ranging from innocuous to disastrous. The QSAs were successful in meeting the three goals of the WICU. This study demonstrates that the identification and analysis of less serious safety events can result in improvement projects that enhance patient safety and organizational learning.
14. Ovarian stromal tumors are related to germline and somatic DICER1 mutations: A report from the International Ovarian and Testicular Stromal Tumor Registry

**Authors:** Kris Ann P. Schultz, MD, Anne Harris, MPH, CCRP, Susan F. Sencer, MD, A. Lindsay Frazier, MD, D. Ashley Hill, MD, Yoav Messinger, MD

**Background:** Ovarian stromal tumors include Sertoli-Leydig cell tumor (SLCT), juvenile and adult granulosa cell tumor and gynandroblastoma. The International Ovarian and Testicular Stromal Tumor (OTST) Registry was established in December 2011 to study these rare tumors.

**Methods:** Participants with a history of ovarian stromal tumors were enrolled in the International OTST Registry. Pathology specimens were centrally reviewed and tumor specimens and germline DNA were collected. DICER1 was sequenced in germline DNA and tumor tissue.

**Results:** Of the 73 enrolled participants, 48 (66%) have SLCT, juvenile granulosa cell tumor (JGCT) or gynandroblastoma and are the subject of this analysis. All available (40/48) pathology samples were centrally reviewed. For the 48 pts with SLCT, juvenile granulosa cell tumor and gynandroblastoma, median age at diagnosis was 15 years (range <1 – 40 years). Thirty patients had SLCT, 16 JGCT and 2 gynandroblastoma. Analysis of germline DNA showed 16/40 (40%) had loss of function mutations in DICER1, including more than half of patients (14/24, 58%) with SLCT. Novel findings included two participants with identical intronic mutations creating a new acceptor site, and 3 patients with mosaic loss of function mutations. In 3 patients without germline mutations, biallelic somatic mutations were seen. Overall, 71% were found to have DICER1-related SLCT. In one case, a woman was found to have a germline DICER1 mutation leading to screening of her child for the mutation and later for PPB. Surveillance imaging of the infant showed a Type I PPB.

**Conclusions:**
- More than half of patients with SLCT have underlying germline mutations in DICER1
- Mosaicism and intronic mutations have been seen
- Diagnosis of germline DICER1 mutations facilitates appropriate personal and family surveillance
- Biallelic somatic mutations may also give rise to DICER1-related SLCT
- Overall 71% (14/24) of SLCT was found to be related to germline or somatic mutations in DICER1

15. Detection and frequency of renal anomalies in 22q11.2 Deletion Syndrome

**Authors:** Dugan S¹, Barrett M¹, Temme R¹, Read L¹, Sidman J¹. ¹Children’s Hospitals and Clinics of Minnesota, Minneapolis, MN, USA

**Background:** Deletion 22q11.2 (velocardiofacial syndrome/VCFS) is a common chromosomal condition with wide clinical variability and may be diagnosed before or after birth. This condition increases risk for developmental and anatomic differences, including various renal anomalies. Performing a renal ultrasound is considered standard of care for these patients, but some providers elect to rely on prenatal ultrasound findings alone. The literature describing the spectrum of renal anomalies in this condition is limited. Current guidelines are not established as to whether a postnatal ultrasound should be obtained upon diagnosis, even if the prenatal ultrasound was reported as normal. Comparisons made of prenatal and postnatal ultrasounds may reveal the importance of obtaining a postnatal ultrasound regardless of normal findings on the prenatal ultrasound. Diagnosing renal findings early in life may lead to improved care for patients with 22q11.2 deletion.
Methods: Subjects were enrolled with a lab-confirmed diagnosis of 22q11.2 and renal anomaly on postnatal ultrasound and/or voiding cystourethrogram who were seen in the VCFS Clinic at Children’s Hospitals and Clinics of Minnesota from January 1, 2009 to August 1, 2014, retrospectively and prospectively. Subjects’ mothers were also enrolled, and their prenatal ultrasound reports were compared with postnatal renal ultrasounds and/or voiding cystourethrogram. Renal anomalies were grouped into six categories: renal size abnormality, vesicoureteral reflux, hydronephrosis/hydroureter/pelviectasis, multicystic dysplastic kidney/unilateral renal agenesis, nephrocalcinosis, and abnormal renal parenchyma.

