

ABSTRACTS

ABSTRACTS FOR THE 2010 NAEMSP SCIENTIFIC ASSEMBLY

1. THE ADVANCED AIRWAY RESEARCH TRIAL: A PROSPECTIVE, RANDOMIZED, MULTICENTER CLINICAL TRIAL COMPARING STANDARD ENDOTRACHEAL INTUBATION AND THE KING LTS-D SUPRAGLOTTIC AIRWAY Christopher S. Russi, Ralph J. Frascone, Charlie Lick, Marc R. Conterato, Sandi S. Wewerka, Kent R. Griffith, Lucas A. Meyers, Jennifer R. Connors, Joshua G. Salzman, *Mayo Clinic Medical Transport, Department of Emergency Medicine*

Introduction. To date, no direct comparison between the "gold standard" of endotracheal intubation (ETI) and any other airway device has been performed in a prospective, randomized, multicenter prehospital trial. **Objective.** To examine placement success rates between endotracheal intubation (ETI) and the King LTS-D supraglottic airway in a prospective, randomized, multicenter clinical trial. **Methods.** Paramedics from four sites were recruited to participate in the study following institutional review board approval. After obtaining consent, all providers completed a 60-minute didactic training session and a hands-on insertion skills test for ETI and King LTS-D insertion. Providers treated all patients meeting criteria for advanced airway management according to a preassigned treatment calendar block randomized by week. Following all insertions, providers contacted a study hotline (available 24 hours a day/7 days a week/365 days a year) to complete data collection. All data were analyzed as intent-to-treat (ITT) and as-treated (AT). Rates of insertion success, defined as the ability to ventilate to chest rise, absence of gastric sounds, presence of bilateral lung sounds, and, where appropriate, qualitative end-tidal carbon dioxide, were compared between the two groups using an unadjusted chi-squared test. Cochran-Mantel-Haenszel statistics were used to examine the effect of multiple factors on insertion success rates. **Results.** Between June 2008 and June 2009, a total of 205 placements (ITT: 129 King LTS-D, 76 ETI; AT: 123 King LTS-D, 82 ETI) were completed by 109

of the 272 providers who consented to participate. No difference was found in cumulative first attempt (ITT: 70% vs. 66%, $p = 0.68$), second attempt (ITT: 80% vs. 81%, $p = 0.93$), or overall insertion success rates (ITT: 82% vs. 81%, $p = 0.87$) between ETI and the King LTS-D. No differences were detected in success rates when adjusted for provider primary impression ($p = 0.59$), provider characteristics [age ($p = 0.90$), gender ($p = 0.86$), and years of experience ($p = 0.88$)], or patient characteristics [age ($p = 0.98$), gender ($p = 0.88$), body mass index ($p = 0.83$), and mechanism ($p = 0.92$)]. Complication rates (vomit or blood in the airway, environmental issues, or equipment problems) between the two devices were equal (47% vs. 45%, $p = 0.74$), but were highly predictive of success regardless of device ($p < 0.001$). **Conclusions.** In our sample, there was no difference in the insertion success rates between ETI and the King LTS-D. Additional research is needed to confirm this finding.

2. PATIENTS RECEIVING CONTINUOUS POSITIVE AIRWAY PRESSURE FOR ACUTE DECOMPENSATED HEART FAILURE DO NOT RECEIVE SUBLINGUAL NITROGLYCERIN ACCORDING TO PROTOCOL Aaron Zachary Hettinger, Jeremy Cushman, Michael Santiago, Manish Shah, *University of Rochester*

Introduction. The use of sublingual nitroglycerin for the treatment of acute decompensated heart failure (ADHF) is the standard of care in prehospital medicine. It is not known if patients who receive continuous positive airway pressure (CPAP) also receive sublingual nitroglycerin according to a protocol of one sublingual nitroglycerin every 5 minutes. **Hypothesis.** We hypothesize that patients who receive CPAP do not receive sublingual nitroglycerin every 5 minutes. **Methods.** Retrospective chart review from April 1, 2008, through March 30, 2009, of patients in a mixed suburban/rural setting who received CPAP for suspected ADHF. Patients with hypotension and those who had CPAP discontinued because of an inability to tolerate it or clinical deterioration were excluded. Data analysis was performed using descriptive statistics and Student's paired t-test. **Results.** The patients

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($N = 49$) were 59% women and 98% white and had a mean age of 78.6 years (standard deviation 9.9). Patients spent a mean of 27 minutes 6 seconds (range 3–130 minutes) on CPAP. Only 63.3% of the patients received sublingual nitroglycerin, at an average rate of one every 15 minutes 43 seconds (range 5.3–73 minutes, $p < 0.0001$). **Conclusions.** Patients receiving CPAP for ADHF do not receive sublingual nitroglycerin every 5 minutes according to protocol. This study was limited by its retrospective nature and lack of nonequivalent comparison group. Further research is needed to investigate the reasons for protocol non-compliance and optimal clinical use of sublingual nitroglycerin in patients being treated with CPAP for ADHF.

3. THE EFFECT OF OPTIMIZATION OF PREOXYGENATION DURING PREHOSPITAL RAPID-SEQUENCE INTUBATION ON THE INCIDENCE OF DESATURATION EVENTS **Daniel P. Davis, John P. Serra, Colleen Buono, UC San Diego**

Introduction. Desaturation events occur frequently during prehospital rapid-sequence intubation (RSI) and have been associated with bradycardia and an increase in mortality. Preoxygenation with positive-pressure ventilation (PPV) increases oxygen reserves in the lungs and delays the onset of desaturation but may not be used aggressively in emergency RSI because of concerns about gastric insufflation and aspiration or because of limitations in time and personnel available to perform this task. **Objectives.** To explore the effectiveness of a simulator-based airway training model to decrease desaturation events during air medical RSI. **Methods.** A simulation-based airway training program is used in our large air medical program, which averages about 250 intubations per year. The RSI algorithm was modified to emphasize several interventions designed to optimize preoxygenation prior to initial laryngoscopy. These included two-person bag–valve–mask (BVM) ventilation, “two-thumbs-up” hand positioning on the mask, proper application of cricoid pressure, aggressive use of nasopharyngeal and oropharyngeal airways, small-volume assisted ventilation prior to administration of RSI medications, and large-volume ventilation following paralysis. A target saturation of peripheral oxygen (SpO_2) value above 93% was defined by a prior investigation and was formalized in the algorithm. Desaturation events (decrease in SpO_2 to below 90% or a continued decrease by at least 2% if initial SpO_2 was already below 90%) were recorded using physiologic data exported from handheld oximeter-capnometer devices. The mean rate of desaturation was defined for each year before and on a quarterly basis after the algorithm changes were made. This allowed more precision during the implementation period. In addition,

overall intubation success rates were recorded over the same time period. **Results.** Desaturation events decreased from 59% before the preoxygenation protocol was implemented to 28% in the first year and 14% in the second year following implementation. Intubation success increased from 94% to 97% following implementation of the preoxygenation protocol. There were no changes in the incidence of intubation over the study period. **Conclusions.** An aggressive prehospital preoxygenation protocol implemented as part of a simulation-based airway training program dramatically reduced the incidence of desaturation events during air medical RSI.

4. ADVANCED AIRWAY MANAGEMENT DOES NOT IMPROVE OUTCOME OF OUT-OF-HOSPITAL CARDIAC ARREST **Mohammed A. Hanif, Amy H. Kaji, James T. Niemann, Harbor-UCLA Medical Center**

Background. The goal of out-of-hospital (OOH) endotracheal intubation (ETI) is to reduce mortality and morbidity for patients with airway and ventilatory compromise. Yet, several studies, mostly involving trauma patients, have demonstrated decreased or no improvement in neurologic outcome or survival to hospital discharge (SHD) after OOH-ETI. To date, there is no study comparing OOH-ETI with the use of bag–valve–mask (BVM) for the outcome of SHD among nontraumatic adult patients with OOH cardiac arrest (CA). **Objective.** To compare SHD among adult OOH-CA patients receiving ETI vs. BVM. **Methods.** In this retrospective cohort study, the records of all OOH-CA patients presenting to a municipal teaching hospital from November 1, 1994, through June 30, 2008, were reviewed. The type of field airway provided, age, gender, race, rhythm on paramedic arrival, presence of bystander cardiopulmonary resuscitation (CPR), whether the arrest was witnessed, site of arrest, return of spontaneous circulation (ROSC), comorbid illnesses, and SHD were noted. A Mantel-Haenszel chi-square was computed to describe the association between the type of airway and SHD. A multivariable logistic regression analysis was performed, adjusting for rhythm, bystander CPR, and whether the arrest was witnessed. **Results.** A cohort of 1,299 arrests was evaluated; 1,025 patients (79.7%) received ETI, while 129 (10.0%) had BVM and 130 (10.1%) had either a Combitube or an esophageal obturator airway (EOA). Fifty-six of 1,299 (4.3%) survived to hospital discharge; there were no survivors in the Combitube/EOA cohort. The univariate odds ratios for SHD were as follows: BVM vs. ETI = 3.13 (95% confidence interval [CI] 1.67, 5.88; $p = 0.0002$); ventricular fibrillation/ventricular tachycardia vs. other rhythms = 7.88 (95% CI 2.46, 25.28; $p < 0.0001$); witnessed vs. unwitnessed = 4.11 (95% CI 2.19, 7.72; $p < 0.0001$); and bystander CPR vs. no CPR = 1.18

(95% CI 0.69, 2.01; $p = 0.55$). Even after multivariable adjustment for bystander CPR, witnessed arrest, and rhythm on paramedic arrival, the odds ratio for SHD for BVM vs. ETI was 4.17 (95% CI 2.13, 8.33; $p < 0.0001$). **Conclusions.** In this cohort, when compared with BVM ventilation, advanced airway methods were associated with decreased SHD among adult patients with nontraumatic OOH-CA.

5. A RANDOMIZED COMPARISON OF CARDIOCEREBRAL AND CARDIOPULMONARY RESUSCITATION USING A SWINE MODEL OF PROLONGED VENTRICULAR FIBRILLATION
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Background. Cardiocerebral resuscitation (CCR) is reportedly superior to cardiopulmonary resuscitation (CPR) for out-of-hospital cardiac arrest (OHCA). This new approach has its skeptics. **Objective.** To quantify the effect of the emergency medical services (EMS) component of CCR as compared with typical OHCA CPR using a swine model of prolonged untreated ventricular fibrillation (VF) in a prospective randomized fashion. **Methods.** The study was approved by the institutional animal care and use committee. All 53 animals were instrumented under anesthesia. Ventricular fibrillation was electrically induced. After 10 minutes of untreated VF, baseline characteristics were recorded, and the animals were block-randomized to one of two resuscitation schemes. The controls had mechanical chest compressions (MCC) at 100/minute with 30:2 ventilations. Consistent with clinical practice, two 30-second pauses in MCC occurred to simulate attempts to accomplish endotracheal intubation (ETI) at minutes 1 and 3 of CPR, and successful intravenous access was simulated to occur 3 additional minutes after ETI. The CCR group had continuous uninterrupted MCC at 100/minute. No active ventilations were provided. A tibial intraosseous needle was placed in real time for vascular access. Both groups received epinephrine (0.1 mg/kg) as soon as access became available, followed by 2.5 minutes of MCC before the first 120-J rescue shock (RS) attempt. After successful RS, standardized postresuscitative care was provided to a 20-minute endpoint. Failed RS was followed by continued MCC with positive pressure ventilation in both groups, repeat doses of epinephrine (0.01 mg/kg) every 3 minutes, and RS every minute as long as a shockable rhythm persisted. Group comparisons were assessed using descriptive statistics. Proportions with 95% confidence intervals (CIs) were calculated for VF termination, return of spontaneous circulation (ROSC), and survival. **Results.** At baseline, the two groups were the same. The table summarizes the outcomes (proportion

[95% CI]).

| | Time to RS1* | VF Termination | ROSC | 20-Minute Survival |
|-----------|-------------------|---------------------------|---------------------------|---------------------------|
| CPR group | 9.18 (9.06, 9.31) | 13/26 (0.50) [0.31, 0.69] | 8/26 (0.30) [0.12, 0.48] | 5/26 (0.19) [0.04, 0.34] |
| CCR group | 3.41 (3.27, 3.55) | 25/27 (0.92) [0.82, 1.00] | 16/27 (0.59) [0.40, 0.78] | 11/27 (0.40) [0.22, 0.58] |

*Mean in minutes (95% CI).

Conclusions. In this swine model of witnessed VF arrest with no bystander-initiated resuscitation, CCR resulted in a substantial improvement in all three outcomes relative to typical EMS CPR for OHCA.

6. EFFECT OF CREW SIZE ON OBJECTIVE MEASURES OF RESUSCITATION FOR OUT-OF-HOSPITAL CARDIAC ARREST
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Background. There is no consensus among emergency medical services (EMS) systems as to the optimal numbers and training of EMS providers who respond to the scene of prehospital cardiac arrests. Increased numbers of providers may improve the performance of cardiopulmonary resuscitation (CPR), but this has not been studied as part of a comprehensive resuscitation scenario. **Objective.** To compare different crew size configurations on objective measures of patient resuscitation using a high-fidelity human simulator. **Methods.** We compared two-, three-, and four-person all-paramedic crew configurations in the effectiveness and timeliness of performing basic life support (BLS) and advanced life support (ALS) skills during the first 8 minutes of a simulated cardiac arrest scenario. Crews were compared to determine differences in no-flow fraction (NFF) as a measure of effectiveness of CPR and time to defibrillation, endotracheal intubation, intravenous access, and medication administration. **Results.** There was no significant difference in mean NFF among two-, three-, and four-provider crew configurations (0.32, 0.26, and 0.27, respectively; $p = 0.105$). More three- and four-person groups completed ALS procedures during the scenario, but there was no significant difference in time to performance of BLS or ALS procedures among crew size configurations for completed procedures. There was a trend toward lower time to intubation with increasing group size, although this was not significant using a Bonferroni-corrected p -value of 0.01 (379, 316, and 263 seconds, respectively; $p = 0.018$). **Conclusions.** This study found no significant difference in effectiveness of CPR or in time to performance of BLS or ALS procedures among crew size configurations, although there was a trend toward decreased time to intubation with increased crew size. Effectiveness of CPR may be hindered by distractions related to the performance of

ALS procedures with increasing group size using an all-paramedic provider model. We suggest a renewed emphasis on the provision of effective CPR by designated providers independent of any ALS interventions being performed.

7. CARDIOPULMONARY RESUSCITATION AND AUTOMATED EXTERNAL DEFIBRILLATOR TRAINING IN SCHOOLS: IS ANYONE LEARNING HOW TO SAVE A LIFE? Laurie J. Morrison, Devin J. Hart, Oscar Flores-Medrano, Cathy Zhan, Li Ka Shing Knowledge Institute, St. Michael's Hospital

Introduction. Education and training in cardiopulmonary resuscitation (CPR) and automated external defibrillator (AED) use in the schools may increase rates of citizen bystander resuscitation, which is associated with a 10-fold increase in survival. **Objectives.** The primary objective was to determine the rates of CPR and AED training for staff and students across all secondary schools (public and private) in a city of 4.5 million in which 22 cardiac arrests occurred in schools in 2008 and bystanders did CPR in 36% and applied the AED in 9% of cases. Secondary objectives were to identify barriers to training, common training techniques, and factors associated with school preparedness for cardiac arrest and to explore the relationship of socioeconomic status with these factors. **Methods.** Dillman methodology was employed to collect data through telephone interviews of key school staff knowledgeable about CPR and AED instruction. Trained interviewers employed an encrypted web-based tool with investigator oversight, built-in logic, and range checks to standardize data collection. Verbal consent was obtained on the first contact. **Results.** School student population ranged from 5 to 2,100. Of 271 schools contacted, key school staff were available for interview in 185 schools (68%), and 166 (90%) consented to participate. Students and staff were trained in CPR in 77% and 83% of schools, respectively. The rate of AED training was 7% for students and 49% for staff. About half the schools had at least one AED installed on campus (49%), but 26% were unaware if their AED was registered with emergency services dispatch. Lack of funding (16%) and school population (too large or too small) (16%) were common barriers to teaching. Frequently employed training techniques were interactive training (e.g., manikins) (31%), didactic instruction (29%), and printed material (15%). **Conclusions.** Training rates in CPR for staff and students were moderate; however, training rates in AED use for both groups were poor. Less than 50% of schools had an AED. Identified barriers to training may be overcome with the use of convenient and cost-effective teaching alternatives, such as digi-

tal video disc (DVD)-based self-instruction videos with manikins.

8. BASIC LIFE SUPPORT TERMINATION-OF-RESUSCITATION GUIDELINE IMPLEMENTATION TRIAL (TORIT) Laurie J. Morrison, Don Eby, Precilla V. D'Souza, Cathy Zhan, Alex Kiss, Michelle Welsford, Chris Loreto, Vince Arcieri, Cathy Prowd, Marty Pilkington, Tim Dodd, Jim Scott, Elma Mooney, Erica Reichl, Jeannette M. Verdon, Tim Waite, Richard Verbeek, Li Ka Shing Knowledge Institute, St Michael's Hospital

Objectives. This implementation study was designed to evaluate the transport rate of out-of-hospital cardiac arrest (OHCA) patients when the universal termination-of-resuscitation (TOR) guideline was applied in eight services. The TOR guideline recommends termination when there is no return of spontaneous circulation, no shocks are delivered, and the arrest was not witnessed by prehospital providers. Secondary aims were to report errors in application and the comfort of paramedics and delegating physicians. **Methods.** This prospective multicenter observational trial was conducted from January 2006 to September 2008 across Ontario, Canada. Adult patients with OHCA of presumed cardiac etiology who were treated by defibrillator-only-trained paramedics were eligible. After applying the guideline, the provider contacted the delegating physician when termination was recommended and both provider and physician completed a data-collection form indicating their comfort on a five-point Likert scale. **Results.** During the study there were 2,421 OHCA, and 953 patients were eligible for TOR guideline application. The TOR guideline was followed in 755 cases, resulting in 388 terminations and 367 transports. The two groups were similar in age, gender, and response time intervals. There were no errors in guideline application. In 198 cases in which the TOR guideline was not followed, paramedics cited 241 reasons: Family distress (56), short time intervals (54), patient age (13), and public venue (10) accounted for 55%. Paramedics cited discomfort 28 times (11%). In 14 cases they were unable to establish telephone contact, and in 23 cases the guideline recommended termination and the physician chose to transport the patient (2.4%). All of these 198 TOR-eligible patients died in hospital. When the TOR guideline was applied the transport rate was 48.6%, which is significantly different from the previously reported transport rate of 100% when the TOR guideline was not applied ($p < 0.001$). Both providers and physicians were very comfortable: median (interquartile range [IQR]) of 5 (4, 5); $p < 0.001$. **Conclusions.** The transport rate was significantly reduced when the universal TOR guideline was followed. It was applied by providers without error. In <3% of cases, physicians transported when the

guideline suggested termination, and all of these patients died. The providers and physicians were equally comfortable following the guideline.

9. PARAMEDICS ASSESSING ELDERS AT RISK FOR INDEPENDENCE LOSS—THE PERIL CLINICAL PREDICTION RULE Jacques S. Lee, Richard P. Verbeek, Michael J. Schull, Peter M. Macintyre, Laurie J. Morrison, Lisa A. Calder, Ian G. Stiell, Brian H. Rowe, Sunil M. Sookram, Gary Naglie, Alexander J. Kiss, David P. Ryan, Sunnybrook Department of Emergency Services

Introduction. Paramedics most often provide care in older clients' homes, and sometimes witness dramatic evidence of declining independence. **Objective.** To develop a clinical decision rule, using paramedic observations in the home environment, to identify older people at increased risk for potentially preventable adverse outcomes. **Methods.** We conducted a prospective observational cohort study of people aged >65 years. We trained over 1,100 paramedics from three Canadian urban emergency medical services (EMS) systems to complete a structured checklist of 40 predictor variables observed in the client's home. The primary outcome was a composite of death, hospitalization, or return to the emergency department within one month after the initial EMS encounter. We also examined the single outcome of death within one month. All outcomes that occurred within one day after the initial EMS encounter were excluded. Predictive variables were linked to population-based administrative databases to determine outcomes. We conducted multivariable logistic regression to identify two predictive models, and compared the final models with the previously validated Identifying Seniors at Risk (ISAR) screening tool. **Results.** Follow-up data were available for 903 subjects. The mean age was 80.1 years, and 61% were female. A multivariate predictive model with three independent predictors was significantly associated with our composite primary outcome ($\chi^2 = 3.08$, $df = 5$, $p = 0.9292$). A two-variable model was significantly associated with death within 30 days ($\chi^2 = 4.69$, $df = 4$, $p = 0.3201$). Each rule performed better than the ISAR (area under the curve [AUC] 0.65 and 0.68 vs. 0.59, respectively, $-2 \log \chi^2 = 13.3$, $df = 3$, $p < 0.005$). The PERIL (Paramedics Assessing Elders at Risk for Independence Loss) prediction rule is positive for the composite outcome if a patient used EMS in the past three months, needed help with the activities of daily living, or was judged by paramedics to be at high risk; the rule was 86% sensitive and 28% specific. The PERIL prediction rule is positive for risk of 30-day mortality if patients were judged by paramedics to be at high risk, or if they had a history of chronic obstructive pulmonary disease (sensitivity 73%, specificity 52%). **Con-**

clusions. Paramedics can identify a higher-risk population of frail older adults. Future research will validate the PERIL decision rule and extend the follow-up period to one year.

10. THE ASSOCIATION BETWEEN PREHOSPITAL ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION BENCHMARK TIMES AND SYSTEM PERFORMANCE Jonathan R. Studnek, Lee Garvey, Steve Ward, Steve Vandeventer, Carolinas Medical Center

Introduction. Prehospital acquisition of 12-lead electrocardiograms (ECGs) and diagnosis of ST-segment elevation myocardial infarction (STEMI) have been shown to reduce door-to-balloon (DTB) times. The American Heart Association recommends a DTB goal of <90 minutes and considers prehospital 12-lead ECG acquisition a class I recommendation. Few studies have explored the impact of time intervals in the prehospital setting and their association with meeting DTB goals. **Objective.** To determine whether prehospital time intervals were associated with system performance, defined as first medical contact to percutaneous coronary intervention (PCI), among STEMI patients. **Methods.** Study patients presented at one of three PCI centers in Mecklenburg County, North Carolina, with an acute STEMI, as diagnosed by prehospital ECG, between May 2007 and March 2009. DTB time <90 minutes was defined as time from 9-1-1 call receipt to PCI. Prehospital time intervals were as follows: 9-1-1 call receipt to ambulance on scene <10 minutes, ambulance on scene to 12-lead ECG acquisition <8 minutes, on-scene time <15 minutes, prehospital ECG acquisition to STEMI team notification <10 minutes, and scene departure to patient on cardiac catheterization laboratory (CCL) table <40 minutes. Time intervals were derived and analyzed against the outcome using descriptive statistics and logistic regression. **Results.** There were 181 patients with prehospital CCL activation who received PCI, with 165 (91.1%) having complete data. Of those, 110 (66.7%) received PCI <90 minutes after 9-1-1 call receipt. A logistic regression model was fit using the above prehospital time intervals, indicating that patients who met all five timing benchmarks had a probability of achieving a DTB time <90 minutes of 0.990 (95% confidence interval 0.961–0.997). CCL table time and scene time had the greatest impact on the probability of achieving goal DTB time. This model demonstrated excellent discrimination with area under the receiver-operating characteristic (ROC) curve 0.90. **Conclusions.** In this patient population, prehospital timing benchmarks were associated with system performance. While meeting all five benchmarks may be an ideal goal, this model may be more useful for identifying areas for system improvement that will have the greatest clinical impact.