Results: Thirty-six patients were eligible for the study; 27 subjects enrolled; prenatal data was unavailable for 7 mothers. Of the 20 subjects with pre/postnatal records, 11 (55%) were diagnosed with normal kidneys prenatal and abnormal postnatal; and 9 (45%) had abnormal prenatal and abnormal postnatal findings. Of the 27 patients with renal anomalies: 15 (56%) were diagnosed with hydronephrosis/hydroureter/pelviectasis, 10 (37%) patients with renal size abnormality, 8 (30%) multicystic dysplastic kidney/unilateral renal agenesis, 4 (15%) with abnormal renal parenchyma, 3 (11%) with vesicoureteral reflux, and 1 (4%) with nephrocalcinosis; 14 (52%) patients carried one renal diagnosis, 12 (44%) patients carried 2 renal diagnoses, and 1 (4%) patient carried three renal diagnoses.

Conclusion: 22q11.2 deletion is a known risk factor for renal anomalies. Our study re-emphasizes this and also shows that prenatal ultrasound is not sufficient to rule out renal anomalies. Postnatal renal ultrasounds should be obtained in all individuals with 22q11.2 deletion regardless of prenatal ultrasound findings.

16. Hospital readmission rates and clinical outcomes of children with chronic respiratory failure due to chronic lung disease or congenital heart disease

Authors: William A. White, BA1, William B. Wheeler, MD1, B. Kelly Han3, MD, Alison E. Overman, BA2, Yi Lu, MS2, Stephen C. Kurachek, MD1. 1Children’s Respiratory & Critical Care Specialists, P.A., Minneapolis, MN. 2Children’s Hospitals and Clinics of Minnesota, Minneapolis, MN. 3 Children’s Heart Clinic, Minneapolis, MN

Background: We studied the outcomes of age-matched children with congenital heart disease (CHD) and chronic lung disease (CLD) who are ventilator-dependent and experience chronic respiratory failure (CRF) requiring home mechanical ventilation (HMV). We hypothesized that, due to comorbidities, CHD would lead to increased readmissions, worse survival, and reduced weaning rates than children with CLD.

Methods: Retrospective review of HMV infants with CRF due to CHD or CLD from January 1, 2000 to June 30, 2013. The cohorts were age and sex matched. The nonparametric Mann-Whitney rank-sum test was used to compare the continuous patient characteristic between the groups. Categorical patient characteristics and binary outcomes were analyzed with either Chi-square or Fisher’s exact test depending on applicability. The Log rank test was used to determine if there was difference in the survival distribution between the groups.

Results: 80 subjects were included (40 CHD and 40 CLD). Survival rates were 97.5% in CLD group and 77.5% in CHD group (p=0.009). Decannulation rates were 96% in the CLD group and 72.5% in the CHD group (p=0.019). Median total readmissions was 11.5 (range:1-33) in the CHD group and 7 (range:2-20) in the CLD group (p=0.009). Median medical/unplanned readmissions was 4 (range:0-17) in the CHD group and 2 (ranges: 0-14) in the CLD group (p=0.006). 233 of 406 (57.4%) unplanned medical
readmissions were associated with acute infections. 60% were readmitted to the intensive care. There were no home airway accidents. RACHS score was not an indicator of readmission rates or survival. Two patients in the CLD group had chromosomopathy compared to 18 in the CHD group (p=<0.001).

**Conclusions:** Children with CHD have greater morbidity than CLD as evidenced by more hospital readmission days, more unexpected readmissions, and less frequent successful decannulations.

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17. Management and outcomes of pediatric motor vehicle collision injuries treated at level I trauma centers: Analysis of the National Trauma Data Bank

**Authors:** Dreyfus J, Flood A, Cutler G, Ortega H, Kreykes N, Kharbanda A. Children’s Hospitals and Clinics of Minnesota

**Background** Motor vehicle collisions (MVCs) are a major source of morbidity and the primary cause of death for children and adolescents. Identification of variations in outcomes and management among Level I trauma centers that treat pediatric MVC-related injuries would allow for interventions to improve care for injured children.

**Objectives:** To examine the association of American College of Surgeons (ACS) pediatric qualifications at Level I trauma centers with outcomes and management of MVC-related injuries.

**Methods:** Observational study. Data from the 2009-2012 National Trauma Data Bank (NTDB). Analyses included a total of 36,355 patients <19 years of age with MVC-related injuries who were directly transported to a Level I trauma center for treatment. Generalized Estimating Equations were used to estimate odds ratios (ORs) for mortality, complications, splenectomies, computed tomography (CT) scans, and blood transfusions comparing freestanding pediatric Level I trauma centers (PTCs) with combined adult/pediatric and adult Level I trauma centers. All models were adjusted for injury severity and other important demographic and clinical risk factors.

**Results:** In fully adjusted models, the odds of mortality were higher at both combined adult/pediatric (OR=1.53, 95% CI 1.16-2.01) and adult (OR=1.41, 95% CI 1.09, 1.81) trauma centers compared with PTCs. Patients treated at adult centers had greater odds of at least one complication (OR=1.56, 95% CI 1.26-1.95), specifically pneumonia (OR=2.09, 95% CI 1.50-2.92) and DVT (OR=2.20, 95% CI 1.08-4.47). Patients treated at adult centers also had greater odds of splenectomy (OR=2.06, 95% CI 1.03-4.15) and lower odds of CT scans (OR=0.87, 95% CI 0.82-0.93). Odds of DVT (OR=2.33, 95% CI 1.08-5.00) and CT scans (OR=1.35, 95% CI 1.25-1.46) were greater at combined adult/pediatric compared with PTCs.

**Conclusions:** Patients treated at free-standing pediatric Level I trauma centers experience lower mortality rates, as well as fewer complications and splenectomies compared with adult Level I centers. Given that most pediatric patients are not treated at a pediatric designated center, identification and sharing of best practices among Level I trauma centers that treat children may reduce variation in care and improve outcomes.

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18. The association of plasma and cerebral spinal fluid cytokines with daytime sleepiness among children with acute lymphoblastic leukemia

**Authors:** J. Dreyfus, PhD, MPH; A. Harris, MPH; A. Panoskaltsis-Mortari, PhD; J. Krueger, PhD; G. Rosen, MD; Y. Messinger, MD. 1Children’s Hospitals and Clinics of Minnesota, Minneapolis, MN;
Background: Fatigue and daytime sleepiness (DS) are understudied among children with acute lymphoblastic leukemia (ALL). Past studies have identified pro-inflammatory cytokines, such as TNFα and interferon-inducible protein measured in serum as potential mediators of fatigue and sleep disturbances in other populations. Cytokines measured in cerebral spinal fluid (CSF) may correlate more closely with DS than those measured in serum. Yet, CSF measurements of cytokines are rare because they are difficult to obtain. ALL patients undergo lumbar puncture as part of routine exams, thus presenting an opportunity to measure CSF levels of cytokines without additional procedures. The aim of our study was to examine the associations of plasma and CSF cytokines with patient-reported fatigue among children with ALL. Our hypothesis was that higher levels of cytokines and soluble cytokine receptors would be associated with greater patient-reported DS.