11. ATTITUDES AND BELIEFS OF THE COMMUNITY REGARDING EMERGENCY RESEARCH AND THE PROCESS OF EXCEPTION FROM INFORMED CONSENT IN EMERGENCY RESEARCH Prasanthi Govindarajan, Neal Workman Dickert, Claude J. Hemphill, Michele Meeker, Rebecca D. Pentz, *University of California San Francisco Medical Center*

Introduction. In 1996, the Food and Drug Administration (FDA) approved regulations authorizing exception from informed consent (EFIC) for research conducted in emergency settings in which prospective informed consent is impracticable. The regulations recommend that institutional review boards (IRBs) review information from community consultation (CC) efforts in evaluating the study. However, little is known about how to conduct CC effectively or how CC impacts IRB decisions. Our goal is to study the CC process as conducted within the Neurological Emergencies Treatment Trials (NETT) network in order to improve understanding of the effectiveness of different CC methods and the attitudes of community members to emergency research and EFIC. **Objective.** To assess the views of CC participants on emergency research and use of EFIC. **Methods.** Following slide presentations on EFIC and the clinical trial being conducted through NETT, in which patients in status epilepticus receive active treatment in the prehospital setting, we administered two surveys to the community consultants from April through September 2008 in the City and County of San Francisco: one to understand their views on EFIC (ES) and the second one to learn about their CC experience (CCS). **Results.** One hundred thirty-four subjects attended the CC meetings, of whom 119 (89%) completed the ES and 103 (77%) completed the CCS. Of those who completed the ES, 107 (90%) reported that they understand patients will be enrolled without consent. Although 110 of 119 (92%) responded that they support the study, only 84 (71%) said they would participate in the study and 78 (66%) reported they would agree to provide consent for a loved one to participate in the study. Of those who responded to the CCS, 99 (96%) wrote they were very satisfied with the meeting and 95 (92%) felt they learned a lot about research at the meeting. While 91 (88%) of the respondents felt researchers heard the community's concerns, only 68 (66%) said researchers would be willing to make changes to the study based on their concerns. Approximately 15 (15%) of the respondents expressed no trust in physician-researchers and felt physician-investigators do not always do what's best for patients. **Conclusions.** Overall, members of our community expressed satisfaction with the CC session and support for the study, although

there is evidence of some lack of trust in physician-investigators.

12. EMERGENCY MEDICAL SERVICES RESPONSE TIME AND MORTALITY IN AN URBAN SETTING: DOES A FASTER RESPONSE SAVE LIVES? Ian E. Blanchard, Andrew R. Anton, Brent E. Hagel, Grant D. Innes, John B. Kortbeek, D. Gregory Powell, David A. Zygun, Christopher J. Doig, *Alberta Health Services*

Background. A principal tenet in emergency medical services (EMS) is that faster response equates to better patient outcome, which has been translated by some EMS operations into an 8-minute response time standard for advanced life support (ALS) units on critical life-threatening events. Adhering to this standard requires substantial EMS resources, which may result in less funding for other EMS programs. **Objective.** To explore whether an ALS response time of ≥ 8 minutes compared with < 8 minutes was associated with an increase in mortality in an urban two-tiered system. **Methods.** This was a one-year (2006) retrospective cohort study of adult patients identified as having potentially critical life-threatening events (Medical Priority Dispatch System Delta and Echo level responses) as assessed at the time of the 9-1-1 call. The study setting was an all-ALS system with basic life support-defibrillation (BLS-D) first response servicing approximately 1 million people. Exposure was defined as the time from 9-1-1 call receipt to ALS unit arrival on scene, and outcome was defined as all-cause mortality at hospital discharge. The primary outcome measures were the crude difference in risk of mortality and the odds ratio (OR) of mortality adjusted for age, gender, and combined scene and transport intervals. **Results.** A total of 7,760 unit responses met inclusion criteria; 1,865 were ≥ 8 minutes. The average patient age was 57 years (standard deviation = 22). The risk of mortality in patients who received a response time ≥ 8 minutes was 7.1%, compared with 6.4% for those who received a response time < 8 minutes. The difference in risk of mortality was 0.7% (confidence interval [CI] -0.5%, 2.0%). The adjusted OR of mortality for ≥ 8 minutes was 1.19 (CI 0.97, 1.47). An exploratory analysis that was restricted to the emergency department setting and the inpatient setting suggested a small beneficial effect for those who survive to become an inpatient (adjusted OR = 1.30; CI 1.00, 1.69). **Conclusions.** There was no evidence of a statistically significant difference in all-cause hospital mortality for ALS unit responses of ≥ 8 minutes versus < 8 minutes. These results call into question the effectiveness of an 8-minute ALS response time standard on mortality for the majority of patients identified as having a critical life-threatening event in an urban EMS system.

13. HELICOPTER EMERGENCY MEDICAL SERVICES TRANSPORT IS ASSOCIATED WITH REDUCED MORTALITY IN INJURED ADULTS Ernest E. Sullivent, Mark Faul, Marlena M. Wald, CDC

Background. Civilian helicopter emergency medical services (HEMS) have played a role in the transport of injured patients since 1967, with increasing numbers of HEMS providers and aircraft committed to this practice ever since. Some studies have shown improved outcomes with HEMS transport, but others have shown no improvement. Increasing concerns regarding cost and safety have prompted reevaluation of the widespread use of HEMS. Although studies have examined the relationship between the mode of trauma patient transport and outcomes in local and regional systems, no large national study of this relationship has been published. **Methods.** Data for 48,974 injured adults aged ≥ 18 years transported to 95 U.S. trauma centers by helicopter or ground ambulance were obtained from the 2007 National Trauma Data Bank research data set. In-hospital mortality was calculated for different demographic and injury severity groups. Odds ratios (ORs) were produced by utilizing a logistic regression model measuring the association of mortality and type of transport, controlling for age, gender, and injury severity (Injury Severity Score [ISS], Revised Trauma Score [RTS]). **Results.** In this data set, odds of death were 26% higher in those transported by ground compared with those transported by helicopter (OR = 1.26, 95% confidence interval [CI] = 1.08–1.48) ($p < 0.003$). Male patients accounted for 72% of helicopter transports and 64% of ground transports, and had a higher odds of death (OR = 1.49, CI = 1.29–1.71). A higher percentage of patients aged < 55 years were transported by helicopter (18%) than those aged ≥ 55 years (10%). Severely injured (ISS > 15) patients were transported by helicopter more frequently than those who were nonseverely injured (29% vs. 12%). Odds of death significantly increased with each year of age (OR = 1.04, CI = 1.04–1.05) and each unit of ISS (OR = 1.09, CI = 1.08–1.09) and decreased with each unit of RTS (OR = 0.45, CI = 0.43–0.46). **Conclusions.** The use of HEMS for the transport of trauma patients is associated with reduced mortality. A validated method of selecting those patients who will best benefit from helicopter transport is expected to enhance this reduction in mortality. To further characterize differences, a study comparing other outcome measures (e.g., intensive care unit days, hospital length of stay) for those transported by helicopter and ground ambulance is warranted.

14. REDUCING AMBULANCE RESPONSE TIMES USING GEOSPATIAL-TIME ANALYSIS OF AMBULANCE DEPLOYMENT Marcus E. H. Ong, Tut Fu Chiam, Faith S. P. Ng, Swee Han Lim, Benjamin S. H. Leong, Victor Y. K. Ong, Elaine Tan, Lai Peng Tham, Susan Yap, V. Anantharaman, Singapore General Hospital

Background. Geographic information system (GIS) technology is able to portray geospatial-time information in a graphical manner and can aid in planning ambulance deployment. Reducing response times has been shown to improve survival in cardiac arrests. **Objective.** To determine whether a deployment strategy based on geospatial-time analysis is able to reduce ambulance response times for out-of-hospital cardiac arrests (OHCAs) in an urban emergency medical services (EMS) system. **Methods.** We conducted an interventional prospective study looking at the geographic location of all OHCAs in Singapore. Location of cardiac arrests was spot-mapped using GIS. A progressive strategy of satellite ambulance deployment was implemented, increasing ambulance bases from 17 to 32 locations. Variation in ambulance deployment according to demand on time of day was also implemented. The total numbers of ambulances and crews remained constant over the study period. **Results.** From October 1, 2001, to October 14, 2004, 2,428 patients were enrolled into the study. The mean age for cardiac arrest patients was 60.6 years, and 68.0% were male. The overall return of spontaneous circulation (ROSC) rate was 17.2%, and the survival to discharge rate was 1.6%. The monthly mean response time decreased significantly as the number of fire stations/fire posts increased (Spearman's rank correlation coefficient, $r = -0.405$, $p = 0.013$). Response times for OHCA decreased from a monthly mean of 10.3 minutes at the beginning to 7.5 minutes at the end of the study. **Conclusions.** Based on geospatial-time analysis, we implemented an ambulance deployment strategy that was able to significantly reduce response times for OHCA.

15. AN ANALYSIS OF AIR AMBULANCE UTILIZATION FOR FIELD TRAUMA PATIENTS IN ARIZONA Joel Bunis, Vatsal Chikani, Terry Mullins, Vicki A. Conditt, Christopher K. Salvino, Bentley J. Bobrow, Arizona Department of Health Services

Background. Transporting critically injured trauma patients from the field via air ambulance may improve outcomes. However, this method of transportation has added risks and expense. State health departments

oversee the appropriateness of air ambulance utilization to maximize the benefit and minimize risk. **Objective.** The Arizona Department of Health Services, Bureau of EMS & Trauma System, sought to determine the appropriateness of prehospital air ambulance utilization for trauma victims in Arizona. **Methods.** A retrospective cohort analysis of a statewide Trauma Registry was performed from January 2005 through December 2008. Appropriateness of air ambulance utilization was determined a priori via standard trauma scoring tools. An Injury Severity Score (ISS) ≤ 15 , a weighted Revised Trauma Score (RTS) ≥ 4 , a probability of survival (Ps) > 0.90 , and "same-day discharge home" were considered non-life-threatening and represented inappropriate air ambulance utilization. **Results.** A total of 67,120 statewide trauma records were reviewed; 16,091 (19.5%) patients were transported from the scene to trauma centers by helicopter and 51,029 were transported by ground. Of the air ambulance transports, 52% had an ISS < 9 , 43% were discharged from the emergency department (ED) or hospital within 24 hours, 88% had a Ps of > 0.90 , and 96% had a calculated on-scene weighted RTS ≥ 4 . **Conclusions.** While the decision to request an air ambulance for trauma victims is multifactorial, there appears to be considerable overuse of air ambulances for patients with non-life-threatening injuries in Arizona. The RTS is the one factor studied that may be used on scene to help determine the most appropriate transport mode. This investigation demonstrates the advantage of accurate trauma system data and ongoing analysis to optimize the benefits and minimize the risks and costs of air ambulance transport.

16. LIFTING AS AN ALTERNATIVE TO THE LOG ROLL TECHNIQUE IN THE PREHOSPITAL MANAGEMENT OF TRAUMATIC SPINAL CORD INJURY **Bradley L. Demeter, John D. Borstad,** *The Ohio State University College of Medicine*

Background. The goal of spinal immobilization techniques is to minimize potentially pathologic movement of the spinal column during the handling of patients with suspected spinal cord injury. There is, however, a growing body of evidence that the current log roll technique used in the prehospital setting may not be as effective at accomplishing this goal as once assumed. **Objective.** We hypothesized that alternative lifting techniques may be able to take advantage of natural anatomic stabilizers of the spine—the pelvis and the rib cage—to minimize movement of the column in its most vulnerable axes—lateral bending and axial rotation—both of which are at particular risk during log rolling. **Methods.** Using a cadaver model and an electromagnetic tracking device attached to pertinent anatomic landmarks, we were able to record angular movement (lateral bending, flexion–extension, and axial rotation) and translations between vertebral

segments in various planes (medial–lateral, anterior–posterior, and compression–distraction). Data were recorded in real time from both the lumbar and cervical spines in cadavers with normal spinal anatomy (uninjured control) and again after a globally unstable injury was induced, with prehospital care providers performing the log roll technique and two alternate lifting techniques. **Results.** In cadavers with an intact spine, lifting techniques showed significant reduction in the amount of motion recorded in the lumbar spine compared with that recorded during the log roll (flexion–extension: -54% , $p = 0.005$; medial–lateral translation: -47% , $p < 0.001$; compression–distraction: -27% , $p = 0.041$). After an unstable lumbar spinal column injury was induced, lifting techniques continued to show improved performance in half of all measurements of movement compared with the results for log rolling (flexion–extension: -55% , $p = 0.04$; medial–lateral translation: -49% , $p = 0.003$; axial rotation: -38% , $p = 0.014$). Lifting also showed significant reduction in movement of the cervical spine in nearly all axes of motion compared with the results for log rolling in both the intact (flexion–extension: -49% , $p = 0.026$; lateral bending: -50% , $p = 0.003$; axial rotation: -31% , $p = 0.031$) and lesioned (lateral bending: -32% , $p < 0.001$; axial rotation: -38% , $p = 0.001$) spines. **Conclusions.** These findings demonstrate that log rolling was the weakest of the three backboarding methods tested and suggest that lifting techniques may be more effective at stabilizing the spine of a patient with suspected traumatic spinal column injury.

17. EFFECT OF TIME FROM INITIAL TRAINING TO FIELD PLACEMENT OF THE KING LTS-D: THE ADVANCED AIRWAY RESEARCH TRIAL **Joshua G. Salzman, Sandi S. Wewerka, Charlie Lick, Marc R. Conterato, Jennifer R. Conners, Lucas A. Meyers, Kent R. Griffith, Ralph J. Frascone, Christopher S. Russi,** *Regions Hospital EMS*

Objective. This study examined the effect that time between initial training and actual field placement of the King LTS-D may have on placement success rates for providers with limited or no previous field experience with the device. **Methods.** Paramedics from four sites were recruited to participate in a prospective, multicenter, randomized, prehospital trial comparing insertion success rates between endotracheal intubation (ETI) and the King LTS-D airway. After obtaining consent, all providers completed a 60-minute didactic training session and a hands-on insertion skills test for ETI and King LTS-D insertion. Similar continuing education was provided for all individuals at all sites during the study, with the exception of one site that conducted one-on-one retraining. Providers treated all patients meeting criteria for advanced airway management according to a preassigned treatment calendar block randomized by week. Following

insertion, providers contacted a study hotline (available 24 hours a day/7 days a week/365 days a year) to complete data collection. All data were analyzed as intent-to-treat (ITT) and as-treated (AT). The time interval (days) between the beginning of the study and the date of insertion with a King LTS-D was compared with insertion success rates using a logistic regression model. Multiple logistic regression was used to examine the timing interval while factoring in the effect of study site, provider age, provider gender, and years of experience as a paramedic. **Results.** Between June 2008 and June 2009, a total of 129 King LTS-D airways were placed by 84 of 272 providers who consented to participate. Mean \pm standard deviation numbers of days to successful vs. failed placement were 198.28 ± 98.32 and 182.72 ± 103.57 , respectively. The time interval from training to actual placement was not predictive of successful placement of the device (odds ratio [OR] = 0.998, 95% confidence interval [CI] 0.997, 1.004). This result was the same when factoring in study site, provider age, provider gender, and years of experience as a paramedic ($p = 0.32$, $p = 0.35$, $p = 0.55$, and $p = 0.97$, respectively). **Conclusions.** In our sample, time from initial training to field placement of the King LTS-D in providers with limited or no previous experience with the device was not associated with or predictive of device placement outcome. More detailed study of this relationship is warranted.

18. PREHOSPITAL INTUBATION: PATIENT POSITION DOES MATTER **Brian Clemency, Craig Cooley, Matthew Roginski, Kristopher Attwood, Anthony J. Billittier, The University at Buffalo, State University of New York**

Introduction. Prehospital providers often intubate in suboptimal conditions. **Objective.** We evaluated whether patient position affects prehospital intubation success rates utilizing a cadaver model. **Methods.** New York State-certified paid and volunteer paramedics and critical care emergency medical technicians (EMTs) were recruited from multiple agencies. Nonembalmed, donated cadavers were placed on the floor, on a simulated elevated stretcher, and in a simulated ambulance. Each participant intubated a different cadaver in each of the three positions, and each cadaver was intubated twice in each of the three positions. Participants were permitted up to 1 minute per attempt and up to three attempts per cadaver. Tube placement was verified by a single attending emergency physician under direct visualization. Participants were asked to report the positions in which they had intubated patients over the previous 12 months. **Results.** Eighty-four (84) participants performed 251 intubations on 42 cadavers. First-attempt and cumulative second-attempt success rates were 77.4% and 89.3% for the floor, 86.9% and 96.4 % for the stretcher,

and 74.7% and 94.0% for the ambulance. Success rates were analyzed using logistic regression. First-attempt odds ratios for the stretcher position compared with the ambulance position and the floor position were 2.25 (95% confidence interval [CI] 1.01–5.03) and 1.94 (95% CI 0.86–4.39), respectively. Cumulative second- and third-attempt odds ratios for the stretcher position were also >1.0 , but failed to reach statistical significance. Cumulatively, participants reported having intubated 57.3% of patients on the floor, 32.7% of patients in the ambulance, and 7.1% of patients on the stretcher over the previous 12 months. **Conclusions.** Despite less experience intubating on an elevated stretcher, our participants had increased first-attempt success in the elevated stretcher position compared with the back of the ambulance. Our sample size may have been insufficient to demonstrate whether intubation in the elevated stretcher position was superior to intubation in the floor position. Optimizing patient position may improve prehospital intubation success rates.

19. COMPARISON OF PROVIDER TIME TO VENTILATION IN ADVANCED AIRWAY PROCEDURES: A LABORATORY SIMULATION TRIAL **Sandi S. Wewerka, Kent R. Griffith, Joshua G. Salzman, Regions Hospital EMS**

Objective. This was a nonblinded, prospective, randomized laboratory time trial comparing time to insertion of an endotracheal tube with that for the King LTS-D airway during standard and difficult airway scenarios. **Methods.** Paramedics from seven emergency medical services (EMS) agencies attending a monthly critical thinking laboratory (CTL) were recruited and consented to participate. All providers completed a brief training session with the King LTS-D device. Each provider completed four advanced airway management scenarios in a randomized order: 1) endotracheal intubation (ETI) standard scenario, 2) King LTS-D standard scenario, 3) ETI difficult scenario, and 4) King LTS-D difficult scenario. Insertions were performed on the MegaCode Kelly Manikin (Laerdal, Inc.), and insertion times were measured by two experimenters using a standard stopwatch. The difficult scenario entailed inflation of the manikin's tongue. Time to insertion was defined as the time the provider opened the airway bag containing either the King LTS-D or ETI equipment to the time visible chest rise was achieved. Mean times to insertion (seconds) in the four scenarios were compared using paired t-tests. Provider characteristics (age and number of years as a paramedic) were examined as potential factors affecting insertion time using correlation coefficients and linear regression analyses. **Results.** From February 2009 to June 2009, 57 providers completed 228 insertions. The mean King insertion time was significantly faster than the ETI insertion time in both the standard (19.88 vs. 37.35, $p < 0.01$) and difficult (21.33 vs. 70.89,

$p < 0.01$) scenarios. There was no difference in time to insertion for the King LTS-D between the standard and difficult scenario (19.88 vs. 21.45, $p = 0.31$). Time to insertion for the difficult ETI scenario was significantly longer than insertion time for the ETI standard scenario (70.88 vs. 37.49, $p < 0.01$). Provider age (38.11 ± 10.33 years) was predictive of insertion time only for the ETI standard scenario ($r = 0.31$, $p < 0.02$). Number of years as a paramedic (8.78 ± 6.79) was not predictive of time to insertion in any of the four scenarios. **Conclusions.** In a simulated training environment, providers were able to successfully place the King LTS-D airway faster, regardless of scenario type. These data should be compared with similar data obtained in the field. The clinical significance of faster insertion times remains unclear.

20. A PROSPECTIVE EVALUATION OF THE EFFECTIVENESS AND SAFETY OF KETAMINE TO FACILITATE ENDOTRACHEAL INTUBATION IN THE HELICOPTER EMERGENCY MEDICAL SERVICES SETTING Aaron K. Sibley, Mark MacKenzie, Jaime Bawden, Danielle Anstett, Brian Rowe, Alberta Health Services

Introduction. Ketamine is a dissociative anesthetic used for sedation and endotracheal intubation in various clinical settings. Despite its proven hemodynamic safety, ketamine has not been widely used in prehospital medicine. **Objective.** This study examined the use and safety of ketamine in helicopter emergency medical services (HEMS). **Methods.** This prospective cohort study enrolled all patients transported by a single HEMS program in whom ketamine was used to facilitate intubation. Data were collected using standard forms by two independent trained research staff. Demographics, medical condition, intubation conditions, vital signs (before and after drug administration), and complications were recorded. Proportions, medians with interquartile ranges (IQRs), change scores, and confidence intervals (CIs) are reported; differences were compared using paired t-tests. **Results.** During the 2.5-year study period, 71 patients received ketamine to facilitate endotracheal intubation. Ketamine was used most often in male patients (52 [73%]), and the median age was 49 years (IQR: 31, 69). Most patients were adults (70 [99%]) suffering from medical illnesses (42 [59%]); 37 (52%) intubations were performed at the sending hospital and 30 (42%) were performed on scene. Indications for intubation were to protect the airway (26 [37%]) and failure to oxygenate or ventilate (25 [35%]). The median ketamine dose was 80 mg (IQR: 60, 100; ~ 1 mg/kg); 53 (75%) patients also received a paralytic agent. Mean arterial pressure (MAP) (2.3 mmHg; 95% CI: -3 to 8) and heart rate (0.45 beats/min; 95% CI: -4 to 5) changes failed to reach statistical or clinical significance. No differences were found between head-injured (21 [29.6%]) and other patients with respect to ketamine dose, changes in vi-

tal signs, and complications. Complications included five (7%) failed intubations, five (7%) hypotension and four (6%) hypertension episodes, one (1%) bradycardia, two (3%) tachycardias, and five (7%) deaths. **Conclusions.** Ketamine is a safe and effective agent in facilitating intubation in a prehospital environment. Complications are similar to its use in the controlled emergency department setting.

21. THE ADVANCED AIRWAY RESEARCH TRIAL: A MULTI-CENTER, PROSPECTIVE, RANDOMIZED TRIAL COMPARING STANDARD ENDOTRACHEAL INTUBATION AND THE KING LTS-D SUPRAGLOTTIC AIRWAY UNDER RAPID-SEQUENCE INDUCTION CONDITIONS Ralph J. Frascone, Jennifer R. Connors, Lucas A. Meyers, Joshua G. Salzman, Kent R. Griffith, Marc R. Conterato, Charlie Lick, Christopher S. Russi, Sandi S. Wewerka, Regions Hospital EMS

Introduction. Rapid-sequence induction (RSI) is most commonly performed with an endotracheal tube, while the use of other airway devices with RSI has not been widely examined. **Objective.** To directly compare primary endotracheal intubation (ETI) with insertion of the primary King LTS-D supraglottic airway when used with RSI medications. **Methods.** The subset of RSI cases collected during a multicenter, prospective, randomized, consecutive patient prehospital clinical trial comparing insertion success rates for ETI versus the King LTS-D airway were used for this analysis. Standardized training in airway device placement and study protocol took place for 272 paramedics who consented to participate. Following successful training and according to individual agency guidelines, paramedics used RSI with ETI and the King LTS-D on a weekly randomized schedule. Following insertion, providers contacted a study hotline (available 24 hours a day/7 days a week/365 days a year) to complete data collection. All data were analyzed as intent-to-treat (ITT). Descriptive statistics for patient characteristics were performed. Rates of insertion success, defined as the ability to ventilate to chest rise, absence of gastric sounds, presence of bilateral lung sounds, and qualitative end-tidal carbon dioxide (ETCO₂), were compared between the two groups using Fisher's exact test. Pre- and postplacement oxygen saturation (SaO₂) values, ETCO₂ values, and times to insertion (seconds) were compared using Student's t-tests. **Results.** Between June 2008 and June 2009, 30 patients received RSI (14 King LTS-D, 16 ETI) by 27 of the 272 providers who consented to participate. Patient demographics included the following: 55% (17/30) trauma, 40% (12/30) female, mean \pm standard deviation age = 50.5 ± 24.3 years, and mean body mass index (BMI) = 30.6 ± 7.6 kg/m². No difference was present in the cumulative first-attempt (81% vs. 93%, $p = 0.29$), second-attempt (100% vs. 93%, $p = 0.98$), or overall insertion

(100% vs. 93%, $p = 0.27$) success rates between ETI and the King LTS-D. No differences were found in pre-SaO₂ (92.1% vs. 92.3%, $p = 0.62$), post-SaO₂ (95.6% vs. 98.5%, $p = 0.28$), ET/CO₂ at approximately 2 minutes (39.7 ± 4.7 mmHg vs. 37.9 ± 4.7 mmHg, $p = 0.62$), or time to insertion (20.0 ± 13.2 seconds vs. 28.4 ± 17.3 seconds, $p = 0.16$) between ETI and the King LTS-D. **Conclusions.** Insertion success rates between ETI and the King LTS-D under RSI conditions in this sample were equivalent. Further research is needed to confirm these findings, because of the small sample size.

22. PREHOSPITAL AIRWAY CONTROL TECHNIQUES: A META-ANALYSIS OF SUCCESS RATES Michael W. Hubble, Lawrence Brown, Denise A. Wilfong, Attila Hertelendy, Randall Benner, Western Carolina University

Background. Airway management is a key component of emergency medical services (EMS) care for seriously ill and injured patients, including the following: oral endotracheal intubation (OETI); nasotracheal intubation (NTI); blind airway devices such as the laryngeal mask airway (LMA), Combitube, King airway (King), and esophageal obturator/esophageal gastric tube airway (EOA/EGTA); and needle and surgical cricothyroidotomy (NCric, SCric). Although multiple studies have reported various rates of success with each of these devices, there are no empirically established benchmarks for EMS airway management success. **Objective.** To determine evidence-based thresholds for airway management success rates through meta-analysis of the published literature. **Methods.** We performed a systematic literature search for all English-language articles reporting success rates for prehospital airway control techniques. Studies of field procedures performed by emergency medical technicians (EMTs), paramedics, nurses, and physicians from any nation were included. All titles were reviewed independently by two authors using prespecified inclusion criteria. Studies not conducted in a field setting or not including sufficient data to calculate a procedural success rate were excluded. Disagreements regarding inclusion were resolved by consensus. Pooled estimates of success rates for each airway technique were calculated using a random-effects meta-analysis model. **Results.** Of 2,004 identified titles, 863 abstracts were evaluated, with 350 studies selected for full review. Of these, 155 studies were retained for final analysis encompassing a total of 69,955 prehospital patients. There was substantial interrater reliability in the review process ($\kappa = 0.81$). The pooled estimates (and 95% confidence intervals [CIs]) for intervention success were as follows: OETI: 89.1% (87.6%–90.4%); NTI: 73.1% (67.8%–77.7%); Combitube: 85.4% (77.3%–91.0%); LMA: 86.7% (78.3%–92.2%), King: 96.5% (71.2%–99.7%); EOA/EGTA: 91.9% (90.5%–

93.1%), NCric: 59.5% (44.5%–72.8%); and SCric: 90.5% (84.8%–94.2%). The success rate for OETI by non-physicians for non-cardiac arrest patients was 73.5% (57.4%–85.1%), but was 83.7% (73.3%–90.6%) for drug-facilitated intubations and 95.9% (92.8%–97.7%) with rapid-sequence induction (RSI). For pediatric patients, the nonphysician OETI success rate was 79.9% (67.8%–88.2%). **Conclusions.** We provide international evidence-based benchmarks for prehospital airway interventions. These data can be useful to policymakers, medical directors, and EMS managers in choosing which interventions to incorporate into their systems, and as international norms for assessing airway management performance.

23. CARDIOVASCULAR COLLAPSE AFTER RETURN OF SPONTANEOUS CIRCULATION IN HUMAN OUT-OF-HOSPITAL CARDIOPULMONARY ARREST Andrew Kuklinski, Shannon Stephens, Henry E. Wang, University of Alabama at Birmingham

Introduction. Cardiovascular collapse (CVC: hypotension or reoccurrence of cardiac arrest) occurs frequently after return of spontaneous circulation (ROSC) in swine models of cardiopulmonary arrest. Few studies describe CVC in humans. **Objective.** We determined the prevalence of CVC in human out-of-hospital cardiopulmonary arrest (OHCA). **Methods.** Using prospective observational data from a site of the Resuscitation Outcomes Consortium, we analyzed treated, nontraumatic OHCA patients achieving initial ROSC. We defined CVC as 1) post-ROSC hypotension (systolic blood pressure [SBP] = 80 mmHg); 2) post-ROSC administration of epinephrine, vasopressin, or dopamine; or 3) post-ROSC recurrent cardiac arrest. We examined the time period between ROSC and emergency department (ED) arrival. We determined the prevalence of and elapsed time to post-ROSC CVC, censoring cases at the point of ED arrival. We compared clinical characteristics between CVC and non-CVC cases. We analyzed the data using exact binomial confidence intervals (CIs), survival analysis, and Fisher's exact and Wilcoxon rank sum tests. **Results.** Of 1,081 treated OHCA patients, ROSC occurred in 58 (5%; 95% CI: 4–7%). Median ROSC-to-ED arrival time was 6 minutes (interquartile range [IQR] 2–13 minutes). CVC occurred in three cases (5%; 95% CI: 1–14%), all due to recurrent cardiac arrest. ROSC-to-CVC times were 1, 2, and 8 minutes. Data for patient age, gender, witnessed arrest, bystander automated external defibrillation, bystander cardiopulmonary resuscitation, initial electrocardiogram rhythm, endotracheal intubation, and administered dosages of epinephrine, atropine, and vasopressin were similar between CVC and non-CVC cases ($p = 0.11$ –1.00). **Conclusions.** In this series of human OHCA, CVC occurred in only a small portion of patients achieving ROSC.

24. INCIDENCE OF RE-ARREST AFTER RETURN OF SPONTANEOUS CIRCULATION IN OUT-OF-HOSPITAL CARDIAC ARREST James J. Menegazzi, Amanda M. Stephenson, David D. Salcido, Joseph P. Condle, Clifton W. Callaway, *University of Pittsburgh*

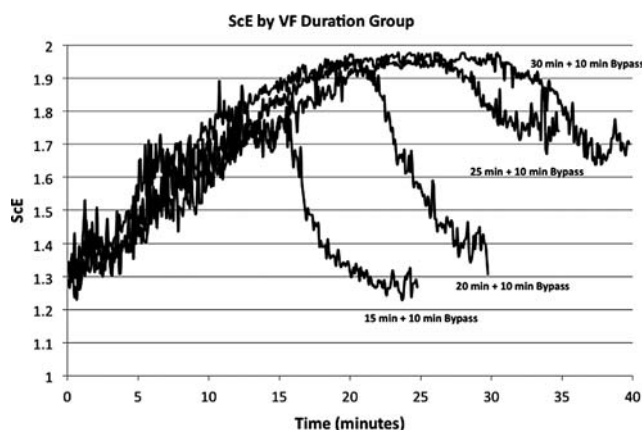
Background. Return of spontaneous circulation (ROSC) occurs in approximately 30% of emergency medical services (EMS)-treated out-of-hospital cardiac arrest (OOHCA). The incidence of re-arrest (RA) before reaching the hospital is unknown, and electrocardiogram (ECG) waveform variability that precedes RA has not been described. **Objectives.** To determine the incidence of RA in OOHCA, to classify RA events by type, and to characterize the ECG waveforms preceding RA. **Methods.** One of the Regional Clinical Centers of the National Heart, Lung, and Blood Institute (NHLBI)-sponsored Resuscitation Outcomes Consortium (ROC) provided the nonclinical trial data for this study. We analyzed defibrillator-monitor ECG tracings (Philips MRx) from EMS-treated cases of OOHCA from 2006 to 2008, patient care reports (PCRs), and audio recordings. Cases had to have adequate ECGs before and after each ROSC/RA event to be included. We defined ROSC as audibly noted pulses and/or ECG findings indicative of pulse corroborated by PCR. We defined RA as audibly noted loss of pulses, visually identified ventricular fibrillation (VF) or asystole, or any rhythm with resumption of CPR. Results are reported in raw numbers, followed by percentage and 95% confidence intervals in parentheses. **Results.** ROSC occurred in 329 of 1,199 patients (27.4%, 25.0–30.0%). Of these, 117 had adequate ECGs. RA occurred in 44 of 117 patients (38%, 29–47%), having a total of 76 RA events. Of the 44 RA cases, 24 patients (55%, 40–69%) were alive upon hospital arrival. RA events by type were as follows: 23 refribrillation (30%, 21–41%), 19 pulseless ventricular tachycardia (VT) (25%, 16–36%), nine pulseless electrical activity (PEA) (12%, 6–21%), six asystole (8%, 3–16%), and 18 cases of probable PEA where pulselessness could not be confirmed (24%, 15–34%). All cases of refribrillation were preceded by ectopy (e.g., numerous premature ventricular contractions [PVCs], runs of VT), often over the course of several minutes. T-wave variability, R-R interval variability, and R-on-T phenomenon were also noted to precede refribrillation. Hypoventilation (based on end-tidal carbon dioxide [ETCO₂]) was the suspected cause of four nonfibrillatory RA events. **Conclusions.** In this sample, the incidence of RA was 38%. Of patients experiencing RA, 55% survived to hospital admission. Refribrillation (35%) and pulseless VT (20%) accounted for the majority of RA. The ECG almost always provides evidence of impending RA, indicating a potential treatment/prevention opportunity for EMS providers.

25. ENHANCING CARDIOPULMONARY RESUSCITATION PERFORMANCE DURING CARDIAC ARREST RESUSCITATION: A PROSPECTIVE TRIAL OF REAL-TIME FEEDBACK David Hostler, Siobhan Everson-Stewart, Thomas D. Rea, Ian G. Stiell, Clifton W. Callaway, Peter J. Kudenchuk, Gena Sears, Scott S. Emerson, Marc-Andre Da Ponti, Graham Nichol, *for the Resuscitation Outcomes Consortium Investigators, University of Pittsburgh*

Background. Better-quality cardiopulmonary resuscitation (CPR) during cardiac arrest may be associated with better patient outcomes. Real-time feedback during resuscitation reduces variability in CPR process, but its effect on patient outcomes is unknown. **Objective.** We tested whether automated real-time CPR feedback provided during out-of-hospital cardiac arrest (OHCA) resuscitation would increase return of spontaneous circulation (ROSC) compared with standard CPR alone. **Methods.** This cluster-randomized trial was performed in 21 U.S. and Canadian emergency medical services (EMS) agencies from three sites in the Resuscitation Outcomes Consortium. Philips MRx defibrillators provided real-time visual and audible feedback about CPR process. After collecting baseline data without feedback (229 cases), clusters ranging in size from individual defibrillator to geographic groups of EMS agencies were randomly assigned to feedback-on or -off. Assignment changed every two to seven months, depending on the expected number of OHCA in each cluster. The study included all subjects who received EMS rescue shocks or chest compressions. The study was designed with 80% power to detect a 10% difference in any prehospital ROSC. Secondary outcomes included ROSC present at the emergency department (ED), survival to discharge, and CPR process variables. Results are presented as crude estimates and cluster-adjusted differences (95% confidence interval [CI]). **Results.** Baseline patient and EMS system characteristics for 1,555 subjects (757 feedback-off, 798 feedback-on) did not differ between groups. EMS muted audible feedback in 15% of cases during the feedback-on period. Compared with feedback-off, feedback-on was associated with increased CPR fraction (64% vs. 66%, cluster-adjusted difference 2.0% [0.5, 3.6]), increased compression depth (37.8 vs. 39.4 mm, cluster-adjusted difference 1.4 [0.3, 2.5]), and decreased proportion of compressions with incomplete release (14% vs. 10%, cluster-adjusted difference -3.0 [-4.8, -1.2]). Frequency of prehospital ROSC (48.3% vs. 47.1%; -0.7% [-5.5, 4.1]), ROSC in the ED (30.6% vs. 30.5%; -0.6 [-4.6, 3.3]), and survival to discharge (12.2% vs. 10.4%; -1.9 [-4.3, 0.4]) did not differ between groups. **Conclusions.** Real-time CPR feedback improved CPR performance but did not improve or impair ROSC or survival to discharge.

26. RECOVERY OF ELECTROCARDIOGRAM ORGANIZATION AFTER PROLONGED VENTRICULAR FIBRILLATION AND CARDIOPULMONARY BYPASS David D. Salcido, Eric S. Logue, Xiaoyi Teng, James J. Menegazzi, University of Pittsburgh School of Medicine, Department of Emergency Medicine

Background. During prolonged ventricular fibrillation (VF), the electrocardiographic (ECG) waveform undergoes a progressive deterioration in organization that can be quantified. Metrics of VF ECG organization, including the scaling exponent (ScE), have been correlated with defibrillation success. **Objective.** To examine the effect of reperfusion on the VF ECG waveform after varying lengths of prolonged, untreated cardiac arrest under optimal perfusing conditions created by administration of cardiopulmonary bypass (CPB). **Methods.** Twelve domestic mixed-breed swine were sedated, anesthetized, and paralyzed. Mechanical ventilation with room air was provided. Large-diameter bypass catheters were placed in the right external jugular vein and right femoral artery for CPB. VF was induced with a 3-second 100-mA transthoracic shock and left untreated for 15, 20, 25, or 30 minutes, followed by 10 minutes of centrifugal pump CPB (Bard CPS). Continuous lead II ECG data were recorded with an electronic data acquisition system (PowerLab, ADInstruments). A quantitative measure of the VF ECG waveform, ScE, was calculated continuously for the untreated VF and bypass periods. **Results.** Three animals were assigned to each VF duration group. The mean (\pm standard deviation) ScEs at the start of VF were similar across all groups (1.32 ± 0.02). Figure 1 shows the progression of the ScE by group from the start of untreated VF to the end of CPB. ScE recovered to VF starting values in the 15- and 20-minute groups but remained high in the 25- and 30-minute groups. **Conclusions.** ECG organization is more responsive to reperfusion after shorter durations of VF. Electrocardiography may be useful for titrating CPB duration before defibrillation.



27. RATE OF OCCURRENCE AND PREDICTORS OF RE-ARREST FOR OUT-OF-HOSPITAL CARDIAC ARREST PATIENTS Don Lundy, Todd McGeorge, Annemarie E. Silver, Charleston County EMS

Introduction. Prehospital cardiac arrest victims for whom stable return of spontaneous circulation (ROSC) is achieved will as a matter of course be transported to a hospital for further postresuscitative care treatment. Some portion of these patients will experience re-arrest. The characteristics of these patients who experience re-arrest have not been described previously. **Objectives.** To determine the frequency with which cardiac arrest patients experience re-arrest and to determine the patient characteristics and short-term clinical outcome for these patients. **Methods.** A retrospective analysis was conducted of 617 consecutive out-of-hospital cardiac arrest patients treated and transported by Charleston County Emergency Medical Services (EMS) between January 2004 and January 2007. **Results.** A total of 148 patients (24%) achieved ROSC during the study period. Of these, 52 patients (35%) experienced re-arrest at some point prior to arrival at the emergency department. There were no statistically significant differences between patients who experienced re-arrest and patients who sustained ROSC in mean (\pm standard deviation) age (64 ± 12 years for patients who experienced re-arrest vs. 65 ± 15 for patients who sustained ROSC, $p = 0.7$), gender (62% male vs. 55% male, $p = 0.6$), incidence of witnessed arrest (69% witnessed vs. 61%, $p = 0.9$), incidence of bystander CPR (33% vs. 23%, $p = 0.2$), location of arrest (65% residence vs. 70%, $p = 0.6$), or EMS response time (9.4 ± 3.2 min vs. 9.1 ± 3.4 min, $p = 0.6$). Patients who experienced re-arrest were significantly more likely to present with a shockable rhythm (49% ventricular fibrillation/ventricular tachycardia) compared with patients who sustained ROSC (31% ventricular fibrillation/ventricular tachycardia, $p = 0.03$). Forty-eight percent of patients who experienced re-arrest had pulses upon arrival at the emergency department. **Conclusions.** Over one-third of out-of-hospital cardiac arrest patients experience re-arrest in the prehospital setting, and nearly half of these patients regain pulses prior to arrival at the emergency department. Patients presenting in ventricular fibrillation or ventricular tachycardia are more likely to experience re-arrest than patients presenting with non-shockable rhythms.

28. NOVEL TECHNOLOGY TO LIMIT CHEST COMPRESSION INTERRUPTION WITH EXPERIENCED ADVANCED LIFE SUPPORT PROVIDERS David Barash, Qing Tan, Annemarie Silver, Concord Healthcare Strategies

Introduction. Chest compression (CC) interruptions are detrimental during the resuscitation of cardiac

arrest patients, especially immediately prior to shock delivery. As a result of CC-induced artifact, advanced life support (ALS) providers must pause CC to determine whether to charge the defibrillator. New defibrillator technology is available to reduce CC-induced artifact and provide reliable rhythm analysis with automatic defibrillator charging to eliminate preshock CC interruption. **Objective.** We hypothesized that CC interruption would be reduced when ALS providers operated the defibrillator in this new mode compared with the standard manual mode of operation. **Methods.** Ten paramedics participated in a randomized crossover manikin study. Subjects performed one trial with an E-series defibrillator (ZOLL Medical) in manual mode and another in the new CPR Ready Charge (CRC) mode. Participants rested a minimum of 30 minutes between trials and watched a 5-minute training video before using the CRC mode. Subjects worked in pairs to perform eight intervals of CC. A simulated waveform was displayed in each interval and the order of waveforms (four shockable and four nonshockable) was randomly assigned. For each interval, subjects performed 2 minutes of continuous CC, analyzed the patient's rhythm, and delivered a shock if appropriate. In the CRC mode, analysis and charging occurred automatically during CC. Every two intervals, subjects switched roles as chest compressor and defibrillator operator. Paired t-tests were used to compare CC interruptions in the CRC and manual mode trials. **Results.** CC interruption was significantly reduced with CRC (43.2 ± 7.3 sec CRC vs. 104.2 ± 30.6 sec manual [mean \pm standard deviation], $p = 0.005$). No-flow fraction was reduced from 9.38% with manual operation to 4.38% with CRC. In particular, the pause prior to shock delivery was decreased with CRC (3.0 ± 1.2 sec CRC vs. 10.2 ± 1.9 sec manual, $p < 0.0001$). Because CRC eliminates pauses for analysis, the total time required to complete eight intervals of CC was shorter in the CRC compared with the manual trial (16.4 ± 0.1 min CRC vs. 18.4 ± 0.4 min manual, $p = 0.0003$). **Conclusions.** No-flow fraction was reduced by approximately 50% and preshock pause was reduced by 70% utilizing a novel technology employing automated analysis and charging during CC.

29. DEATH NOTIFICATION TRAINING FOR PREHOSPITAL PROVIDERS: A PILOT STUDY Alex Ponce, Robert Swor, Tammie Quest, Comilla Sasson, *University of Michigan*

Background. In an out-of-hospital cardiac arrest, family members are likely to be present during a resuscitation effort. However, little training is provided to prehospital providers on how to best handle a family-witnessed resuscitation (FWR) and deliver the news of death in the field. **Objective.** To study the feasibility

and impact of an FWR and death-notification educational intervention designed for prehospital providers, including physicians, paramedics, nurses, firefighters, and emergency medical technicians. **Methods.** We used a prospective cohort study design to assess the impact of an educational intervention on prehospital providers' attitudes and comfort with FWR and knowledge acquisition of death notification skills. A convenience sample of 45 prehospital providers participated in an educational lecture, with 20 providers then attending a small-group standardized patient session. Ten participants voluntarily identified themselves and were included in a subgroup analysis to evaluate the impact of the educational intervention on attitudes before and after the intervention. Descriptive statistics were calculated to assess pre- and postintervention attitudes, knowledge, and comfort with respect to FWR and death notification. **Results.** All participants had participated in at least one cardiac arrest, with 93.3% having performed an FWR. More than a third of the total sample reported to be uncomfortable during an FWR, with 80% ($n = 36$) expressing difficulty stopping resuscitation efforts because of family presence. 55.5% ($n = 25$) of participants had an interest in improving their death-notification skills. After the educational seminar, almost 80% of all participants correctly answered six knowledge-based questions. Post-small-group intervention results showed an improvement in death-notification skills, with a majority of participants expressing confidence in their ability to effectively communicate with others, and debriefing family members during an FWR. The subgroup analysis of linked session participants showed an overall positive change in attitudinal scores and confidence to effectively carry out death notification. **Conclusions.** Our results of this pilot study show that a short educational intervention can impact prehospital providers' comfort with FWR and ability to perform a death notification. Future research will need to be conducted on prehospital provider skill retention and the impact this training has on family members.

30. PLACEMENT OF THE EZ-IO STERNAL AND EZ-IO MANUAL NEEDLE SETS WITH AND WITHOUT CHEMICAL PROTECTIVE EQUIPMENT: A CADAVERIC STUDY Christopher Mitchell, Dustin Tauferner, Kermit Huebner, Carl R. Darnall *Army Medical Center*

Introduction. The prehospital environment is becoming more complicated with the threat of terrorism or hazardous materials. In this setting, the safety of prehospital providers and physicians is paramount. The protective equipment used by the military is the Joint Services Lightweight Suit Technology (JSLIST) accompanied by an M-40 Protective Mask. Knowing

that intravenous access can be difficult or impossible in trauma patients in a hazardous environment, the placement of EZ-IO intraosseous needles with and without JSLIST was evaluated. Finally, the sternal EZ-IO device is a new variation of a manual EZ-IO intraosseous device and has not been tested in a cadaveric model before this study. **Objective.** This study evaluated the placement of both sternal and tibial EZ-IO devices with and without JSLIST by emergency medicine resident physicians. The expectation was that no difference would exist in placement. **Methods.** Fifteen emergency medicine residents placed manual EZ-IO needles in the proximal tibia and sternum with/without JSLIST in a cadaveric model. Times to placement, success rates, and preferences of route of access were compared with each resident physician acting as his or her own control. GraphPad was used to perform statistical analysis. The p-values were determined using nonparametric tests. **Results.** There were no significant differences between times to placement for the manual tibial needle with/without JSLIST (25 vs. 33 seconds, $p = 0.0637$), for the manual sternal needle with/without JSLIST (26 vs. 28 seconds, $p = 0.9341$), or for the sternal versus tibial placement in JSLIST (33 vs. 26 seconds, $p = 0.2293$). Placement was successful in 87% of attempts for both the manual and sternal EZ-IOs (95% confidence interval [CI] 78.8%–92.4%). Eleven of 15 preferred manual placement over sternal placement (95% CI 47.6%–89.5%). **Conclusion.** The use of JSLIST did not significantly increase the time or success of intraosseous placement using tibial or sternal EZ-IO needles. The sternal needle required more steps to perform, which could explain the preference for manual tibial placement. Limitations include completion in an environmentally controlled setting.

31. DIRECT VERSUS VIDEO LARYNGOSCOPIC INTUBATION BY NOVICE PREHOSPITAL INTUBATORS DURING CHEST COMPRESSIONS: A PILOT MANIKIN STUDY **Young Min Kim, Hyung Goo Kang, Ji Hoon Kim, Hyun Soo Chung, Hyeon Woo Yim, Seung Hee Jeong, The Catholic University of Korea, Department of Emergency Medicine**

Introduction. There are few studies on whether chest compressions prolong intubation using direct and video laryngoscopy in prehospital conditions. **Objective.** To evaluate the time taken for intubation (TTI) using the conventional laryngoscope and two portable video laryngoscopes (VLs) with and without chest compressions by novice prehospital intubators in a prehospital condition. **Methods.** We performed a randomized crossover study with a manikin model. The TTIs using the three laryngoscopes (Macintosh laryngoscope [Mac], GlideScope Ranger [GVL-R], and Air-

way Scope [AWS]) by 20 novice emergency medical technicians using a manikin on the floor were measured with and without chest compressions. **Results.** Chest compressions prolonged the TTI using the Mac (2.99 sec, $p = 0.06$), the AWS (0.91 sec, $p = 0.10$), and the GVL-R (2.04 sec, $p = 0.11$). The AWS (15.46 sec) was significantly faster than the Mac (24.14 sec) and the GVL-R (24.12 sec) during chest compressions for the novice prehospital intubators ($p = 0.028$ and $p = 0.004$, respectively). **Conclusions.** In a manikin model, chest compressions did not significantly affect the TTI using the Macintosh and the two VLs. Two portable VLs may be potentially useful adjuncts for advanced airway management during chest compressions for novice prehospital intubators. Further clinical investigations are necessary to confirm these findings.