Methods: This study included 16 children aged 4-11 years with ALL who had cytokine and DS measures available. The cytokine IL-6, and cytokine receptors IL-1 R1 & R2, TNF R1 & R2 were measured in plasma and/or cerebral spinal fluid at up to three time points during maintenance chemotherapy regimens, approximately 3 months apart. DS was assessed at each of these same time points using the Pediatric Daytime Sleepiness Scale (PDSS), which is completed by the child and has possible values between 0 and 32 points. Higher scores on this scale indicate greater DS, with a score of 17 or greater indicating clinically relevant DS. We used repeated measures linear regression models to examine the association of each cytokine with PDSS scores, adjusting for age at each visit.

Results: The mean age at study entry was 6.1 years (SD=2.4), and 47% of patients were male. The mean PDSS score was 20.4 points (SD=6.1, range 4 to 29), and 79% of the patients had a PDSS score ≥17. Table 1 shows the age-adjusted associations of each cytokine with PDSS score. Each 100 pg/mL increase in CSF TNF R2 was associated with a 2.13 (SE=0.76) point higher score on the PDSS (p=0.01). In general, higher cytokine levels in both plasma and CSF were associated with higher PDSS scores, although no other associations reached statistical significance.

Conclusions: We found that the majority of ALL patients undergoing maintenance chemotherapy experienced clinically relevant DS. Higher CSF levels of TNF R2 were associated with greater patient-reported DS, which supports results from past studies that measured TNFα in plasma. This association is biologically plausible because TNF R2 mediates the many metabolic effects of TNF that can include fatigue and sleep. We are in the process of evaluating other cytokines and cytokine-receptors on sleep. Our findings suggest that the complex relation of fatigue, daytime-sleepiness, and CSF cytokines should be evaluated in a larger patient population, and that targeting chronic stimulation of the TNFα pathway may help to mitigate daytime sleepiness in ALL patients.

<table>
<thead>
<tr>
<th>Cytokine or Cytokine Receptor</th>
<th>Beta (SE) per 100 pg/mL unit increase</th>
<th>p-value</th>
</tr>
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<tbody>
<tr>
<td>IL-1R1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plasma</td>
<td>1.74 (3.1)</td>
<td>0.59</td>
</tr>
<tr>
<td>CSF</td>
<td>--</td>
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</tr>
<tr>
<td>IL-1R2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plasma</td>
<td>0.01 (0.02)</td>
<td>0.39</td>
</tr>
<tr>
<td>CSF</td>
<td>0.05 (0.08)</td>
<td>0.55</td>
</tr>
<tr>
<td>IL-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plasma</td>
<td>0.02 (0.02)</td>
<td>0.29</td>
</tr>
<tr>
<td>CSF</td>
<td>0.28 (0.38)</td>
<td>0.47</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>Plasma</td>
<td>0.29 (0.28)</td>
</tr>
<tr>
<td></td>
<td>CSF</td>
<td>0.77 (0.74)</td>
</tr>
<tr>
<td>TNF R2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Plasma</td>
<td>0.04 (0.07)</td>
</tr>
<tr>
<td></td>
<td>CSF</td>
<td>2.13 (0.76)</td>
</tr>
</tbody>
</table>

* Estimates are from repeated linear regression models, adjusted for age at each visit.

19. Troponin I testing in the pediatric emergency setting in cases of possible myocardial injury

**Authors:** Kerstin Halverson BA, MS; Ernest Krause, BA, BS; Donna Milner, MD

**Background:** The current standard of care in adult medicine is to measure cardiac Troponin I protein in patients with suspected myocardial infarction as an indicator of myocardial muscle damage. Troponin I testing is not part of pediatric standard of care in evaluating suspected cardiac-related chest symptoms and no studies have described the sensitivity, specificity, or measurement timing intervals of cardiac protein testing in pediatric patients while evaluating for myocardial injury in this population.