32. IDENTIFICATION OF ADVERSE EVENTS IN GROUND EMERGENCY MEDICAL SERVICES BY MEDICAL DIRECTORS **P. Daniel Patterson, Chris Martin-Gill, Matthew Weaver, Ronald Roth, Joe Suyama, Kaleab Abebe, Francis Guyette, Jon Rittenberger, Department of Emergency Medicine, University of Pittsburgh**

Introduction. Despite concern for adverse events (AEs) in prehospital medicine, few studies exist. **Objectives.** To develop a definition and classification scheme for identifying AEs in ground emergency medical services (EMS) and determine agreement among EMS medical directors (EMDs) in identifying AEs. **Methods.** Five highly trained and experienced EMDs reviewed a list of common definitions of medical error and AEs in order to craft their own definitions of an AE. The five resultant definitions were sent to each EMD for consideration toward editing his or her own definition. This process was repeated five times, resulting in a unanimous definition of AE: "An adverse event in EMS is a harmful or potentially harmful event occurring during the continuum of EMS care that is oftentimes preventable and thus independent of the progression of the patient's condition." The same process was used to construct a seven-level AE severity-rating scheme that ranged from 1 (AE with harm due to commission) to 7 (no AE identified in chart). Four EMDs then retrospectively reviewed 52 EMS patient charts flagged by an EMS agency quality officer and applied the AE definition and rating scheme. We examined agreement among the EMDs in identifying the presence and number of AEs using Fleiss' kappa for multirater agreement and corresponding 95% confidence intervals (CIs). Agreement was assessed using a six-level scale that ranged from poor (0.0) to perfect (1.00) agreement. **Results.** An AE was identified by at least one EMD in 96% of charts reviewed. There was wide variation across EMDs in which charts contained an AE (36%–81%). A maximum of three AEs

were identified in any chart. Agreement among EMDs on the presence of an AE was poor ($\kappa = 0.13$, 95% CI 0.02, 0.24). Agreement on the total number of AEs per chart was poor ($\kappa = 0.08$, 95% CI 0.002, 0.16). **Conclusions.** We discovered wide variation in the identification of AEs among a group of highly trained and experienced EMDs. These findings raise important questions about the utility of EMS chart review as a primary source of information in identifying AEs in EMS and suggest a need to establish a standardized process for AE identification using multiple EMDs.

33. CAN HIGH-FIDELITY PATIENT SIMULATOR CASES INTENDED FOR EMERGENCY MEDICINE PHYSICIAN EDUCATION BE USED FOR EMERGENCY MEDICAL TECHNICIAN/EMERGENCY MEDICAL TECHNICIAN-PARAMEDIC CONTINUING EDUCATION? **Andrew L. Juergens, Margaret K. Strecker-McGraw, David L. Morgan, Timothy C. Stallard, Scott and White Hospital, Department of Emergency Medicine**

Introduction. Although the use of high-fidelity simulation in medical education has significantly increased, there are very few reports of its use for the continuing education of prehospital providers. One of the obstacles in using simulators is the difficulty in developing complex patient scenarios (cases) that reflect realistic emergency situations. The Society for Academic Emergency Medicine (SAEM) Simulation Interest Group has developed about 100 such cases primarily for emergency medicine (EM) physician resident education. **Objective.** To determine whether these scenarios could be easily modified for the continuing education of emergency medical services (EMS) providers. **Methods.** Four scenarios were selected from the SAEM Simulation Case Library (emedu.org/sim). One scenario ("Burn Victim") was developed for EM residents and emergency medical technicians-paramedic (EMT-Ps) and was used unchanged. The others ("Eclampsia," "Croup," and "Myocardial Infarction") were developed for medical students and EM residents. These were modified by removing laboratory results, radiographic information, and emergency department (ED) actions. Each case had three to seven critical actions that were timed. Volunteer teams of three to four EMS providers (each team had at least one EMT-P) completed each high-fidelity scenario using SimMan or SimBaby. **Results.** Twenty-two teams completed at least one scenario. Of the 406 total critical actions, 55.7% (95% confidence interval [CI] 50.8–60.4%) were done within 5 minutes, and 90.6% (95% CI 87.4–93.1%) were done within 10 minutes. Nineteen teams completed the "Burn Victim" scenario; 89.5% (95% CI 82.5–93.9%) of actions were done within 10 minutes. Eighteen teams completed "Eclampsia"; 97.2% (95% CI 90.4–99.2%) were done within 10 minutes. Twenty-

two teams completed both "Myocardial Infarction" and "Croup"; 90.9% (95% CI 85.3–94.5%) and 84.8% (95% CI 74.3–91.6%) were done within 10 minutes, respectively. For three scenarios, over 62% of critical actions were completed within 5 minutes. Only 29.2% of actions were done in 5 minutes for "Myocardial Infarction." **Conclusions.** This pilot study found that the average proportion of actions completed under 10 minutes was 90.6%. There was little variability between the percentage of tasks completed between exercises, whether or not they were designed for EMS use. SAEM simulation cases can be easily modified for use in prehospital provider training.

34. DOES FRONT-LOADING HOSPITAL CLINICAL ROTATIONS IMPROVE PARAMEDIC STUDENT SUCCESS DURING FIELD INTERNSHIPS? **David Page, Timothy Howey, Inver Hills Community College**

Introduction. Paramedic student (PS) clinical experiences remain an essential component of today's educational standards. Current accreditation standards recommend that a PS 1) complete the majority of field internships after didactic and hospital clinical rotations and 2) successfully lead 50 patient encounters (leads) in the field. No evidence is available to support these recommendations, and previous research has shown that low numbers of graduates achieve the number of leads recommended. **Hypothesis.** Completing hospital clinical rotations before going to the field results in greater optimization and leadership success during paramedic student field internships. **Methods.** Between October 1998 and October 2008, paramedic students participating in FISDAP, a national computerized student tracking system, used a web page to prospectively report their clinical experiences. The student's preceptors also completed a paper evaluation. Instructors at each of the participating training programs then verified the data by comparing the computerized records with the paper evaluations. Inclusion criteria consisted of student consent, successful graduation, and instructor verification of student records. **Results.** A total of 4,889 students met the inclusion criteria. These students completed a total of 420,417 field encounters (average 86; range 1–514). Students who completed hospital clinicals before their first field encounter led 0.74% (95% confidence interval [CI] 0.007) of the encounters they had in the field. Students who completed hospital clinical rotations and field internships mixed together led 0.60% (95% CI 0.014) of the encounters they had in the field. **Conclusions.** Students who complete hospital clinical rotations before completing field internships lead a greater percentage of their field encounters. EMS educators should consider the order in which clinical experiences are scheduled to optimize PS achievement.

35. PUBLIC ACCESS TO DEFIBRILLATION: A FIVE-YEAR FOLLOW-UP **Shannon W. Stephens, University of Alabama at Birmingham, Department of Emergency Medicine**

Introduction. The Public Access to Defibrillation (PAD) trial showed that community cardiopulmonary resuscitation (CPR) training supplemented by automated external defibrillators (AEDs) increased out-of-hospital cardiac arrest (OHCA) survival. While the trial provided intensive CPR training and AED maintenance during the trial, no studies have evaluated the longevity of these programs. **Objective.** We evaluated the status of community PAD programs five years after the end of the PAD trial. **Methods.** In this prospective observational study, we evaluated Alabama community sites of the PAD trial, including only locations that continued CPR training and AED use after the conclusion of the study. We evaluated sites five years after the end of the original PAD trial. At each PAD site, we determined the availability and frequency of CPR training. We confirmed the presence and maintenance status of AEDs, including the expiration dates of AED batteries and pads. Using site logs and AED downloads, we identified AED use for OHCA. We analyzed the data using descriptive statistics, calculating exact binomial 95% confidence intervals (CIs). **Results.** We studied 32 community PAD sites, encompassing 75 AEDs (median 2 per site, interquartile range [IQR] 2–2) and 454 CPR-trained persons (median 11, IQR 5–20). AEDs were still present at 30 of 32 sites (94%; 95% CI: 79–99%). One-fifth of sites abandoned AED maintenance (20%; 95% CI: 8–39%). Over half had not inspected AEDs within the prior 12 months (52%; 95% CI: 33–70%). Over half had expired AED pads (57%; 95% CI: 37–76%). One-fourth had expired AED batteries (25%; 95% CI: 11–45%). One-third had AEDs with unresolved maintenance alerts (33%; 95% CI: 13–59%). While most sites continued to provide CPR training (81%; 95% CI: 64–93%), only half required CPR training (45%; 95% CI: 27–64%). Few sites annually performed mock CPR drills (32%; 95% CI: 71–51%). Of five OHCA identified since the end of the PAD trial, only three received AED application. **Conclusions.** Five years after the PAD trial, PAD communities demonstrated poor AED maintenance, fair CPR training, and marginal AED application.

36. RE-ARREST AFTER PREHOSPITAL RESUSCITATION **Michael O'Connell, E. Brooke Lerner, Ronald G. Pirrallo, Medical College of Wisconsin**

Objectives. To determine how often out-of-hospital cardiac arrest (OHCA) patients who achieve return of spontaneous circulation (ROSC) experience re-arrest during their emergency medical services (EMS) care and to analyze their arrest characteristics, including

survival to hospital discharge. **Methods.** A retrospective patient care record review was conducted for all treated cardiac-etiology OHCA patients between January 1, 2000, and February 28, 2008. Data were obtained from a countywide EMS patient care database that included treating EMS provider documentation and patient outcomes provided by the receiving hospital. Except for those cases for whom resuscitation was not attempted, all ages of OHCA patients were included in the study. Those who achieved ROSC were identified and the number of patients who experienced re-arrest was determined. ROSC was defined as documentation of a palpable pulse and re-arrest was defined as a change in cardiac rhythm associated with loss of a palpable pulse, regardless of duration. Utstein-style cardiac arrest characteristics were analyzed using chi-square and t-test for resuscitated patients who experienced re-arrest compared with those who did not experience re-arrest. **Results.** During the study period, OHCA resuscitation was attempted on 7,296 patients. Of these, 2,454 had field ROSC (34%; 95% confidence interval [CI]: 33–35%). Of those who achieved ROSC, 994 experienced re-arrest prior to hospital arrival (41%; 95% CI: 39–42%). The average age of patients who experienced re-arrest was 2 years older than those who did not experience re-arrest (64 years vs. 62 years; $p < 0.011$). The proportion of women in the re-arrest group was less than that in the non-re-arrest group (40% vs. 46% $p < 0.008$). Witnessed arrest rates were similar between the two groups (65% vs. 68% $p < 0.124$). Fewer patients who experienced re-arrest survived to hospital admission (53% vs. 85%; $p < 0.000$) and hospital discharge (15% vs. 35%; $p < 0.000$). Of those who experienced re-arrest, 102 (10%) experienced re-arrest while being transported. There was no difference in survival for those who experienced re-arrest prior to transport (14%) compared with those who experienced re-arrest during transport (16%), $p < 0.671$. **Conclusions.** A significant number of OHCA patients who achieved field ROSC experienced re-arrest prior to hospital arrival. Patients who experienced re-arrest were less likely to survive. Future research is needed to determine which factors may improve these patients' outcome yet maintain EMS provider safety during transport.

37. CARDIOPULMONARY RESUSCITATION OUTCOME OF OUT-OF-HOSPITAL CARDIAC ARREST IN LOW-VOLUME VERSUS HIGH-VOLUME EMERGENCY DEPARTMENTS: AN OBSERVATIONAL STUDY AND PROPENSITY SCORE MATCHING ANALYSIS **Sang Do Shin, Ki Ok Ahn, Gil Joon Suh, Kyoung Jun Song, Seoul National University Hospital, Korea**

Introduction. It is unknown whether transporting victims of out-of-hospital cardiac arrest (OHCA) to an emergency department (ED) that experiences a high

volume of cardiopulmonary resuscitation (CPR) is related to better outcomes. **Objective.** We aimed to determine whether CPR case volume is associated with the rate of survival to discharge for OHCA victims. **Methods.** We used the Korean nationwide EMS-assessed OHCA cohort database (2006–2007). The database is composed of hospital chart review and ambulance run sheet (CAVAS project) data. Prehospital ambulance service in Korea is provided by the fire department, and only basic life support is available. We enrolled data from the 20 regional (level 1) and 99 local (level 2) emergency departments (EDs) in Korea, and excluded cases without available hospital outcome data. OHCA CPR volume was calculated for each ED from the data. The median number of CPR cases (model 1, cutoff value = 120) and 75th percentile (model 2, cutoff value = 158) were defined as the cutoff values for high-volume (HV) versus low-volume (LV) EDs. A matching process based on propensity score was used to equalize potential prognostic factors in both groups, and formulate a balanced 1:1 matched cohort study. The adjusted odds ratio (OR) and its 95% confidence interval (95% CI) for survival to admission and survival to discharge from hospital were the main outcomes. **Results.** Of the 34,552 patients with OHCA treated in nationwide EDs, 15,458 (45.7%) from the 119 designated EDs were included. Overall survival to admission and survival to discharge were 14.0% and 4.5%, respectively. Using propensity score matching, 4,005 cases (model 1) and 1,614 cases (model 2) were assigned to each arm (HV versus LV). The adjusted OR for survival to admission in HV compared with LV EDs was 1.091 (95% CI 0.960–1.241) in model 1 and 1.342 (95% CI 1.103–1.634) in model 2. The adjusted OR for survival to discharge was 1.518 (95% CI 1.240–1.868) in model 1 and 1.447 (95% CI 1.073–1.953) in model 2. **Conclusions.** EDs with high volumes of OHCA CPR cases showed significantly better outcomes for OHCA patients than those with low volumes.

38. CASE STUDY OF CARDIOPULMONARY RESUSCITATION PERFORMED BY BYSTANDERS ON PATIENTS WHO ARE NOT IN CARDIAC ARREST **Kari Haley, E. Brooke Lerner, Ronald G. Pirrallo, Anne Johnson, Micheal Uihlein, Medical College of Wisconsin**

Introduction. The American Heart Association encourages trained and untrained bystanders to perform cardiopulmonary resuscitation (CPR) for any patient who “is unconscious, not moving, and not breathing (ignoring occasional gasps).” It is possible that people who are not in cardiac arrest may receive bystander CPR, from which the potential for injury is unknown. **Objectives.** To determine the number of patients who received bystander CPR but were not in cardiac arrest, and to identify any injuries that might have resulted from receiving bystander CPR. **Meth-**

ods. A retrospective review of patient care records from a countywide emergency medical services (EMS) database was performed. All patients, regardless of age or etiology, treated by EMS between March 2003 and February 2009 who received bystander CPR were queried. Patients who were determined not to be in cardiac arrest upon arrival of EMS personnel were identified as receiving bystander CPR but were likely not in cardiac arrest. If transported, hospital medical records for those patients were reviewed for any injuries possibly related to CPR. Utstein-style demographics were collected and descriptive statistics were used for analysis. **Results.** During the six-year study, 668 incidents of bystander CPR occurred, with 77 (12%) cases not being identified as cardiac arrests by EMS: 51% of patients were male; 56% were white; 23% were aged less than 19 years; and 71% were older than 54 years. Thirty-nine percent were found in a private residence, and EMS arrived in less than 6 minutes for 68%; in only two cases was the EMS arrival interval longer than 10 minutes. Sixty-five cases were evaluable for injury (two refused transport, 10 hospital records were unavailable). Of those, 54% were admitted to the intensive care unit. Only one patient (1.5%) had a possible CPR-related injury: rhabdomyolysis. Seventeen percent of the cases had a cardiac-related discharge diagnosis. It is unknown how many patients may have actually had a return of spontaneous circulation prior to EMS evaluation. **Conclusions.** Bystander-“misidentified” cardiac arrest occurs at a relatively low frequency. Short-duration bystander CPR caused injury in less than 2% of patients. Our results reaffirm that the benefits of bystander CPR for cardiac arrest patients outweigh the risk of injury for “misidentified” cardiac arrest patients.

39. THE ASSOCIATION BETWEEN HOSPITAL OUTCOME AND FLOOR LEVEL OF OUT-OF-HOSPITAL CARDIAC ARREST IN HIGH-STORY BUILDINGS: A NATIONWIDE OBSERVATIONAL STUDY **Ji Yeon Jang, Sang Do Shin, Ki Ok Ahn, Won Chul Cha, Kyoung Jun Song, Seoul National University Hospital**

Background. Little has been studied about the effect of high-story buildings on emergency medical services (EMS). **Objective.** To determine the association between the outcome and floor level of EMS-assessed out-of-hospital cardiac arrest (OHCA). **Methods.** A Korean nationwide EMS-assessed OHCA database (2006–2007) (the CAVAS project) that was constructed from ambulance run sheet and followed by medical record review was used. The data set included floor level of the OHCA as well as Utstein-style variables. Patients with conditions of presumed cardiac origin and confirmed hospital outcome were included. The level of floor was categorized into the outdoor (reference group), the underground, the low level (first floor to

fifth floor), the middle level (sixth floor to 10th floor), and the high level (above 11th floor). The primary outcome was survival to discharge for the total group and witnessed group. Demographic findings were analyzed and a multivariate logistic regression was done to determine the adjusted effect of the floor level on the hospital outcome. Adjusted odds ratio (OR) and its 95% confidence interval were calculated for each group. **Results.** The total number of EMS-assessed OHCA was 34,552. Of these, 8,367 (24.2%) patients were selected for the final analysis. Rates of survival to admission rate for the total and witnessed cardiac groups were 9.6% and 14.3%, respectively. Rates of survival to discharge were 3.5% and 5.9%. The effect of floor level was compared with outdoor OHCA. For survival to discharge in the total group of patients, the OR was 0.601 (0.457–0.814) for the low level, 0.413 (0.248–0.678) for the middle level, 0.385 (0.223–0.666) for the high level, and 0.805 (0.874–2.420) for the underground. For survival to discharge in the witnessed group, the OR was 0.638 (0.454–0.895) for the low level, 0.439 (0.248–0.777) for the middle level, 0.440 (0.240–0.806) for the high level, and 0.592 (0.217–1.617) for the underground. **Conclusions.** OHCA in multiple-story buildings showed poor outcome regarding the floor level. The rates of survival to discharge in the total and witnessed subgroups significantly decreased as the floor level increased.

40. CARDIOPULMONARY RESUSCITATION PERFORMANCE BY EMERGENCY FIRST RESPONDERS **Scott A. Matin, Charles Livezey, Peter Dworsky, Robert Bauter, Brian O'Neill, Paul Scalzo, Phil Shepherd, James Knight, MONOC Mobile Health Services**

Introduction. In a recent state study it was found that first responders—police, fire, and emergency medical services (EMS)—initiated cardiopulmonary resuscitation (CPR) in 83% of prehospital cardiac arrests. American Heart Association (AHA) 2005 Emergency Cardiac Care guidelines focus on the importance of early high-quality CPR for successful resuscitation. Many studies show that early CPR is the single most important link in the chain of survival. This study will measure the ability of first responders to meet AHA CPR time standards. **Hypothesis.** CPR performed by first responders often does not meet AHA timing standards. **Methods.** This prospective study evaluated one-rescuer health care provider (HCP) adult CPR. AHA instructors used a standardized skill sheet of AHA-established criteria to document performance on a manikin. The study group consisted of 651 practicing first responders—police, fire, and EMS—with a current HCP CPR card. Three critical tasks were timed, the initial breathing check, initial pulse check, and delivery

of 30 compressions. **Results.** Only 33.33% (217/651) demonstrated correct timing in all three critical tasks. One timing error occurred with 24.58% (160/651), two errors occurred with 22.27% (145/651), and errors occurred in all three tasks with 19.82% (129/651). First responders demonstrated adequate initial breathing checks (5 to 10 seconds) 58.68% of the time (382/651). Average time was only 4.87 seconds, with 95.17% of the incorrect checks performed too fast. First responders demonstrated adequate initial pulse checks (5 to 10 seconds) 58.22% of the time (379/651). Average time was only 4.89 seconds, with 94.85% of the incorrect checks performed too fast. First responders delivered 30 chest compressions at the correct rate (15 to 23 seconds) 54.53% of the time (355/651). The average time was 19.67 seconds. 57.43% of the incorrect compressions were delivered too slowly and 42.57% were delivered too fast. **Conclusions.** This study showed that despite HCP CPR certification, there is still a high incidence of critical CPR performance errors by first responders. Early high-quality CPR is an essential component of successful resuscitation. Emergency first responders who do not perform CPR regularly must practice CPR frequently. Further research is needed to determine what method is most efficacious in helping first responders maintain their CPR proficiency.

41. DEFINING THE METRICS OF SURGE: MEASURING OFFLOAD DELAY **Alix Carter, Jerry Overton, David C. Cone, Yale University/Nova Scotia EHS**

Introduction. “Offload delay” occurs when the transfer of care from an ambulance crew to the emergency department (ED) is prolonged. Little is known about offload delay, as most systems are able to collect only the total “turnaround interval,” which starts when the ambulance arrives at the ED and ends when the crew is ready for another call. Only a portion of this represents the transfer of patient care (the actual offload, or “delivery interval”). Automated transmission of the offload time has been difficult to achieve, and manual methods are labor-intensive and not practical for large projects. **Objective.** This study was conducted to assess whether the turnaround interval is a reasonable surrogate for offload time. If so, it will allow researchers to study offload delay using data that are already automatically captured. **Methods.** This observational study was conducted at two sites. Richmond Ambulance Authority crews manually logged the delivery and recovery times for consecutive runs from April 1 to December 31, 2008. To assess generalizability, a convenience sample of these same times was collected by direct observation at Yale–New Haven Hospital. Simple regression analysis was used to determine the amount of variability in turnaround time

that can be attributed to the delivery interval. **Results.** A total of 1,732 ambulance runs from Richmond and 60 runs from Yale were included. In the regression model using the Richmond Ambulance data, delivery explained 86% of the variability in turnaround ($p < 0.0001$). For an increase of 1 minute in delivery time, the turnaround time increased by 1.32 minutes (1.30, 1.35) assuming an intercept of 0. With the Yale data, delivery explained 77% of the variability in turnaround ($p < 0.0001$). The increase in turnaround was 1.50 minutes (1.28, 1.71) for every 1-minute increase in delivery. **Conclusions.** Delivery time is a strong predictor of turnaround time. Efforts to decrease turnaround time would be assisted by knowing where in the process the delay exists. However, in the absence of a functional way to measure the delivery time, turnaround time provides a valid measure of how long it is taking to offload ambulances.

42. THE ASSOCIATION BETWEEN AMBULANCE HOSPITAL TURNAROUND TIMES AND PATIENT ACUITY, DESTINATION HOSPITAL, AND TIME OF DAY Jonathan R. Studnek, Steve Vandeventer, Steve Ward, John Garrett, *Carolinas Medical Center*

Introduction. The availability of ambulances to respond to emergency calls is related to their ability to return to service from the hospital. Extended hospital turnaround times decrease the number of effective unit hours ambulances are deployed, which in turn can increase coverage costs or sacrifice coverage. **Objective.** To determine whether ambulance turnaround times were associated with patient acuity, destination hospital, and time of day. **Methods.** This retrospective analysis of ambulance hospital turnaround times utilized 12 months of data from a single, countywide, metropolitan emergency medical services (EMS) system. Turnaround time was defined as ambulance arrival at the hospital until the ambulance was available. Independent variables included patient acuity (life-threatening, non-life-threatening, or routine transport), destination hospital (seven regional hospitals), and time of day (one-hour interval). Data analysis consisted of descriptive statistics, t-tests, and linear regression. **Results.** Of the 61,935 patient transports, mean turnaround time was 35.5 minutes (standard deviation [SD] = 16.5). Turnaround time was significantly associated with patient acuity ($p < 0.001$). Life-threatening calls had a mean turnaround time of 52.4 minutes (SD = 21.6), while non-life-threatening and routine transports had a mean turnaround time of 41.9 minutes (SD = 16.4) and 32.4 minutes (SD = 14.4). A statistically significant relationship between destination hospital and turnaround time was found, with a difference in means ranging from 30 seconds to 8 minutes. Similarly, time of day was associated with turnaround

times, with the longest turnaround times occurring between 6:00 AM and 4:00 PM ($p < 0.001$). **Conclusions.** While the results are intuitive, this study demonstrated that patient and system characteristics were associated with variation in ambulance turnaround times. Research describing other system characteristics such as current emergency department census and patient handoff procedures may further demonstrate areas for improvement in turnaround times. Although the practical significance of some variables may be questioned, accounting for system-level variables in future turnaround analyses should not be dismissed. Future research should also investigate the impact of turnaround times on system efficiency.

43. A LONGITUDINAL STUDY OF TURNOVER AND ITS COSTS IN EMERGENCY MEDICAL SERVICES P. Daniel Patterson, Cheryl B. Jones, Michael Hubble, Matthew Weaver, Matthew Carr, John Engberg, Nicholas Castle, *University of Pittsburgh, Department of Emergency Medicine*

Introduction. Few studies have examined employee turnover and associated costs in emergency medical services (EMS). **Objective.** To quantify the mean annual rate of turnover, total median cost of turnover, and median cost per termination in a diverse sample of EMS agencies. **Methods.** A convenience sample of 40 EMS agencies was followed over a six-month period. We used Internet, telephone, and on-site data-collection methods to document terminations, new hires, open positions, and costs associated with turnover. The cost associated with turnover was calculated based on a modified version of the Nursing Turnover Cost Calculation Methodology (NTCCM) developed by Jones (1990). The NTCCM identified direct and indirect costs through a series of questions that agency administrators answered monthly during the study period. We used a previously tested measure of turnover to calculate the mean annual rate of turnover. We weighted all calculations by size of EMS agency rosters. The mean annual rate of turnover, total median cost of turnover, and median cost per termination were determined for three categories of agency staff mix: all-paid staff, mix of paid and volunteer (mixed), and all-volunteer. **Results.** The overall weighted mean annual rate of turnover was 10.7%. This rate varied slightly across agency staffing mix: all-paid = 10.2%, mixed = 12.3%, and all-volunteer = 12.4%. Among agencies that experienced turnover ($n = 25$), the weighted median cost of turnover was \$71,613.75, which varied across agency staffing mix: all-paid = \$86,452.05, mixed = \$9,766.65, and all-volunteer = \$0. The weighted median cost per termination was \$6,871.51 and varied across agency staffing mix: all-paid = \$7,161.38, mixed = \$1,409.64, and

all-volunteer = \$0. **Conclusions.** This study found that annual rates of turnover and costs associated with turnover vary widely across types of EMS agencies. The study's mean annual rate of turnover was lower than expected based on information appearing in the news media and EMS trade magazines. Findings provide estimates of two key workforce measures—turnover rates and costs—where previously none have existed. Local EMS directors and policymakers at all levels of government may find the results and study methodology useful toward designing and evaluating programs targeting the EMS workforce.

44. PERCEIVED EFFECTS OF SLEEPINESS AND SLEEP DEPRIVATION AMONG FIREFIGHTERS AND EMERGENCY MEDICAL SERVICES PROVIDERS WORKING A 24/48-HOUR SHIFT SCHEDULE *Lynne Dees, University of Texas Southwestern Medical Center at Dallas*

Introduction. Sleep deprivation has been identified as a threat to health and safety worldwide, including among public servants. **Methods.** This mixed-method descriptive study examined perceived sleepiness and health in a volunteer convenience sample of 242 career firefighters who were systematically surveyed using the Epworth Sleepiness Scale (ESS) and Duke Health Profile (DHP). Firefighter sleep needs and habits were assessed with open-ended questions. Using archival records, vehicle accidents, patient errors, and job-related injury rates occurring by time of day were evaluated. **Results.** The study found a significant level of perceived sleepiness in this cohort of firefighter/emergency medical services (EMS) providers. The results of the one-way analysis of variance (ANOVA) revealed that firefighters with other employment possessed significantly greater sleepiness, particularly those who were self-employed and worked more than 20 hours weekly at a second job. The one-way ANOVA also revealed significantly increased sleepiness in providers who commuted 20 miles or more to work. Pearson's product-moment correlations revealed a significant positive relationship between increasing numbers of hours worked in another job with an increase in sleepiness. All study p-values were <0.05. A one-way multivariable ANOVA (MANOVA) was conducted to examine the effect of sleepiness on DHP health scores. Post hoc comparisons using Tukey's honestly significant difference (HSD) test revealed a significant univariate effect identifying that firefighters with high levels of sleepiness experienced significantly poorer physical health, especially in the categories of perceived health and pain. The overall multivariate effect identified increased sleepiness with lower social health scores, higher anxiety levels, and increased pain. Finally, the results failed to reveal significant differences in the number of patient

care report omissions or medical mistakes between day and night hours as determined by nonparametric chi-square tests of association; however, injuries and accidents were found to be significantly more likely to occur during day rather than night hours. Open-ended questions assessed the firefighters' sleep habits, and descriptive statistics revealed an average sleep time requirement of 6.8 hours. **Conclusions.** Firefighters perceived themselves as sleepy, and their ESS scores averaged 10.5 on a clinically normal scale of 2–10. Open-ended responses indicated a high level of functioning despite fatigue and a marked need for a sleep health education program.

45. WHEN DO WE REALLY NEED PARAMEDICS? *David Castillo, Howard Felderman, Brian Walsh, Morristown Memorial Hospital*

Introduction. Prehospital providers are struggling with decreasing numbers of advanced life support (ALS) providers and a need for greater efficiency. Some studies suggest that paramedics are not needed for many of the patients they treat. **Objective.** To determine the percentage of calls that required critical ALS interventions and the dispatch categories most likely to require these interventions. **Methods.** We retrospectively reviewed all ALS patient care records from February 1, 2007, through July 15, 2009, in our two-tiered, suburban emergency medical services (EMS) system. A priori, we defined critical actions as the following: defibrillation, cardioversion, external pacing, needle thoracotomy, continuous positive airway pressure (CPAP) or bilevel positive airway pressure (BiPAP), invasive airway intervention, or administration of the following medications: epinephrine, vecuronium, 50% dextrose, succinylcholine, dopamine, or benzodiazepines (for seizures only). We calculated the percentage of all ALS calls that required critical interventions and then calculated the odds ratios (ORs) with 95% confidence intervals (CIs) for each of 31 dispatch categories. **Results.** 36,143 ALS calls were reviewed, with 1,536 patients (4.2%) requiring critical interventions. Compared with the total group, the following dispatch categories had statistically significant higher rates of critical actions: anaphylaxis/allergy (OR 3.0), cardiac arrest (OR 13.8), convulsion/seizures (OR 1.8), diabetic problems (OR 1.6), traumatic cardiac arrest (OR 9.7), and unconscious/fainting (OR 1.8). The following categories had statistically significant lower rates of critical actions: AMS (OR 0.6), cardiac (OR 0.3), fall victim (OR 0.5), gastrointestinal (OR 0.1), medical not otherwise specified (NOS) (OR 0.2), respiratory (OR 0.9), cerebrovascular accident (CVA) (OR 0.5), syncope (OR 0.2), traffic accident (OR 0.6), weakness (OR 0.2), and not available (OR 0.6). The following categories had no critical

actions: flu-like symptoms, pregnancy, pronouncement, electric shock trauma, and spinal cord trauma. **Conclusions.** Critical interventions are required in only a small percentage of ALS calls. Increasing need for efficiency may require that more patients be treated in the prehospital setting with basic life support (BLS) scoop-and-run care. Determining which traditional ALS calls can be treated by BLS is important and requires prospective research.

46. UTILIZATION OF EMERGENCY MEDICAL SERVICES IN A LARGE URBAN AREA: DESCRIPTION OF CALL TYPES AND TEMPORAL TRENDS **Kevin Munjal, Robert A. Silverman, James Braun, Kaufman Bradley, John Freese, Doug Isaacs, David Prezant, Fire Department—City of New York**

Introduction. New York City (NYC) experienced a 14.22% increase in the number of 9-1-1 emergency medical services (EMS) calls from the years 1999 to 2007 compared with an approximately 3.3% population growth. The etiology of this increased utilization of EMS resources is unclear. **Objective.** To explore whether all types of calls uniformly increased or whether the rise in EMS utilization was due to an increase in specific medical problems. **Methods.** In NYC, emergency medical dispatchers classify calls into one of 91 distinct call types according to the nature of the emergency. The call type designation from all NYC 9-1-1 EMS calls between 1999 and 2007 were compiled into a single data set. All call types were grouped into eight categories of medical complaints for macroscopic analysis. The 91 call types were reduced to 53 for more specific analysis after grouping similar call designations and exclusion of those with insufficient number of calls to achieve significance. Statistical analysis was performed to describe temporal trends among the different categories and unique call types. **Results.** The total number of EMS calls between 1999 and 2007 (n) was 9,954,999. The yearly average was 1,106,111. The volume of calls rose by 14.22% from 1999 to 2007, with an average yearly increase of 1.68%. Among broad categories, the largest rise was among psychiatric/drug-related calls (60.32%, average 6.10%/year) and cardiac calls (25.38%, 2.92%/year). There were significant negative trends in violence calls (−23.01%, average −3.10%/year) and obstetric/gynecologic calls (−10.09%, −1.25%/year). Among specific call types, the most significant positive trends were in hypothermia (18.81% average annual rise), inhalation injury (10.65%), drug-related (7.85%), altered mental status (7.10%), and drowning (6.46%). The most significant negative trends were in motor vehicle accidents (−11.39% average annual decrease) minor traumatic injuries (−9.95%), asthma (−9.34%), gunshot wounds (−5.33%), and minor illness or flu symptoms (−4.80%).

Conclusions. There was an increase in EMS utilization in excess of what might be explained by rising population. This study has shown that all call types did not rise uniformly. Rather, there were significant increases and decreases among different call types, reflecting either changing medical needs or changing patterns of EMS utilization in NYC's population.

47. EFFECT OF ARRIVAL MODE TO THE EMERGENCY DEPARTMENT ON TIME TO EARLY GOAL-DIRECTED THERAPY OF THE SEPTIC PATIENT **Timothy Shiu, Thomas Sweeney, James Reed, Christiana Care Health Systems**

Background. There has been much attention focused on the role of emergency medical services (EMS) in the early identification, treatment, and rapid transport of patients with myocardial infarction, severe trauma, and strokes; however, little attention has been directed to patients with sepsis. Mortality from severe sepsis and septic shock approaches 50%, with over half of potentially septic patients being transported by EMS. **Objective.** To determine whether mode of arrival (advanced life support [ALS], basic life support [BLS], or walk-in) has any effect on time to early goal-directed therapy (EGDT) of the septic patient. **Methods.** Retrospective chart review was conducted of all consecutive patients meeting criteria for a hospital-system EGDT sepsis protocol between July 2007 and August 2008. Times of arrival to measurement of lactate level, administration of antibiotics, and central venous access were calculated for each patient. **Results.** One hundred patients were enrolled during the study period. Two patients were excluded, as mode of arrival could not be determined. Eighty percent of patients arrived by ambulance, with 50% of all patients having ALS level care. Time of arrival to lactate measurement was shorter in the ALS group than in the BLS and walk-in groups (57.3 ± 49.2 min vs. 133.4 ± 130.7 min, $p = 0.001$, and 131.3 ± 155.3 min, $p = 0.004$, respectively). Time of arrival to administration of antibiotic was also shorter in the ALS group compared with the BLS and walk-in groups (122.2 ± 65.8 min vs. 190.1 ± 100.1 min, $p = 0.001$, and 170.2 ± 97.7 min, $p = 0.02$, respectively). Time of arrival to central venous access was similarly shorter in the same groups (210.4 ± 92 min vs. 330.2 ± 151 min, $p < 0.001$, and 268.9 ± 128 min, $p = 0.07$). The mean initial lactate levels did not differ among the three groups. Mortality in the same groups were 26.5%, 20.7% and 10% ($p = 0.561$). **Conclusions.** This study demonstrates that a non-ALS mode of arrival predicts a marked delay in the identification of the septic patient (time to initial lactate measurement) and initiation of EGDT. Although ALS patients tended to be more acutely ill than their counterparts, BLS patients also had a high rate of mortality and the most

extended time to EGDT. Further education and development of early alert systems incorporating all tiers of the EMS system should be considered to improve the care of the potentially septic patient.

48. INTRAMUSCULAR GLUCAGON VERSUS RAPID TRANSPORT FOR PREHOSPITAL HYPOGLYCEMIA Eli Segal, Marc Afilalo, *Urgences-sante*

Introduction. Hypoglycemic coma can lead to serious and life-threatening complications. In prehospital systems without intravenous capability, intramuscular (IM) glucagon is the only therapeutic option. However, in urban settings, rapid transport to the hospital for intravenous therapy may lead to shorter recovery periods than prehospital IM glucagon. **Objective.** To compare times to normal glucose level and mental status for hypoglycemic patients in a basic life support (BLS) system who received either IM glucagon or supportive treatment (ST) and transport to the nearest hospital. **Methods.** Retrospective chart review was conducted of all patients with hypoglycemia and altered mental status during a 12-month period in an urban BLS service. Patients were treated by one of two groups of emergency medical technicians (EMTs): those with training in IM glucagon administration and those able to provide ST alone. The EMTs in the IM glucagon group were selected for training based on seniority, shifts worked, and availability. The EMTs in the ST group were matched for seniority and shifts worked. Dispatch of an ambulance to each call was determined by proximity, not level of training or ability to administer IM glucagon. Data from run sheets were extracted by research assistants, and all were reviewed by one author. Predefined variables were extracted into a standardized data abstraction form. Wilcoxon two-sample test was used to compare times between the two groups. **Results.** In the IM glucagon group there were 219 EMTs trained and 402 patient encounters, while in the ST group there were 169 EMTs and 97 patient encounters. Average ages of the patients in the two groups were similar (60 vs. 63 years). In the IM glucagon group, time to normal glucose level was available for 377 (94%) encounters and time to normal mental status was available for 382 (95%) encounters, while in the ST group, this information was available for 82 (85%) and 40 (41%), respectively. The median time to normal glucose level for the IM glucagon group was significantly less than that for the ST group: 31 minutes (interquartile range [IQR] 20–50) vs. 41.5 minutes (IQR 30–53), $p = 0.005$. The median time to normal mental status in the IM glucagon group was also significantly less than that for the ST group: 20.5 minutes (IQR 12–33) vs. 33.5 minutes (IQR 30–53), $p < 0.0001$. **Conclusions.** BLS EMT administration of IM glucagon for hypoglycemia with altered mental status leads to

a quicker recovery than rapid transport to the hospital for treatment in this urban setting.

49. A NATIONAL SURVEY: AEROMEDICAL EMERGENCY MEDICAL SERVICES AWARENESS AND PERCEPTION OF SEPSIS SYNDROMES Christopher E. Anderson, Robinder Jeet Singh Dhillon, Christopher S. Russi, *Mayo Clinic College of Medicine*

Introduction. Aeromedical emergency medical services (AEMS) organizations frequently transport patients with sepsis syndromes, which require time-critical diagnosis and treatment. The Surviving Sepsis Campaign (SSC) and early goal-directed therapy (EGDT) provide guidelines on diagnosis and management of sepsis syndromes. It is unknown how frequently AEMS personnel are able to correctly diagnose and treat patients with sepsis syndromes. **Objective.** To evaluate aeromedical managers' ability to correctly diagnose sepsis syndromes and knowledge of the published guidelines. **Methods.** A survey was disseminated electronically to managers of all U.S. AEMS organizations. The survey instrument contained questions regarding general program information, monitoring and diagnostic capabilities, current awareness, and practice of sepsis syndrome management. **Results.** AEMS managers were surveyed from March to July 2009. Of the 154 organizations surveyed, 88 responded (response rate = 57%). More than 90% of managers had over 10 years' work experience. AEMS managers were nurses (86%), paramedics (10%), physicians (6%), and other medical personnel (6%), with 9% having more than one certification. The most common working crew configuration was of a nurse and a paramedic (81%). AEMS managers reported familiarity (in %) in differentiating between systemic inflammatory response syndrome (SIRS) and sepsis (75%), sepsis and severe sepsis (76%), and severe sepsis and septic shock (85%). Of the EMS managers surveyed, 45% were unfamiliar with the 2008 SSC guidelines and 36% were unfamiliar with EGDT. Respondents were asked to correctly identify the sepsis syndrome in three multiple-choice simulated patient cases. SIRS, sepsis, and septic shock were correctly identified by 73%, 65%, and 80% of managers, respectively. In two additional cases, 97% of managers would appropriately initiate crystalloid fluid resuscitation in a patient with septic shock and 80% would appropriately initiate a vasopressor in a patient with septic shock refractory to fluid resuscitation. Formal training in the recognition and management of sepsis syndromes is provided by only 64% of AEMS organizations, with 62% receiving annual training. The others receive training once only, as needed, or on other schedules. **Conclusions.** Experienced AEMS managers are frequently unfamiliar with current guidelines for

identifying and managing sepsis syndromes. Early identification of sepsis by AEMS personnel will improve outcomes. AEMS personnel lack consistent formal training in recognition and management of sepsis syndromes.

50. IMPLEMENTATION OF STATEWIDE EMERGENCY MEDICAL SERVICES PROTOCOLS IS ASSOCIATED WITH A DECREASED USE OF FUROSEMIDE IN PATIENTS WITH SHORTNESS OF BREATH **Caroline A. Colleran, Douglas F. Kupas, Geisinger Health System, Department of Emergency Medicine**

Introduction. It is hypothesized that statewide emergency medical services (EMS) protocols lead to more consistent and evidence-based patient care. In 2007, new statewide protocols for patients with congestive heart failure (CHF) sought to minimize the EMS administration of diuretic by limiting furosemide to patients who already take a diuretic. **Objective.** We studied the effect of a statewide CHF protocol on the usage of furosemide for patients with suspected CHF. **Methods.** This retrospective study analyzed data from a statewide electronic database of EMS patient care reports. We compared data that included all patients transported to a receiving facility by an advanced life support (ALS) practitioner during two six-month periods, before and after the implementation of statewide ALS protocols on July 1, 2007. Because the diagnosis of CHF was not a specific data element in the database, we used surrogate elements of suspected illness reported as respiratory or cardiac symptoms, with and without nitroglycerin administration, to identify patient groups that contain those with CHF. The rates of furosemide use were compared in all patients, in those with suspected respiratory illness, and in those with suspected respiratory illness who also received nitroglycerin. Chi-square was used for all comparisons. **Results.** After implementation of the statewide protocols, there was a 35% reduction in the overall rate of furosemide use (1.00% [4,069/ 407,548] vs. 0.65% [2,770/ 425,030]; $p < 0.0001$). For patients with suspected respiratory illness who received nitroglycerin, the use of furosemide decreased by 24% (41.83% vs. 31.80%; $p < 0.0001$). For patients with suspected cardiac symptoms who received nitroglycerin, the use of furosemide decreased by 27% (4.95% vs. 3.60%; $p < 0.0001$). For cases of suspected respiratory illness or suspected cardiac symptoms, the furosemide use decreased by 36% and 35%, respectively (7.17% vs. 4.60%; $p < 0.0001$; and 2.87% vs. 1.86%; $p < 0.0001$), and there was no increase in the rate of online medical direction in these cases (36.9% vs. 37.5%; $p = 0.71$). **Conclusions.** In this statewide EMS system, implementation of statewide protocols was associated with decreased rates of furosemide use, both overall and in cases of

suspected respiratory or cardiac symptoms. This was accomplished without an increase in online medical direction in patients who received furosemide.

51. IS TREATMENT OF PREHOSPITAL HYPERTENSION NECESSARY? **Fritzgerald Estinfa, Howard Felderman, Brian Walsh, Morristown Memorial Hospital**

Background. The treatment of hypertension in the prehospital setting is controversial. It is unclear how accurate prehospital blood pressure (BP) readings are and whether BP routinely drops over the course of a patient's prehospital care without any intervention. **Objective.** To measure the effect of various interventions used to treat elevated BP in the prehospital setting. **Methods.** Setting: A suburban, two-tiered prehospital system primarily serving three hospitals. Protocol: The prehospital and emergency department (ED) charts of all patients evaluated by our advanced life support (ALS) providers between February 2007 and July 2009 with initial systolic BP (SBP) > 220 mmHg or diastolic BP (DBP) > 115 mmHg were reviewed. Patients were divided into groups based on their prehospital antihypertensive treatment: no treatment, nitroglycerin, labetalol, and metoprolol. Patients given more than one antihypertensive agent were excluded. The mean arterial pressures (MAPs) on paramedic initial evaluation and on initial evaluation in the ED were measured, and a percent change was calculated. BP changes between groups were compared using a Student t-test with statistical significance set at 0.05. **Results.** The charts of 229 patients with initial SBP > 220 mmHg or DBP > 115 mmHg were reviewed. Twenty patients were excluded because they received more than one antihypertensive medication, and 10 additional patients were excluded for missing data. In the no-treatment group, there were 90 patients with an average initial BP of 198/122 mmHg, and MAP decreased by 21%. In the nitroglycerin group, there were 85 patients with an average initial BP of 214/118 mmHg, and MAP decreased by 24%. In the labetalol group, there were 13 patients with an average initial BP of 208/124 mmHg, and MAP decreased by 17%. In the metoprolol group, there were 11 patients with an average initial BP of 212/117 mmHg, and MAP decreased by 16%. The decrease in MAP was no different for patients getting treatment and those getting no treatment, and there were no statistically significant differences between any of the treatment groups. **Conclusions.** Even without treatment, patients with markedly elevated BPs experience a significant decline in BP over the course of their prehospital care. Furthermore, specific treatments do not result in additional declines on initial evaluation in the ED. Outcome-based studies are needed to confirm that prehospital antihypertensive medications provide no significant benefit.

52. ARE INTRAVENOUS CATHETERS NECESSARY FOR ALL ADVANCED LIFE SUPPORT TRANSPORTS? Joseph Orloski, Howard Felderman, Brian Walsh, Morristown Memorial Hospital

Introduction. One of the most common advanced life support (ALS) skills performed by paramedics is the placement of intravenous (IV) catheters, but many of these catheters may not be necessary. Previous studies in this area are limited to one-tiered emergency medical services (EMS) systems. **Objective.** Our study attempted to identify patients likely to benefit from IV catheter placement (those with high initiation rates and high utilization rates) and those in which IV catheter placement may be withheld (those with high initiation rates and low utilization rates) in two-tiered EMS systems. **Methods.** We compared the chief complaints of patients transported by paramedic units to determine the IV initiation rates and IV utilization rates in a two-tiered, suburban EMS system. We retrospectively reviewed consecutive ALS transports over 30 months. Prehospital charts were reviewed for each chief complaint to determine whether an IV line was established and whether it was utilized. An IV line was considered utilized if it was documented that either an IV medication was administered or the patient received IV hydration en route to the hospital. We computed odds ratios (ORs) and 95% confidence intervals (CIs) for the initiation of an IV line (OR_i) and utilization of an established IV line (OR_u). **Results.** Of the 10,671 paramedic transports, an IV line was initiated for 6,850 (64%) patients. Of those patients who had an IV line, it was utilized in 3,156 (46%). The chief complaints demonstrating statistical significance for both high IV initiation rates and high utilization rates of placed IV catheters were the following (expressed as OR_i, OR_u): cardiac arrest (20.0, 19.9), chest pain (1.6, 3.0), diabetic problem (1.8, 6.1), dyspnea (1.2, 1.5), and unresponsiveness (3.1, 1.7). The chief complaints demonstrating statistical significance for high IV initiation rates and low IV utilization rates were the following: altered mental status (2.2, 0.7), automatic implantable cardioverter-defibrillator (AICD) discharge (17.9, 0.4), cerebrovascular accident (CVA) (2.1, 0.2), gastrointestinal (GI) bleeding (1.8, 0.5), syncope (1.8, 0.4), and weakness (1.5, 0.5). **Conclusions.** Identification of patients who are likely to need IV lines may help avoid the placement of unnecessary IV catheters. Prospective, outcome-based studies are needed to determine whether patients have worse outcomes if IV catheters are not placed in the prehospital setting.