**Objective:** Determine the sensitivity and specificity of a Troponin I point of care test in pediatric patients.

**Methods:** Patients who received cardiac Troponin I (cTnI) testing were identified in the medical record. A new Troponin I testing protocol, based on the established adult protocol, was implemented in the Emergency Department (ED) with the introduction of the Troponin I point of care test. The cTnI testing occurred shortly after patient presentation and a second test was recommended 6 hours after the initial reading or six hours after onset of symptoms, as troponin elevations may be delayed several hours and may persist for up to 10 days. All cTnI levels were measured using iSTAT point of care analyzers. Results from the initial test were recorded, as were those from the second test when available. Investigators also recorded time of symptom onset, time of presentation, time of the first and second cTnI tests, patient complaints, ECG, Echo, CK, BNP, chest x-ray and chest CT results, and final diagnoses at disposition. Presence of myocardial injury was defined as an abnormal ventricular Ejection Fraction % interpreted by a cardiologist. A positive cTnI test was defined as any value outside the adult reference range of 0.00 to 0.08 ng/mL. Sensitivity and specificity of the cTnI test were calculated from these values.

**Results:** 182 patients were included in the study, 87 (47.8%) had initial cTnI tests ≥ 6 hours after symptom onset, 64 (35.2%) had testing repeated, 31 (17%) had no retest. Sensitivity and specificity of the initial cTnI test was 69.4% and 83.0% respectively with a false positive rate of 4.1% and a 30.6% false negative rate. Sensitivity and specificity of the second test was 90.5% and 100% respectively with a false positive rate of 0.0% and a 9.5% false negative rate.

**Conclusions:** Troponin testing is a useful test in evaluation of pediatric suspected cardiac-related chest symptoms especially when conducted with a 6-hour follow-up measurement.

20. Pre-hospital pediatric arrests receiving epinephrine (PREPARE) in the United States
Background: The AHA and PALS algorithm for cardiac arrest clearly state that epinephrine should be administered and repeated every 3-5 minutes (Class I, LOE B). Survival from out-of-hospital cardiac arrest in infants and children is poor; 3% for infants and 9% for children and adolescents. Despite emphasis on improving pre-hospital care in children, there has been no increase in survival rates over the past 20 years. In contrast, survival from in-hospital cardiac arrest, in infants and children, has improved from 9% in 1980 to 27% in 2006. The purpose of this study was to evaluate the current rate of pre-hospital epinephrine administration in pediatric and adult cardiac arrest patients.

Methods: We analyzed data from the National Emergency Medical Services Information System (NEMSIS) Public-Release Data Set. We identified two groups of patients with a prehospital diagnosis of cardiac arrest, pediatric patients aged 0-18 years of age and adults (>19 years of age). We used descriptive statistics to report the percentages of out-of-hospital pediatric cardiac arrest patients that received epinephrine in the field in all ages and stratified by pediatric age groups and compared them to the adult cohort. Patients were classified as arrest prior to EMS arrival and after EMS arrival.

Results: NEMSIS 2012 data accessed on 4/10/14 had 19,831,189 patient files from 42 of 50 participating states. Data was extracted for patients coded as cardiac arrest. There were 5,318 patients 0-18 years and 154,306 patients >19 years. The overall rate of epinephrine administration is much lower in pediatric patients compared to adults. Epinephrine 1:10,000 administration was documented in 31% of patients 0-18 years and 45% for patients >19 years of age.

In patients 0-18 years, the rate of epinephrine administration for cardiac arrest prior to EMS arrival was much higher at 38% when compared to 16.5% for patients with cardiac arrest after EMS arrival and on independent sample t test, this difference is statistically significant (p < 0.0005).

Conclusions: The rate of epinephrine administration in out-of-hospital pediatric cardiac arrest patients is low, averaging 31% in all pediatric age groups, and even lower (16.5%) in the setting of cardiac arrest after EMS arrival. Further investigation is required to evaluate the reasons for such low rate of epinephrine administration in out-of-hospital cardiac arrests and to determine if an association exists between low epinephrine rate and survival.