53. PULMONARY DYSFUNCTION IS COMMON AFTER CARDIAC ARREST Matthew J. Stull, Xiaoyi Teng, Clifton W. Callaway, Francis X. Guyette, Jon C. Rittenberger, University of Pittsburgh School of Medicine

Introduction. Pulmonary injury following out-of-hospital cardiac arrest (OHCA) is common but in-

completely described. **Objective.** To characterize and determine the incidence of chest x-ray (CXR) abnormalities and pulmonary dysfunction in patients after OHCA. **Methods.** Retrospective chart review of patients suffering OHCA between January 1, 2005, and December 31, 2008, was performed after institutional review board (IRB) approval. Radiology interpretations of initial and 24-hour CXR abnormalities were recorded. Clinical data included use of hypothermia, antibiotic treatment, the ratio of PaO₂/FiO₂ ratio obtained within eight hours of the CXR, and survival to discharge. The PaO₂/FiO₂ ratio was coded as severe pulmonary dysfunction (SPD; PaO₂/FiO₂ <200), moderate pulmonary dysfunction (MPD; PaO₂/FiO₂ = 201–300), or normal (PaO₂/FiO₂ >300). Statistical comparisons between groups were assessed using chi-squared analyses. **Results.** Of 207 subjects, 201 (97.1%) had an initial CXR, 183 (88.4%) had repeat CXR, 128 (61.8%) had initial blood gas values, and 83 (40.1%) had repeat blood gas values; and 87 of 198 (43.9%) patients survived to discharge. On initial CXR, 128 (61.8%) patients presented with an abnormality, including pulmonary edema (27.1%), atelectasis (20.4%), and consolidation (15.4%). SPD was initially present in 54 of 128 (42.2%) patients and 38 of 83 (45.8%) on repeat arterial blood gas (ABG) testing. MPD was initially present in 22 of 128 (17.2%) patients and 21 of 83 (25.3%) on repeat ABG testing. In patients receiving hypothermia therapy (*n* = 111, 54%), there were no differences in CXR abnormalities compared with normothermic patients (59% vs. 41%, $\chi^2 = 1.86$, *p* = 0.17). Consolidation (27% vs. 10%, $\chi^2 = 7.96$, *p* < 0.01) was more common on repeat CXR in the hypothermic cohort. Neither MPD nor SPD was more common in hypothermic patients than normothermic patients (MPD: 20% vs. 12%; SPD: 45% vs. 37%, $\chi^2 = 11.5$, *p* = 0.22). Patients with consolidation on initial CXR were treated with antibiotics in 15 of 31 (48.4%) cases. **Conclusions.** Lung injury after OHCA is common. SPD develops in over 40% of patients after OHCA. Hypothermic patients are more likely to demonstrate a consolidation on 24-hour CXR, but did not demonstrate increased rates of SPD or MPD. There is variability in clinical use of antibiotics in OHCA with consolidations on CXR.

54. GENDER DIFFERENCES IN TOTAL ISCHEMIC TIME DETERMINED BY THE USE OF PREHOSPITAL ELECTROCARDIOGRAPHY IN PATIENTS WITH COMPLAINT OF CHEST PAIN Steve A. Aguilar, James P. Dunford, Edward M. Castillo, Roger Fisher, Ginger Ochs, Ekta Patel, UC San Diego, Department of Emergency Medicine

Introduction. Cardiovascular disease remains a leading cause of mortality in the United States, with an estimated 864,480 deaths occurring in 2005. **Objective.** To measure and compare the impacts on total ischemic time with the introduction of a prehospital (PH)

electrocardiography (ECG) protocol between men and women with initial complaint of chest pain. **Methods.** We retrospectively analyzed the City of San Diego computer-assisted dispatch (CAD) and emergency medical services (EMS) runsheets of patients with initial complaint of chest pain between January 2003 and April 2008. The time between arrival and departure of the first unit on scene was recorded as the scene time (ST). Transport time (TT) was recorded as the time from departure from the scene to arrival at the accepting emergency department. The overall interval from first arrival on scene to arrival at the hospital was defined as arrival to hospital (A2H) time. The average STs, TTs, and A2H times were compared before and after implementation of the PH ECG protocol. After stratification by gender, times were compared in patients with ST-segment elevation myocardial infarction (STEMI) and non-ST-segment elevation myocardial infarction (NSTEMI). **Results.** There were 21,742 EMS activations for chest pain. When comparing before and after implementation of the PH ECG protocol, there were no statistically significant difference in ST (all times are expressed in hours:minutes:seconds) (00:19:50 vs. 00:19:57, $p > 0.05$), TT (00:14:01 vs. 00:14:08, $p > 0.05$), or A2H time (00:33:50 vs. 00:34:06, $p > 0.05$) overall. When stratified by NSTEMI and gender, there was a significant reduction of ST (00:19:16 vs. 00:20:48, $p < 0.000$, 95% confidence interval [CI] 00:01:17– 00:01:48) and A2H time (00:33:22 vs. 00:35:44, $p < 0.000$, 95% CI 00:01:21– 00:02:24) favoring male patients. In cases of STEMI, male patients again had a significant reduction of ST (00:17:27 vs. 00:20:29, $p < 0.000$, 95% CI 00:01:24– 00:04:40) and A2H time (00:30:30 vs. 00:34:25, $p < 0.01$, 95% CI 00:01:23– 00:06:26) compared with female patients. **Conclusions.** Male patients had significantly reduced STs and A2H times when compared with female patients. These differences may be reflection of a gender bias in prehospital management. We demonstrated that our EMS system has successfully implemented a PH ECG protocol that can successfully reduce total ischemic time; however, it is not fully utilizing its potential to reduce total ischemic time equally between the sexes.

55. TREATMENT COURSES FOR ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION ALERT PATIENTS J. Lee Garvey, Lisa Monk, Jonathan R. Studnek, Mayme Lou Roettig, Christopher B. Granger, James G. Jollis, Carolinas Medical Center

Introduction. Institutional and regional response networks are known to speed time to treatment for ST-segment elevation myocardial infarction (STEMI). Such STEMI alerts require mobilization of significant resources. However, some STEMI alert activations do not result in patients' receiving reperfusion by pri-

mary percutaneous coronary intervention (PCI). **Objective.** To follow the course of treatments for patients with STEMI alert activations to determine the proportion of cases cancelled or deemed inappropriate. **Methods.** From December 2008 through May 2009, 14 PCI-capable hospitals participating in the Reperfusion of Acute Myocardial Infarction in North Carolina Emergency Departments–Emergency Response (RACE-ER) initiative prospectively reported treatment courses for consecutive STEMI alert patients. STEMI alerts occurred based on prehospital or emergency department (ED) clinical and electrocardiogram (ECG) data. STEMI alerts were considered cancelled if the patient was not taken to the cardiac catheterization laboratory (CCL). STEMI alerts were considered "overactivations" if the cancellation was due to discrepancies regarding the ECG diagnosis, or if the patient was deemed not to be a candidate for cardiac catheterization. **Results.** Two thousand two hundred thirteen patients (median age 60 years, 70% male) had STEMI alerts, with 1,778 (80%) undergoing angiography. Of those, 1,284 (72%) had primary PCI, 207 (12%) had no significant coronary artery disease (CAD), 105 (6%) had rescue PCI, 88 (5%) required bypass surgery, 65 (4%) were managed medically, and 13 (0.7%) experienced reperfusion following fibrinolytic therapy. STEMI alerts were cancelled in 388 cases (17%). Of those, 283 (73%) were classified as "overactivations," with 88 (4% of total activations) deemed not to be CCL candidates, 95 (4.2%) due to discrepancies regarding STEMI diagnosis on prehospital ECG, and 100 (4.5%) due to discrepancies regarding STEMI diagnosis on ED ECG. A further 21 (0.9%) patients died, 37 (1.7%) had resolution of symptoms or change in clinical status, and 44 (2%) had STEMI alerts cancelled for other unspecified reasons. **Conclusions.** Overactivation of the STEMI alert systems occurred in low proportions because of prehospital ECG, ED ECG, and CCL candidacy issues. Collectively, however, these overactivations result in some inefficiency in system resource use. Refinement of these issues in STEMI alert activations may help enhance system efficiency while retaining rapid STEMI network performance.

56. CAN ELECTROCARDIOGRAMS BE TRANSMITTED QUICKLY AND RELIABLY VIA A CELL PHONE CAMERA FROM THE FIELD TO AN EMERGENCY DEPARTMENT? Jason Porter, Marcy Rosenberg, Christine Van Dillen, Andrew Parrish, Vanessa Vasquez, George A. Ralls, Linda Papa, Salvatore Silvestri, Orlando Regional Medical Center

Introduction. It has previously been shown that photos of electrocardiograms (ECGs) taken with a smartphone camera provide adequate electronic images to make decisions regarding treatment plans of ST-segment elevation myocardial infarction (STEMI) vs.

non-STEMI. However, this has not yet been demonstrated with real-time field transmission of similar images. **Objective.** To determine the speed and reliability of cell phone transmission technology of 12-lead ECG images from an out-of-hospital location to the emergency department (ED). **Methods.** The study setting was a large urban regional emergency medical services (EMS) system. A smartphone was used to take an image of a 12-lead ECG from an out-of-hospital location. Transmission of the ECG occurred from a site where a recent patient transport had originated. Up to two addresses were randomly selected from the 9-1-1 call log from 62 different fire station first-due jurisdictions. The cell phone image was transmitted in real time from the out-of-hospital site origin to a dedicated web address at the ED, where a study investigator received the image. The study investigator calculated the success of transmission as well as the transmission time. The transmission time recording was stopped when an interpretable 12-lead ECG was available on the web site. Descriptive and comparative statistics will be used to evaluate the data using Microsoft Excel, SAS, and STATA. **Results.** Images were obtained from 109 different 12-lead ECGs from 109 different out-of-hospital locations and transmitted to the study ED. The initial attempt transmission rate was 100%, with 100 of 109 (91.7%) transmitted in <2 minutes, seven of 109 (6.4%) transmitted in 2 to 4 minutes, and two of 109 (1.8%) transmitted in >4 minutes. The mean transmission time (\pm standard deviation) was 1.33 (\pm 0.54) minutes, with a range of 0.58 to 5.04 minutes. **Conclusions.** In the out-of-hospital setting we evaluated, transmission of 12-lead ECG images is quick and reliable. Future studies should focus on the impact of real-time use of ECG transmission via cell phone technology.

57. GENDER DISPARITIES IN THE TIME FROM PARAMEDIC ARRIVAL TO IDENTIFYING ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION **Margaux Snider, Debra Resurreccion, Diane McGinnis-Hainsworth, James F. Reed, Ross Megargel, Christiana Care Health Services**

Introduction. The time to identification of an acute ST-segment elevation myocardial infarction (STEMI) in the prehospital setting has the potential to impact the time to definitive treatment. **Objective.** To examine whether a patient's gender impacted the time to identification of this life-threatening condition. **Methods.** A retrospective analysis of the data on STEMI patients obtained from the emergency medical service (EMS) system of the State of Delaware was performed. All patients who were identified by electrocardiography as having a STEMI were then evaluated to determine time from paramedic arrival to formal identification of the STEMI. EMS records from 2007 then identified the patient's age, gender, and ethnicity. Statistical comparisons of time to identification were made across these

listed categories. **Results.** In 2007, 262 patients were identified by EMS as having a STEMI. Of the 262 patients, 154 were male and 108 were female. The average (\pm standard deviation) time to STEMI identification in male patients was 6.9 minutes \pm 6 minutes, whereas for female patients it was 9.6 minutes \pm 6.5 minutes. This difference was statistically significant, with a p-value of 0.001. **Conclusions.** Cardiovascular disease is not only the leading cause of death in women in the United States, it is responsible for a third of all deaths in women older than 50 years in all developing countries. As such, identification of STEMI, a deadly sequela of cardiovascular disease, is very important. Studies have identified that women frequently have different clinical presentations than men with acute coronary syndrome, making early identification that much more difficult. Our data suggest that gender disparities in STEMI identification in the prehospital setting do exist in this population. These data have important implications as education of out-of-hospital responders regarding atypical clinical presentation might have the potential to impact future findings.

58. ASSESSMENT OF THE IMPACT OF PREHOSPITAL 12-LEAD ELECTROCARDIOGRAPHY ON TIME TO REPERFUSION FOR PATIENTS WITH ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION IN SAGUENAY, QUEBEC **Royer Sandrine, Maynard Olivier, CSSS Chicoutimi**

Introduction. There is an inverse relationship between speed of access to percutaneous transluminal coronary angiography (PTCA) in patients with ST-segment elevation myocardial infarction (STEMI) and mortality/morbidity. Systematic use of prehospital 12-lead electrocardiography (ECG) allows STEMI patients to be transported directly to a hospital with PTCA capability, instead of to an outlying care facility for diagnosis and subsequent transfer to a specialized center. **Objective.** To determine whether the use of prehospital 12-lead ECG reduced the time between emergency medical services (EMS) personnel management of the patient and PTCA, specifically in a rural area (Saguenay). **Methods.** We conducted a retrospective study from January 2005 to January 2009, before and after the systematic use of 12-lead ECG by EMS personnel. The program was started on April 2007 and patients from outlying areas were transported directly to the Chicoutimi hospital, where the exclusion criteria were applied. Descriptive and inferential statistical analyses of the time lapse between the call to the EMS system and PTCA were performed for all STEMI ambulance-transported patients admitted to the Chicoutimi hospital and who subsequently underwent PTCA ($n = 115$). **Results.** There was a significant reduction in time to PTCA for patients transported directly from the outlying area to the PTCA center (20-minute reduction; $p = 0.050$). The time for patients living near the PTCA

center was also significantly reduced (15-minute reduction; $p = 0.04$) after introduction of prehospital 12-lead ECG. **Conclusions.** Management of patients with STEMI has been accelerated and time to PTCA significantly reduced since prehospital 12-lead ECG has been used in Quebec's Saguenay region.

59. IMPLEMENTATION OF STATEWIDE EMERGENCY MEDICAL SERVICES PROTOCOLS IS ASSOCIATED WITH INCREASED USE OF ANALGESIA IN PATIENTS WITH SUSPECTED FRACTURES **Caroline A. Colleran, Douglas F. Kupas, Geisinger Health System, Department of Emergency Medicine**

Introduction. Pain is the most common symptom in patients treated by emergency medical services (EMS), and providing appropriate analgesia is an important part of patient care. In 2007, a new statewide protocol for patients with extremity injury was instituted, adding standing orders for analgesia in regions of the state that previously required online medical contact for these medications. **Objective.** We hypothesized that this statewide protocol would increase the rate of administration of analgesia to patients with suspected extremity fracture. **Methods.** This retrospective study analyzed data from a statewide electronic database of 1.8 million EMS patient care reports annually. We compared data that included all patients transported to a receiving facility by an advanced life support (ALS) practitioner during two six-month periods, before and after the implementation of statewide ALS protocols on July 1, 2007. Potential analgesic medications included morphine, nitrous oxide, and other medication (e.g., fentanyl) as documented by EMS personnel. Analgesic use was compared, before and after protocol implementation, in patients with the reported injury type of "fracture/dislocation" of the extremity or EMS treatment of splinting (data elements included extremity splint or traction splint). Chi-square test was used for all comparisons. **Results.** When comparing the study periods, analgesic use increased for patients with the injury type of fracture/dislocation (27.7% of 5,009 vs. 31.3% of 4,910; $p < 0.0001$), with treatment of splinting of the extremity (23.8% vs. 28.5%; $p < 0.0001$), and with traction splinting (47.2% vs. 56.7%; $p = 0.06$). Patients from counties classified as rural had a higher rate of analgesic use for fracture/dislocation injury type than those classified as urban for both time periods (before protocol = 35.3% vs. 23.9%; after protocol = 40.9% vs. 26.8%). The rate of analgesic use for the subgroup of patients aged 0–14 years was 30.0% of 464 vs. 31.8% of 443; $p = 0.54$. **Conclusions.** In this statewide EMS system, implementation of statewide protocols was associated with an increased rate of analgesic administered by EMS in patients with suspected fractures. Patients in rural counties were more likely to receive analgesia before and after implementation of a statewide protocol.

60. REVISITING THE SHOCK INDEX: DOES IT HAVE A ROLE IN PREHOSPITAL TRAUMA CARE? **John Ligon Coyner, Derrel D. Graham, Jeremy Burnham, Simon A. Mahler, Louisiana State University Health Sciences Center-Shreveport**

Objectives. To determine whether an elevated shock index (SI)—heart rate/systolic blood pressure—in the prehospital setting correlates to admission to the hospital. Additionally, to determine whether an elevated SI correlates to admission to an intensive care unit (ICU) setting or the need for emergency surgery, thus indicating the need for transport to a level I trauma center. **Methods.** A retrospective chart review was performed. All trauma patients for the calendar year of 2007 transported to a level I trauma center by the sole provider of advanced life support (ALS) transport in the city were reviewed. Patients who were 18 years of age or older and had at least one set of prehospital vital signs recorded were included. Patients who were in arrest were excluded. Prehospital charts were linked to hospital data to determine patient outcome. Student t-test was used to compare groups. **Results.** Of 948 patient care records reviewed, 33 were excluded because of incomplete data. A total of 915 patients were included in the analysis. Three hundred ninety-one patients were in the admitted group and 524 were discharged from the emergency department (ED). The mean SI for the admitted group was 0.77 (95% confidence interval [CI] 0.75–0.80) compared with 0.72 (95% CI 0.71–0.74) for those discharged from the ED ($p < 0.001$). The mean SI for the combined endpoint of intensive care unit (ICU) admission or emergency surgery was 0.89 (95% CI 0.79–0.98) compared with a mean of 0.74 (95% CI 0.72–0.75) for patients not requiring ICU admission or emergency surgery ($p = 0.005$). **Conclusions.** Although there is a statistically significant difference in the mean SI scores for patients admitted to the hospital, the difference is small and not likely clinically useful. The mean SI for ICU admission and emergency surgery is also significant and may be clinically useful when combined with other triage criteria used in prehospital care.

61. MOTOR VEHICLE INTRUSION ALONE POORLY PREDICTS THE NEED FOR TRAUMA CENTER RESOURCES **Derek L. Isenberg, David C. Cone, Yale University School of Medicine**

Background. The U.S. Centers for Disease Control and Prevention (CDC) published the *Guidelines for Field Triage of the Injured Patient* in January 2009. One of the "mechanism of injury" criteria in the CDC guidelines is motor vehicle intrusion of 12 inches at the occupant site, or 18 inches at any site. **Objective.** To evaluate the sensitivity, specificity, and positive predictive value (PPV) of intrusion as to need for a trauma

center. **Methods.** Data were extracted from prehospital patients care reports (PCRs), emergency department (ED) records, and hospital records of patients who presented by ambulance to a level I trauma center between July 2007 and June 2008 with injuries sustained in motor vehicle collisions (MVCs). Patients who had a completed prehospital PCR and ED chart were included in the study. Sensitivity, specificity, and PPV were calculated for hospital admission, and for trauma center resource use, defined as any surgical intervention, intracranial hemorrhage, or admission to an intensive care unit. **Results.** Four hundred seventy-four patients were included in our analysis, of whom 38 (8%) met intrusion criteria only (did not meet any anatomic, physiologic, or other mechanism of injury criteria). Fourteen patients (3%) in the no-intrusion group and 12 patients (32%) in the intrusion group were admitted. The sensitivity, specificity, and PPV of intrusion for admission were 46%, 94%, and 31%, respectively, and for utilization of trauma center resources were 66%, 93%, and 10%, respectively. This study was limited by the large number of PCRs that were unavailable. While EMS providers were visually estimating (not measuring) motor vehicle intrusion, this is how this criterion is typically used. **Conclusions.** Our data suggest that motor vehicle intrusion criteria, by themselves, are neither sensitive nor highly predictive of the need for hospital admission or trauma center resources.

62. SPINAL BOARD IMMOBILIZATION MAY BE ASSOCIATED WITH PERSISTENT PAIN AFTER MOTOR VEHICLE CRASH Robert Swor, Young Lee, Stacey Anderson, Jeff Jones, Robert Domeier, Sam McLean, William Beaumont Hospital

Introduction. Previous work has centered around whether spinal immobilization may be deferred from emergency medical services (EMS) care after a motor vehicle crash (MVC). **Objective.** To assess whether spinal immobilization is associated with persistent pain in MVC patients transported by EMS. **Methods.** This is a secondary analysis of a cohort of patients enrolled in project CRASH, an ongoing multicenter trial whose purpose is to identify predictors of chronic pain after MVC. Patients who are involved in a "minor" MVC (patients discharged from the emergency department [ED]) are interviewed by research associates in the ED using a structured interview tool. Patient demographics, event characteristics, severity of neck pain (0–10 scale), method of transport to the ED (EMS, other), income (>\$30,000 or <\$30,000 annually), and whether a backboard was used are recorded. ED assessment of psychological response to the MVC includes the Peritraumatic Distress Index (PDI) and the Michigan Critical Events Perceptions Scale (MCEPS). A structured telephone interview one month after the

event is performed to assess for persistent neck pain (0–10 scale) and posttraumatic stress disorder (PTSD) symptoms (Impact of Event Scale–Revised [IES-R]). Our primary outcome was pain persistence at one month. Pain was dichotomized as moderate/severe if pain score was >4; significant posttraumatic stress disorder symptoms were defined as IES-R score >33. Parametric and nonparametric tests were used for analysis. **Results.** Thus far, 94 patients were transported by EMS and have been included. Of these, 57 (61.6%) were placed on a backboard on arrival. Backboarded patients were similar for age, educational level, ethnicity, and perceived distress on ED arrival. They were more often female (72% vs. 46%, $p = 0.02$), had incomes <\$30,000 (63.6% vs. 35.1%, $p = 0.01$), and had greater mean neck pain (4.4 vs. 3.4, $p = 0.01$). At one month, a greater proportion of backboarded patients had moderate to severe pain, 42.1% vs. 13.9% (relative risk [RR] = 1.49; 95% confidence interval about the RR = 1.15–1.92). There was not an increased proportion with PTSD at one month (IES-R >33, 25.3% vs. 18.8%, $p = 0.44$). **Conclusions.** In this preliminary analysis, backboarded patients had a higher degree of pain persistence at one month. Further work is needed to assess whether this represents a clinical effect, or is associated with other variables predictive of pain persistence.

63. PREDICTING TRAUMA CENTER NEED USING THE MECHANISM OF INJURY CRITERIA E. Brooke Lerner, Manish N. Shah, Robert Swor, Jeremy T. Cushman, Karen Brasel, Clare Guse, Alan Blatt, Gregory J. Jurkovich, Medical College of Wisconsin

Objective. To determine the best criteria for using mechanism of injury (MOI) to predict trauma center need. **Methods.** Emergency medical services (EMS) providers caring for injured adult patients transported to the regional trauma center in three midsized communities were interviewed upon emergency department (ED) arrival over two years. Included was any injured patient, regardless of injury severity. The interview collected patient physiologic condition, apparent anatomic injury, and MOI. Using the 1999 American College of Surgeons Field Triage Scheme, patients who met the physiologic or anatomic steps were excluded. Patients were considered to need a trauma center if they had nonorthopedic surgery within 24 hours, had intensive care unit (ICU) admission, or died. Data were analyzed by calculating receiver-operating characteristic (ROC) curves for each estimated MOI criteria. The value with the highest positive likelihood ratio (+LR) was identified as the ideal cutpoint and compared with the value used in the Field Triage Scheme. **Results.** 11,892 patients were enrolled. Two were excluded because outcome data were not available and 2,410 were excluded because they

met the physiologic or anatomic step of the Scheme. The patients whose mechanism was pedestrian or bicyclist struck, speed of ≥ 55 mph, had a higher +LR (30.6) than those with a speed of >5 mph (1.0). Those who fell from a height of ≥ 35 feet had a higher +LR (12.4) than those who fell from >20 feet (5.3). Those in a motorcycle crash with an estimated initial speed of ≥ 80 mph (19.6) had a higher +LR than those >20 mph (1.2). Those who were in a motor vehicle crash with an estimated initial speed ≥ 100 mph (5.8) had a higher +LR than those >40 mph (2.0), intrusion of ≥ 66 inches (12.0) had a higher +LR than >12 inches (4.2), deformity of ≥ 66 inches (5.3) had a higher +LR than >20 inches (2.5), a rollover with eight quarter turns (1.7) had a higher +LR than one quarter turn (1.0), and extrication time ≥ 80 minutes (43.1) had a higher +LR than >20 minutes (5.1). **Conclusions.** Changing the cutpoints used to identify patients who need a trauma center will improve the accuracy of the MOI criteria of the Field Triage Scheme. However, even using the ideal cutpoint, many of the MOI criteria are not reliable predictors of trauma center need.

64. SHOULD LABETALOL BE USED IN THE PREHOSPITAL SETTING TO TREAT HYPERTENSION? Alex Bray, Howard Felderman, Brian Walsh, *Morristown Memorial Hospital*

Background. The treatment of hypertension in the prehospital setting is controversial. Labetalol is used by our advanced life support (ALS) providers, but there are limited data evaluating its safety and efficacy in the prehospital setting. **Objectives.** Our primary objective was to determine whether the administration of labetalol induced hypotension and/or bradycardia when given to hypertensive patients in the prehospital setting. As secondary objectives, we sought to determine what percentage of patients given labetalol had a good clinical response. **Methods.** We conducted a retrospective review of consecutive patients from a suburban emergency medical services (EMS) system over a 30-month period who were treated with labetalol. Vital signs on initial evaluation and on arrival at the emergency department (ED) were recorded. A hypotensive response was defined as a decrease in mean arterial pressure (MAP) $>25\%$. Bradycardia was defined as an arrival heart rate (HR) <60 beats/min. A good clinical response was defined as a decrease in blood pressure (BP) between 10% and 25%. Descriptive statistics and 95% confidence intervals (95% CIs) were calculated. **Results.** There were 118 patients who received labetalol during the 30-month period; one was excluded from the study because of insufficient data. Of the remaining 117 patients, the average initial systolic BP was 213 mmHg (standard deviation [SD]: 29), the average initial diastolic BP was 122 mmHg (SD: 21). Mean initial HR was 97 beats/min

(range 62–168 beats/min, SD: 21). Patients received an average total dose of labetalol of 13.4 mg (range 5–40 mg). No patients become bradycardic. Twenty-one patients (18%; 95% CI: 11–25%) had an excessive drop in BP. A good clinical response was seen in 48 patients (41%; 95% CI: 32–50%). **Conclusions.** Labetalol administration in the prehospital setting was associated with a high rate of excessive BP decreases. Until prospective studies show its use in the prehospital setting to be safe and effective, we recommend limiting its use significantly.

65. ANALYSIS OF ABNORMAL EVENTS IDENTIFIED BY THE INTEGRATED PULMONARY INDEX IN NORMAL ADULTS DURING NONINVASIVE POSITIVE PRESSURE VENTILATION Jonathan B. Waugh, Arthur A. Taft, Kathleen H. Niebel, *University of Alabama at Birmingham*

Introduction. Noninvasive positive pressure ventilation (NPPV) is increasingly used outside of critical care units and commonly relies on noninvasive methods to monitor respiratory status such as capnography and pulse oximetry, data from which can be difficult to interpret. A novel respiratory index, the Integrated Pulmonary Index (IPI), calculated from respiratory rate (RR), end-tidal carbon dioxide (etCO₂), heart rate (HR), and pulse oxygen saturation (SpO₂) has been developed to ease interpretation. **Objective.** This study evaluated the ability of the IPI to predict ventilatory events in normal adults undergoing NPPV. **Methods.** This institutional review board (IRB)-approved study with informed consent enrolled 40 adult volunteers with normal spirometry and body temperature (ages 21–42 years; 65% white; 28 women) at two academic medical centers. Patient data were recorded in 5-second increments while the patients were breathing at rest on NPPV (Vivo 40, Breas) at three pressure levels (continuous positive airway pressure [CPAP] +5 cmH₂O, bilevel positive airway pressure [BiPAP] +10/+5 cmH₂O, and BiPAP +20/+5 cmH₂O) using three brands of masks (FlexiFit 431, Fisher & Paykel [FP]; Mirage Quattro, ResMed [RM]; and Performa-Trak, Respironics [RP]). The patient parameters were measured with a Capnostream 20 monitor (Oridion Capnography Inc.) using a nasal/oral sampling cannula under the NPPV masks. The greatest IPI deviations from normal range were determined by the IPI magnitude and duration of abnormal IPI value. **Results.** The table shows the three subjects from each site (six total) with the greatest deviations from normal (IPI of 8–10). **Conclusions.** These findings indicate that the integration of the capnography and oximetry values into one parameter in the form of the IPI appears to allow noninvasive detection of overventilation during NPPV as well as underventilation, which is not easily determined from traditional capnography or pulse oximetry.

| Subject | No. of IPI | Events IPI Range | Events Total Duration | Contributing Factors |
|---------|------------|------------------|-----------------------|-------------------------------|
| | Events | | | |
| 1 | 5 | 4-6 | 2,850 sec | Overventilation |
| 2 | 5 | 4-7 | 780 sec | Overventilation and/or low HR |
| 3 | 5 | 5-7 | 430 sec | Overventilation and/or low RR |
| 4 | 5 | 4-7 | 660 sec | Overventilation and/or low HR |
| 5 | 10 | 3-7 | 1,800 sec | Overventilation |
| 6 | 4 | 5-7 | 430 sec | Overventilation |

66. AN ASSESSMENT OF STATE-LEVEL PREHOSPITAL TREATMENT PROTOCOLS FOR CHILDREN **Toni K. Gross, Cristina Novak, Dennis Durbin, The Children's Hospital of Philadelphia, Leonard Davis Institute**

Introduction. The recent Institute of Medicine report highlighted the need for coordination of emergency medical services (EMS) systems within the United States, along with the need for evidence-based model prehospital care protocols. The National Association of EMS Physicians (NAEMSP) developed evidence- and consensus-based model pediatric protocols for 24 conditions. **Objective.** To determine the presence and diversity of prehospital care protocols for children among state lead EMS agencies. **Methods.** EMS websites for all 50 states and the District of Columbia were accessed and inspected for the presence of state-level prehospital treatment protocols. All available protocols were downloaded and reviewed by study personnel. Presence of a protocol for each NAEMSP condition was the primary outcome. Also noted were the presence of adult protocols, presence of protocols for other conditions, and format of protocols. Descriptive statistics were used to describe study variables. Similar data from states without web-published protocols are currently being collected via questionnaire. **Results.** Thirty-eight (75%) state websites provided state-level prehospital treatment protocols. Few states had pediatric protocols for the majority of NAEMSP conditions. Conditions for which a majority of states had pediatric protocols included child-birth/newborn resuscitation (74%), seizures (74%), respiratory distress/failure/arrest (68%), anaphylactic shock/allergic reaction (59%), and bradycardia (53%). Almost one-third of states had protocols for additional pediatric conditions, including tachycardia, heat emergencies, hypothermia, hypoglycemia, suspected abuse/neglect, and poisonings. **Conclusions.** Although model pediatric protocols exist for a variety of conditions, a minority of states had such protocols in place. Future efforts should remain focused on improving the dissemination of existing model protocols and creating evidence-based model protocols for other conditions.

67. PREVALENCE AND DIVERSITY OF PEDIATRIC PREHOSPITAL PAIN MANAGEMENT PROTOCOLS AT THE STATE LEVEL **Cristina Novak, Toni K. Gross, Dennis Durbin, University of Pennsylvania**

Background. Pain relief is clinically important in pre-hospital medicine. The National Association of EMS Physicians (NAEMSP) recommends that all emergency medical services (EMS) systems have a protocol for pain management and has published a model protocol for pediatric pain management. **Objectives.** To assess the prevalence of pain management protocols for pediatric patients among state lead EMS agencies and to describe the variability of protocols, specifically regarding pain assessment and treatments. **Methods.** We conducted a descriptive analysis of state-level EMS prehospital treatment protocols by review of the EMS website for each state and the District of Columbia (DC). Available protocols were downloaded and reviewed by investigators. The primary outcome was presence of a pediatric pain management protocol. Secondary outcomes were inclusion of a pain assessment tool and details of pharmacologic and non-pharmacologic interventions. Data were analyzed using descriptive statistics. Data from states without web-published protocols are currently being collected via questionnaire. **Results.** Pediatric prehospital treatment protocols were available from 38 of 51 (75%) states and DC. Of these, 13 (34%) had pain management protocols. Four (31%) included a pain assessment tool. All 13 included opioid medications, and four (31%) included nonopioid medications. Two (15%) included antiemetic medications. All 13 provided for intravenous administration of medications, eight (62%) for intramuscular administration, four (31%) for subcutaneous administration, two (15%) for intranasal administration, and none for medications given by mouth. Nonpharmacologic interventions, such as splinting, elevation, ice, and distraction, were included in five (38%) protocols. **Conclusions.** Only one-third of states with published pediatric prehospital protocols possess a protocol for pain management. Among these protocols, there is a deficiency in pain assessment tools and considerable variation in nonopioid medications. To ensure a standard of care for treating pediatric pain in the prehospital setting, national organizations should continue to improve dissemination and implementation of the available model treatment protocol.

68. PARAMEDICS TREAT VERY FEW INFANTS IN NEED OF CRITICAL CARE **Kevin Shulz, Alex Troncoso, Richard D. Shih, Brian Walsh, Morristown Memorial Hospital**

Introduction. Paramedics often feel uncomfortable treating young children, and our paramedics have noted a lack of experience and education in this area.

Objective. We sought to determine what types of illness, medications, and procedures are needed in infants (age <1 year) in order to focus our educational efforts. **Methods.** We retrospectively reviewed the prehospital records all infants who were evaluated by paramedics in a suburban, hospital-based emergency medical services (EMS) system over a 30-month period. Dispatch category, medications administered, and procedures performed were noted. Oxygen administration was not considered a medication or a procedure. Percentages of patients and 95% confidence intervals (CIs) were calculated. The hospital and state institutional review board (IRB) approved the study. **Results.** Of 36,143 patients treated by the paramedics, 177 (0.5%) were less than 1 year old. Of these patients, 43% (CI: 36–50) were dispatched as “respiratory,” 17% (CI: 11–22) were “seizures,” 9% (CI: 5–13) were “trauma,” 8% (CI: 4–13) were “anaphylaxis/allergy,” and 6% (CI: 3–10) were “cardiac,” “cardiac arrest,” “unresponsive,” or “altered mental status.” Of the 177 patients, 29 patients (16% [CI: 11–22]) were treated with a medication: 18 patients (10% [CI: 6–17]) received albuterol/ipratropium, six patients (3% [CI: 1–6]) received benzodiazepines, three patients (2% [CI: 0–4]) received epinephrine, and three patients (2% [CI: 0–4]) received another medication (morphine, dexamethasone, or diphenhydramine). Of the 177 infants, a procedure was performed in 14 patients (8% [CI: 4–12]): 12 patients (7% [CI: 3–10]) received peripheral intravenous (IV) lines and two patients (1% [CI: 0–3]) received intraosseous lines. No patients were intubated. **Conclusions.** Overall, paramedics treat very few infants in need of critical care. Many of the infants they evaluate have respiratory illnesses that need no prehospital treatment or can be treated with albuterol/ipratropium only. Only about eight of every 10,000 patients whom paramedics evaluate are infants in need of a medication, and four of every 10,000 patients are infants needing a procedure. Furthermore, in 30 months, paramedics in our system did not intubate any infants. Given this very low rate of treatment, our recent emphasis on pediatric training may be unnecessary.

69. TIMELINESS OF POSTINTUBATION CAPNOGRAPHY APPLICATION—EFFECTS OF EDUCATIONAL INTERVENTION ON PARAMEDIC PERFORMANCE T. J. Reginald, Jeffrey M. Goodloe, Miranda Phillips, Stephen H. Thomas, *University of Oklahoma School of Community Medicine, Department of Emergency Medicine*

Introduction. Monitoring of end-tidal carbon dioxide (EtCO₂) after endotracheal intubation (ETI) has become a standard of care in prehospital medicine. An evolving understanding of the criticality of feedback enabled by early post-ETI continuous waveform capnography led our large urban emergency medical

services (EMS) system to change its capnography utilization standards in July 2008. Specifically, we emphasized to paramedics the initiation of capnography within 60 seconds after ETI. **Objective.** To assess the impact of educational efforts on the speed of post-ETI capnography initiation. **Methods.** The study comprised all intubated patients receiving care in our EMS system from May 1, 2007, until June 1, 2009. Time of ETI (if performed or witnessed by paramedics) or time of initial patient contact (if ETI was performed prior to paramedic arrival) was recorded. The time of initial capnography placement was recorded, and the capnography time (CapTime) was defined as the interval between ETI time (or initial patient contact, for paramedic-unwitnessed ETI) and initial capnography data time. Associations between variables of interest and time intervals (nonparametric) were assessed with Kruskal-Wallis univariate testing and Fisher’s exact test for the dichotomous endpoint “CapTime = 60 seconds.” The relationship between the dependent variable, CapTime = 60 seconds, and the primary independent variable, pre-July 2008 vs. post-July 2008, was assessed using logistic regression adjusted for patient characteristics. For all tests, a p-value of 0.05 was defined as significant. **Results.** One thousand eight hundred sixty-five patients met inclusion criteria, with capnography applied in 1,797 cases (96.4%). Eight hundred five patients (44.8%) had a CapTime of 60 seconds; the median (interquartile range [IQR]) CapTime was 91 seconds (0–246). CapTime in the post-July 2008 time frame (median 4 seconds, IQR 0–74) was significantly ($p < 0.001$) faster than the pre-July 2008 CapTime (median 186 seconds, IQR 87–350). Multivariate analysis adjusted for diagnosis, geographic location, and ETI operator indicated that the post-July 2008 CapTime was far more likely than the pre-July 2008 CapTime to fall within the 60-second benchmark (odds ratio 11.1, 95% confidence interval 8.8–13.9, $p < 0.001$). **Conclusions.** Institution of educational efforts allowed for over 10-fold improvement in rapidly applying capnography after ETI in a large urban EMS system.

70. PATIENT SAFETY IN EMERGENCY MEDICAL SERVICES: A SYSTEMATIC REVIEW Blair L. Bigham, Steven C. Brooks, Merideth Morrison, Kaveh Shojania, Laurie J. Morrison, *Rescu, St. Michael’s Hospital, University of Toronto*

Background. Every day, unsafe acts put patients in the health care system at risk for harm. Emergency medical services (EMS) providers care for patients in the field, perhaps the most challenging and dynamic of clinical environments in which to work. **Objective.** To understand the threats to patient safety unique to the EMS environment, we completed a systematic review of the literature. **Methods.** We searched

MEDLINE, EMBASE, and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) for combinations of key EMS and patient safety terms composed by a national group of experts in using year limit 1999 to 2009. We excluded commentaries, opinions, letters, abstracts, and non-English publications. Two investigators performed an independent hierarchical screening of titles, abstracts, and full-text articles blinded to source. Data abstraction was done by two investigators independently and was resolved by consensus. **Results.** The kappa statistics for titles, abstracts, and full texts were 0.65, 0.79, and 0.87, respectively. We retrieved 4,274 titles, and 69 publications met the inclusion criteria and were categorized into six themes: adverse events and medication errors (16 articles), interfacility transport (16), intubation (15), clinical judgment (9), ground vehicle safety (7), and aircraft safety (6). Only two articles were randomized controlled trials; the remainder were surveys, retrospective database/chart reviews, or prospective observational studies. The theme of intubation contained both positive and negative studies, however, differing methodologies and definitions did not allow for meta-analysis. Most studies attempted to measure the incidence of adverse events. Although some studies did examine interventions intended to assess paramedic judgment or reduce adverse events associated with medication administration and transport, only two were controlled trials, and of these only one studied live providers/patients in the field setting. **Conclusions.** We found a paucity of high-quality scientific literature exploring patient safety in EMS. Lessons could be learned from other acute care specialties in medicine. Gaps in the current EMS patient safety literature include infection control, patient handling and lifting, clinical decision making by EMS providers, and the safety of procedures other than intubation. Operators, regulators, medical directors, and prehospital practitioners should drive more research in this important area of study to improve patient care.

71. EFFECT OF COMPUTER SIMULATION ON FLIGHT CREW CONFIDENCE IN PERFORMING AN INFREQUENTLY USED PROCEDURE **Jeffrey Lubin, Joseph Grover, University Hospitals Case Medical Center**

Introduction. As out-of-hospital care becomes increasingly more complicated and technologically advanced, simply providing education sessions and a chance to use new equipment under supervision may not be adequate. Despite training by a representative from a medical equipment manufacturer and one-on-one instruction with the service's medical director on the use of new noninvasive ventilation settings, our helicopter emergency medical services (EMS) crew members still were not confident in their use. **Objective.** Taking ad-

vantage of computer simulation to provide an avenue for "deliberate practice," we examined whether using repeated simulation would be an effective method to improve providers' confidence with this infrequently used procedure. **Methods.** Study participants completed an anonymous survey, which was marked with a randomly assigned study ID. They used a five-point Likert scale (5 = highest) to estimate their comfort level using the equipment and their perceived understanding of the equipment and adjustment of settings. A simple computer simulation program, created to provide opportunities to practice and deliver immediate anonymous feedback to the crew members, was then made available. Participants were asked to use the program several times per shift during the following months. A follow-up survey was completed six months later and matched to the initial surveys by ID number. Results were compared using Wilcoxon signed rank testing. **Results.** Twenty crew members participated. Their initial mean comfort level with the noninvasive ventilation equipment was 2.8 (95% confidence interval [CI]: 2.3–3.2), which improved to 3.6 (3.3–3.9) six months after making the computer program available ($z = 0.001$). Their perceived understanding of how to place patients on the noninvasive ventilation equipment had an initial mean of 3.0 (2.6–3.5), improving to 3.9 (3.6–4.2) after six months ($z = 0.003$). Their initial mean level of understanding of how to adjust settings was 2.7 (2.2–3.2), while the follow-up was 3.8 (3.4–4.2, $z = 0.0004$). **Conclusions.** There was a statistically significant improvement in comfort and perceived understanding of noninvasive ventilation after using the computer simulation training program for six months. Simple computer simulation methods may provide the deliberate practice needed to successfully implement new techniques or procedures.

72. PREHOSPITAL PROVIDER EXPERIENCE AND IMPACT ON INTRAOSSEOUS SUCCESS RATES **Jaime Massucci, Ketaki Abhyankar, Laura S. Murphy, Debra Resurreccion, James F. Reed, Diane McGinnis-Hainsworth, Ross Megargel, Christiana Care Health System**

Objective. To examine prehospital variables that may affect emergency medical services (EMS) providers' ability to obtain vascular access. Delaware EMS began intraosseous (IO) implementation in 2005. Our hypothesis is that there will be an increase in success rates of IO access as EMS personnel became more experienced with the device. We further speculate that gender and age will affect IO success. **Methods.** This was a retrospective study analyzing the methods of vascular access obtained by paramedics. The data include type of access provided, amount of time spent obtaining access, age, and gender. The study population

included 656 patients >18 years requiring an IO device in Delaware between 2005 and 2008. Statistical testing included chi-test analysis and analysis of variance (ANOVA). **Results.** In the years 2005 through 2008 there were 20 IO attempts with 85% success, 26 IO attempts with 96.2% success, 280 IO attempts with 92.1% success, and 330 IO attempts with 94.2% success, respectively. No statistical differences were revealed over time, but there was a trend for improved success rates as hypothesized. Overall, there were 356 IO attempts in male patients and 291 in female patients. The 96.2% success rate for male patients was significantly better than 90% for female patients ($p = 0.004$). In the subset where IO access was attempted prior to intravenous (IV) access, in the years 2005 through 2008 there were eight IO attempts with 75% success, 11 IO attempts with 90.9% success, 145 IO attempts with 91% success, and 203 IO attempts with 95.6% success, respectively. **Conclusions.** As prehospital providers became more experienced with using the IO device, success rates revealed an upward trend toward significance. There was also a trend toward significance when IO access was attempted prior to IV access. IO attempts in male patients were significantly more successful than those in female patients. Explanations for this gender difference may include an older male population and/or gender differences in adipose tissue distribution. In certain patient populations, the use of the IO device may be a reasonable first attempt at vascular access. The ability to deliver life-saving medications has been shown to have a significant impact on morbidity and mortality. These findings have important implications for continued focus on additional training and development of IO protocols for EMS personnel.

73. NOVICE PARAMEDICS CAN BE TRAINED TO PERFORM FAST EXAMINATIONS IN REAL TIME USING VIDEOCONFERENCING TECHNOLOGY **Stephen Leech, Salvatore Silvestri, Jennifer Daugharthy, Dominic Zigrossi, Orlando Regional Medical Center**

Introduction. Prior reports have shown the utility of focused assessment with sonography in trauma (FAST) examination in mass-casualty incidents. Most paramedics lack adequate experience to perform and interpret FAST. Case reports have shown that transmission of ultrasound images from the prehospital setting to an expert reviewer is feasible, but no prior study has shown the ability to provide remote real-time instruction and image review using videoconferencing (VC) technology. **Objective.** We hypothesized that novice paramedics could receive instruction using VC equipment and adequately perform the FAST examination with instruction. **Methods.** Novice paramedics with no FAST experience participated in the study.

Video output from a SonoSite MicroMaxx was digitally converted and fed to a laptop computer, and this feed was streamed in real time to a second laptop computer over a wireless network using VC software (iChat, Apple). An expert provided online FAST instruction and interpreted FAST images obtained on a healthy volunteer. Instruction covered cardiac, right upper quadrant (RUQ), left upper quadrant (LUQ), pelvic, and thoracic views. Two blinded observers rated each FAST view using explicit predefined criteria for technique (TQ) and image quality (IQ) on a five-point Likert scale (1 poor, 2 fair, 3 adequate, 4 good, 5 excellent). These criteria were developed using the American College of Emergency Physicians (ACEP) guidelines for FAST. Users rated the video and audio feeds, ease of use, instruction, and their FAST ability with instruction on a 10-cm visual analog scale (VAS). Data were analyzed using descriptive statistics. **Results.** Nine paramedics participated in the study. None had prior FAST experience or training. Every user was able to obtain all five views with at least an adequate rating. TQ and IQ scores ($n = 18$), median (number of scores from 1 to 5): cardiac TQ 4 (0, 0, 2, 11, 5), cardiac IQ 4 (0, 0, 1, 11, 6), RUQ TQ 4 (0, 0, 2, 11, 5), RUQ IQ 4 (0, 0, 1, 14, 3), LUQ TQ 4 (0, 0, 1, 12, 5), LUQ IQ 4 (0, 0, 0, 12, 6), pelvis TQ 4 (0, 0, 2, 9, 7), pelvis IQ 4 (0, 0, 2, 7, 9), thoracic TQ 4 (0, 0, 2, 6, 10), and thoracic IQ 4 (0, 0, 0, 9, 11). User scores, mean (95% confidence interval [CI]): video quality 8.9 (8.1–9.7), audio quality 8.3 (6.5–10), ease of use 9.1 (8.4–9.8), instruction 9.6 (9.1–10), and user ability 8.4 (7.5–10). **Conclusions.** Novice paramedics can adequately obtain and interpret FAST using real-time remote VC instruction.

74. EVALUATING THE EFFECTIVENESS OF DIDACTIC TEACHING AND SIMULATOR TRAINING ON THE ABILITY OF EMERGENCY MEDICAL SERVICES TO RECOGNIZE THE APPROPRIATE PATIENTS FOR THERAPEUTIC HYPOTHERMIA AND IMPLEMENT A HYPOTHERMIC PROTOCOL **Joseph Sabato, Andrew Lim, Zachary Dembitsky, Colby Redfield, University of Florida**

Background. Therapeutic hypothermia (TH) for comatose patients after return of spontaneous circulation (ROSC) has been shown to improve survival and outcome. Most cardiac arrests occur in a prehospital setting. The ability of prehospital providers to implement TH protocols in the field after simulation training has not been well described. **Objective.** To determine the knowledge and practice of providers before and after a brief educational program paired with high-fidelity simulation in an ambulance environment. **Methods.** Training involved a county prehospital agency with a service population of approximately 70,000 and was conducted over three days to accommodate typical emergency medical services (EMS) schedule rotations.

Emergency physicians from an urban university-based training program provided didactic and simulation training focused on initiating prehospital TH protocols. Training consisted of a 30-minute PowerPoint presentation accompanied by three standardized patient simulation scenarios utilizing the Laerdal SimMan in an ambulance. Participants completed a pretest prior to the didactic session and then a posttest. Participants were assessed during the simulated scenarios through a checklist of critical actions when implementing TH procedures. Finally, participants were asked to rate effective learning strategies on a Likert scale. **Results.** Fifty-four of the 96 possible participants completed the training, with 49 participants completing both a pre- and posttest. A paired-sample t-test was performed to determine improvement in TH knowledge among the participants. The mean scores increased from 58.47 (standard deviation [SD] = 14.66) on the pretest to 86.33 (SD = 8.46) on the posttest. The difference between the two means is statistically significant ($p = 0.000$) at the 0.05 level ($t = -13.51$, $df = 48$). During the simulation training, 35 of 37 groups chose to correctly include or exclude a patient from TH. Additionally, participants reported that the didactic session with question and answers (78%) and the simulation exercises (83%) were both effective in their knowledge gain. **Conclusions.** Prehospital providers significantly increased their knowledge of TH after a brief training course and found that a combination of didactic and simulation instruction was effective. Retention of knowledge and practice pattern changes need to be assessed in six months.

75. DRIVE-THROUGH EMERGENCY DEPARTMENT: A NOVEL METHOD FOR RAPID EVALUATION OF PATIENTS DURING AN INFLUENZA PANDEMIC **Jessica Ngo, Eric Weiss, Gregory Gilbert, James Quinn, Stanford Hospital**

Introduction. During an influenza pandemic, emergency departments (EDs) may be overwhelmed by an increase in patient visits and may foster an environment where cross-infection can occur. As an alternative to the traditional ED waiting rooms, we developed and tested a novel drive-through emergency department (DTED) model for the rapid evaluation of patients during an influenza pandemic. **Objective.** To test the novel DTED model for rapid evaluation and diagnostic accuracy of patients during an influenza pandemic. In this model, health care providers examine and treat patients while the patients remain in or adjacent to their automobiles, eliminating the need for patients to enter ED waiting rooms or other interior spaces. **Methods.** A study was designed to compare the efficiency and accuracy of disposition decisions for patients with influenza-like illness (ILI) treated via the traditional walk-through emergency department (WTED), com-

pared with simulated patients with the same complaint who went through a DTED. Charts of patients with ILI who were seen at Stanford University Medical Center during the initial H1N1 outbreak in April 2009 were used to create 38 patient scenarios for the DTED. Volunteers from the American Red Cross were used as simulated patients for the DTED. The drill occurred in a parking structure adjacent to the Stanford University Medical Center. Main outcome measures: ED lengths of stay and disposition decisions for the DTED were compared with those for the WTED. **Results.** Mean differences in time to complete the WTED and DTED visits were assessed. The mean reduction in length of stay with the DTED was 86 minutes (95% confidence interval [CI] 65–108). Physicians in the DTED had a perfect agreement kappa of 1.0 (95% CI 0.67–1.00), with 100% diagnostic accuracy (95% CI 91–100%), compared with the WTED dispositions. **Conclusions.** Our DTED produced significantly reduced lengths of stay, while preserving diagnostic accuracy, compared with a traditional WTED. By using the patient's vehicle as an isolation compartment, the DTED model may be a rapid and effective alternative care site and a mechanism for social distancing during an influenza pandemic, bioterrorism, or other emerging infectious disease events.

76. THE RELATIONSHIP BETWEEN THE RAPID ACUTE PHYSIOLOGY SCORE AND PREHOSPITAL PATIENT ACUITY **Scott Bourn, Uwe Stolz, Kurt Denninghoff, Dan Spaite, American Medical Response, University of Arizona**

Introduction. The Rapid Acute Physiology Score (RAPS) was developed to predict mortality of critical care transport patients. The score is based on vital signs and Glasgow Coma Scale score and has proven to be an accurate predictor of mortality in adults in emergency medical services (EMS) and the emergency department (ED). **Objective.** To evaluate the relationship between RAPS and EMS patient acuity. **Methods.** Retrospective analysis of a clinical database from a large national EMS provider (63 operations in 24 states: 2006–2008). All the records for encounters in which the patient was aged 18 years or older were reviewed. Relationships were evaluated between RAPS and the following indicators of patient acuity: emergency medical technician (EMT)/paramedic primary impression of the patient's criticality; performance of oral endotracheal intubation; administration of medications (excluding oxygen); and emergent transport to the hospital. **Results.** There were 1,222,193 EMS adult patient encounters; 184,496 records (15.1%) were excluded because of incomplete data for RAPS calculation, leaving 1,104,590 records (84.9%) for analysis. Cases included trauma and medical calls across a broad variety

of clinical conditions. The table shows the evaluation of correlation between RAPS and indicators of patient acuity. Logistic regression analysis is under way to determine the relationship between RAPS and indicators of patient acuity, categorized by specific patient conditions. For example, the preliminary analysis evaluating the association between RAPS and the likelihood of endotracheal intubation across the entire range of RAPS scores for patients with altered level of consciousness reveals an odds ratio of 1.8 for each one-point increase in RAPS. Thus, on average, the likelihood of a patient's being intubated increases by nearly twofold with each increase of the RAPS by one. **Conclusions.** Across a very large population of patients from widely varied types and sizes of EMS systems, RAPS is strongly associated with EMS acuity indicators in some specific clinical conditions. Further study is needed to determine the relationship between RAPS and validated patient acuity measures.

| Factor | Correlation |
|--|--------------|
| Nonemergent transport to hospital | -0.912014744 |
| Emergency transport to hospital | 0.946325171 |
| Oral Intubation | 0.886560743 |
| Medication administration (excluding oxygen) | 0.834437483 |
| Paramedic assessment: noncritical | -0.943202904 |
| Paramedic assessment: critical | 0.962892024 |

77. DEVELOPMENT AND VALIDATION OF THE EXCESS MORTALITY RATIO-BASED PREHOSPITAL SEVERITY INDEX USING THE MEDICAL PRIORITY DISPATCH SYSTEM'S PROTOCOLS **Ki Jeong Hong, Sang Do Shin, Kyoung Jun Song, Daegu Emergency Medical Information Center**

Objective. In order to measure severity of emergency patients at the prehospital stage, we developed and validated the Excess Mortality Ratio-based Prehospital Severity Index (EMR-PSI) using protocols of the Medical Priority Dispatch System (MPDS). **Methods.** We collected clinical data of emergency department (ED) patients transported by emergency medical services (EMS) from the National Emergency Department Information System (NEDIS). Patients from 114 EDs who were transported between January 2005 and June 2008 were included. With the Delphi method, we mapped initial chief complaints of emergency patients to 34 MPDS protocols. Nine emergency physicians participated in the Delphi method by e-mail survey. The agreement rate of the mapping result was 87.4% in the first survey. We finished getting the agreement on mapping in the second survey. The EMR-PSI of each MPDS protocol was calculated from the ratio of age-gender-standardized hospital mortality for each

MPDS protocol versus the age-gender-standardized mortality of the entire 2006 population of Korea. We tested discrimination power on the prediction of mortality or severity (admission, transfer, and hospital mortality) with the area under the receiver-operating characteristic curve (AUC). A multivariate logistic regression model was built with adjustment for five parameters: gender, age, mental status, systolic blood pressure, and respiratory rate. The Hosmer-Lemeshow (HL) chi-square was calculated to test the goodness of fit of the logistic model. **Results.** A total of 440,190 patients were enrolled (male 55.8%, mean age 47.86 ± 22.16 years). The EMR for each MPDS protocol was distributed from 0 to 26.71 (mean \pm standard deviation: 3.76 ± 5.89 ; median 1.74). For instance, for the MPDS protocol of "breathing problem," the EMR was 3.79, meaning that a patient with a breathing problem has a 3.79 times greater chance of dying than the overall population of the same age. The adjusted odds ratio of the EMR-PSI for hospital mortality using the multivariate logistic regression model was 1.073 (95% confidence interval: 1.069 to 1.077). The AUCs to predict total hospital mortality, ED mortality, and admission mortality were 0.910 ($p < 0.0001$), 0.966 ($p < 0.0001$), and 0.801 ($p < 0.0001$), respectively. **Conclusions.** The EMR-PSI using MPDS protocols showed very good performance for prediction of hospital outcome for emergency patients transported by EMS.

78. PUBLIC UNDERSTANDING OF, USE OF, AND SUPPORT FOR EMERGENCY MEDICAL SERVICES **Margarita Tsionsky, Kurt Krumperman, Cathy Gotschall, University of Maryland Baltimore County**

Introduction. Accurate understanding, perceptions, and expectations are critically important to generate the public support needed to expand and improve emergency medical services (EMS) systems. **Objective.** To describe public confidence, understanding, expectations, and support of the EMS systems. **Methods.** Data were taken from the 2007 Motor Vehicle Occupant Safety Survey (MVOSS). The MVOSS is a national population-based telephone survey administered by the National Highway Traffic Safety Administration (NHTSA) on a periodic basis to obtain data on attitudes, knowledge, and self-reported behavior primarily in areas of occupant protection. The 2007 version of the questionnaire contained an EMS module and was administered to 6,010 people aged 16 years and older. Descriptive statistics were used to describe respondents' personal experience with EMS and their opinions on perceived importance of EMS compared with police and fire services; confidence in emergency workers; knowledge of the abbreviation EMS; expected ambulance arrival time; and willingness to pay for EMS services. **Results.** Survey results

indicate that 94% of respondents valued EMS as or more highly than police and fire protection services. 66.8% (95% confidence interval [CI] 65.3% to 68.3%) of the total population were very confident and 29% (95% CI 27.5% to 30.4%) were somewhat confident in EMS providers. Confidence in emergency workers remained high among respondents with personal experience with EMS, and respondents who had called 9-1-1 were more confident in emergency workers than were those who had not called 9-1-1. However, public understanding of EMS was not nearly as strong: 57.9% (95% CI 56.3% to 59.5%) did not know what the acronym EMS stands for. The public expectations of ambulance arrival times were unreasonable based on industry recommendations. Nearly half (44.4%) of the respondents expected the ambulance to arrive within 5 minutes after the 9-1-1 call was placed. Expected arrival times did not become more accurate among people who had dealt with EMS before or among those with higher education. **Conclusions.** Although public opinion for EMS is very positive and public support is strong, public knowledge of the EMS system is limited and public expectation of EMS system performance is considerably higher than current industry response standards.

79. THE IMPACT OF ELIMINATION OF DIVERSION ON EMERGENCY MEDICAL SERVICES UNIT OFF-LOAD TIME
Christine Van Dillen, Salvatore Silvestri, George A. Ralls, Linda Papa, Orange County EMS, Orlando Regional Medical Center

Background. Emergency department (ED) crowding has had an impact on the availability of emergency medical services (EMS) units. **Objective.** To examine the impact of eliminating diversion on the off-load time of EMS units. **Methods.** This 76-month longitudinal observational study from January 2003 to April 2009 recorded off-load data from a countywide regional EMS system consisting of multiple EMS agencies that transport approximately 100,000 patients per year. The receiving hospital is an urban tertiary care teaching hospital with an annual volume of approximately 70,000 adult patients. Off-load time is the interval between ED arrival via an EMS unit and transfer of care to an ED-assigned location. We tracked EMS unit off-load time from January 2004 through April 2009. The primary outcome was change in off-load time. Data were analyzed using 95% confidence intervals (CIs). **Results.** Overall, median offload times decreased from 40.6 minutes (95% CI = 39.7–41.4) in the diversion period to 33.7 minutes (95% CI = 32.7–34.7) in the period when diversion was eliminated ($p < 0.001$). The mean off-load time in January 2003 was 41.2 minutes and in January 2009 it was 27.1 minutes ($p <$

0.001). The mean decline in offload time was 7.0 minutes (95% CI = 5.5–8.3, $p < 0.001$). The longitudinal median offload time over the study period consistently and steadily decreased. **Conclusions.** In our system, despite the elimination of hospital diversion, EMS unit off-load time improved. Although the causes of this effect are multifactorial, the result is that of increased EMS unit availability.

80. EMERGENCY DEPARTMENT "OPEN WITH DELAY" STATUS DOES NOT AFFECT THE RATE OF AMBULANCE ARRIVALS
Brian Clemency, Matthew Roginski, Craig Cooley, Michael Manka, Kristopher Attwood, Anthony J. Billittier, The University at Buffalo, State University of New York

Introduction. Emergency departments (EDs) in the City of Buffalo, New York, report their status as open, open with delay (OWD), or diversion, which is then posted online and disseminated by ambulance dispatch to all hospitals, ambulances, and base stations. EDs are typically polled for their status by a single dispatch center every four hours, but may change their status at any time. It is widely believed that "going on delay" reduces the rate of ambulance arrival, and potentially avoids the need for diversion. **Objective.** To examine whether the OWD status reduces the rate of ambulance arrivals compared with the open status. **Methods.** 9-1-1 data were obtained for all ambulance transports originating from within the City of Buffalo between July 1, 2007, and June 30, 2009. Only hospitals that received at least an average of four ambulances per day were included in this retrospective analysis. Hospital status at the time an ambulance began transport was used. Ambulance arrival rates were calculated per hour for both open and OWD status for each hospital and four-hour time period that mirrored the intervals of dispatch polling. **Results.** There were 64,592 ambulance transports originating from the City of Buffalo 9-1-1 system over the 24-month period. Six hospitals that met the inclusion criteria had a total of 59,440 ambulance arrivals. A two one-sided t-test (TOST) for equivalence compared paired open and OWD arrival rates for each hospital for each time period. A total of 36 comparisons were performed. Open and OWD ambulance arrival rates were equivalent ($p < 0.01$, mean = 1.019, 90% confidence interval 0.985–1.053). **Conclusions.** OWD status does not decrease the rate of ambulance arrivals in our system. EDs should explore other methods of dealing with periods of increased volume. Further studies are needed to evaluate potential causes for this lack of effect, the effects of diversion, and the relationship between call volumes and the status of neighboring hospitals.

81. VARIATION OF OUT-OF-HOSPITAL CARDIAC ARREST MANAGEMENT AMONG CARDIAC ARREST REGISTRY TO ENHANCE SURVIVAL (CARES)–PARTICIPATING COMMUNITIES Jason McMullan, Prasanthi Ramanujam, Lisa Lin, Adam Landman, Bryan McNally, Allison Crouch, Comilla Sasson, *University of Cincinnati*

Introduction. Management of out-of-hospital cardiac arrest (OHCA), including termination of resuscitation, likely varies among emergency medical services (EMS) agencies, possibly because of the adoption of practices publicized since the last update of Advanced Cardiac Life Support (ACLS) in 2005. A cross-section of practices of major EMS agencies could highlight variables that impact survival of OHCA. **Methods.** Cardiac Arrest Registry to Enhance Survival (CARES) is a registry of OHCA and includes multiple EMS agencies representing many communities across the United States. CARES investigators developed and distributed a descriptive survey of current policies and practices of participating EMS systems in early 2009. The survey was Internet-based, with a paper option, and included telephone follow-up. Questions concerned termination of resuscitation, frequency of rhythm checks, adherence to 2005 ACLS guidelines, and postresuscitation care. **Results.** Twenty-one of the 25 (84%) participating CARES EMS systems completed the survey. There were large variations in the current protocols for the care of cardiac arrest patients. Eleven (52%) systems had modified the 2005 ACLS guidelines; most changes surrounded medication administration and airway/ventilatory strategies. One system performed 3-minute compression cycles, while another performed continuous chest compressions. All respondents performed 2 minutes of cardiopulmonary resuscitation (CPR) prior to rhythm check if no bystander CPR was performed, and 14 (67%) continued CPR for 2 minutes even with bystander CPR. Six (29%) performed CPR before rhythm check in EMS-witnessed cardiac arrest, while only four (19%) continued CPR during AED rhythm analysis. Eighteen of the 21 (86%) agencies performed post-return of spontaneous circulation electrocardiography. Nine (43%) triaged these patients to specific destination (resuscitation) hospitals. Seventeen of 21 (81%) respondents currently had a termination-of-resuscitation (TOR) protocol, with 5–60% of attempted resuscitations by those EMS systems resulting in field termination of efforts. TOR criteria varied widely among the responders. Resuscitation efforts must last 10–30 minutes, and online medical control contact and endotracheal intubation were not always required before TOR. **Conclusions.** Considerable OHCA protocol variations exist among CARES EMS systems. Frequency and methods of TOR, durations of prerhythm check CPR, modification of ACLS protocols, and postresuscitation care all vary among the CARES sites. Additional research should investigate

whether or not these protocol differences affect OHCA survival.

82. DESCRIPTION OF THE ACCELERATION FORCES AFFECTING BALANCE OF PREHOSPITAL PROVIDERS WHILE DELIVERING CARDIOPULMONARY RESUSCITATION Siddhartha A. Dante, Ulrich R. Herken, Annemarie E. Silver, T. Hammer, Michael Christopher Kurz, *Virginia Commonwealth University*

Introduction. Emergency medical services (EMS) personnel are subjected to numerous large forces due to ambulance acceleration while caring for patients. These forces may increase the risk of crew injury due to balance loss and negatively affect patient care, especially if crew members are standing to perform cardiopulmonary resuscitation (CPR). Previous studies have demonstrated that acceleration exceeding 0.6 to 0.93 m/s² leads to loss of balance. Furthermore, acceleration per unit time (i.e., jerk) has been suggested as a stronger predictor of balance loss and should be limited to 0.5 to 0.6 m/s³. **Objective.** We sought to identify the frequency with which ambulance personnel are at risk of balance loss during the transport of cardiac arrest patients. **Methods.** An onboard monitoring system (Road Safety, Thousand Oaks, CA) was utilized to record lateral and axial acceleration data during the transport of 50 cardiac arrest patients. Acceleration and acceleration change vectors were calculated for every second of drive time (speed >0 mph). Percentage of drive time with critical acceleration (>0.93 m/s²) and jerk (>0.6 m/s³) was determined by identifying all events exceeding the critical threshold. **Results.** Total drive time during these transports was 348.03 minutes (mean 6.95 min per transport). Acceleration exceeded 0.93 m/s² 49% of the time (165.27 min, mean 3.31 min), and acceleration changes (jerk) exceeded 0.6 m/s³ 26% of the time (86.87 min, mean 1.74 min). Either critical threshold was exceeded 60% of the time (202.42 min, mean 4.05 min) during transport. **Conclusions.** During cardiac arrest patient transports, emergency medical personnel are at significant risk of balance loss 60% of the time because of frequent, large acceleration forces. The resulting loss of balance may result in personal injury or the delivery of poor-quality CPR.

83. RE-ARREST IS RARE DURING AIR AMBULANCE TRANSPORT OF POST-CARDIAC ARREST PATIENTS Bryn Mumma, Amy Hartke, Clifton Callaway, Frank X. Guyette, Jon C. Rittenberger, *University of Pittsburgh*

Background. Patients successfully resuscitated from cardiac arrest (CA) can benefit from integrated multidisciplinary care. This care may be volume- and resource-dependent. Short transfer delays from scene to tertiary care hospitals have not been shown to

adversely affect outcome following CA. **Objectives.** To determine the rate of re-arrest and the rate of other critical events during air ambulance transport of resuscitated CA patients. **Methods.** Retrospective chart review was conducted of CA patients transported via air ambulance to a single tertiary care facility between January 1, 2001, and October 23, 2008. Data abstracted included demographics, presumed etiology, arrest rhythm, re-arrest, in-flight critical events and medications, hospital interventions, and outcome. Critical events were classified as hypotension (systolic blood pressure <90 mmHg), hypoxia (saturation of peripheral oxygen [SpO₂] <90%), both hypotension and hypoxia, or none. The primary outcome was the rate of re-arrest in flight. Secondary outcomes were the rates of critical events in flight. Data were analyzed using descriptive statistics. **Results.** We reviewed 206 charts; 59 were excluded for trauma. Of the remaining 147 patients, the average age was 61 ± 15 years (standard deviation), and 97 (65%) were male. Ventricular fibrillation/ventricular tachycardia (VF/VT) was the most common rhythm (54%); 73% of patients were comatose (Glasgow Coma Scale score [GCS] = 8). Transport infusions included vasopressors (53%), antiarrhythmic agents (42%), heparin (42%), and nitroglycerin (15%). Eight patients (5%) experienced re-arrest in flight; however, three of these patients had good outcomes. Forty-one (28%) experienced a critical event. Cardiac interventions were common: 84 (59%) patients received coronary catheterization, 51 (36%) received a stent, and 21 (15%) received an automatic implantable cardioverter-defibrillator (AICD). Hypothermia was administered to 24 patients (17%). Seventy-one patients (49%) survived and 59 (41%) had a good outcome. **Conclusions.** Critical events during transfer of CA patients to specialty care are common, including a 5% incidence of re-arrests. Rapid transport using air ambulance capable of in-transport critical care may optimize patient safety.

84. HOW MANY AMBULANCES MUST BE DISPATCHED FOR EACH CARDIAC ARREST? **Nicholas J. Johnson, Karl A. Sporer, University of California, San Francisco**

Introduction. The Medical Priority Dispatch System (MPDS) is an emergency medical dispatch (EMD) system that is widely used to prioritize 9-1-1 calls and optimize resource allocation. Calls are assigned an MPDS determinant, which includes a numerical category (1–32) representing chief complaint and a priority (Alpha through Echo) representing acuity. **Objective.** To evaluate the number of ambulances that must be dispatched to detect one cardiac arrest in each MPDS determinant. **Methods.** All patients assigned a determinant by MPDS from January 1, 2008, to June 31, 2009, in a large metropolitan area in California were included. Prehospital electronic patient care records were linked

with dispatch data. For each MPDS determinant, the number of calls for which the paramedic impression was listed as “Cardiac Arrest–Non-Traumatic” was tabulated. The number needed to dispatch (NND) of ambulances for each cardiac arrest was calculated for each MPDS determinant and for the system as a whole. **Results.** A total of 101,642 patients were included. Among them, 557 had “Cardiac Arrest–Non-Traumatic” listed as the paramedic impression. The Cardiac/Respiratory Arrest/Death category had the highest number of cardiac arrests (286), followed by Breathing Problems (99) and Unknown Problem/Man Down (76). Overall, 182 ambulances were dispatched for each cardiac arrest, 131 of which were with lights and sirens. The NND per cardiac arrest was seven in the Cardiac/Respiratory Arrest/Death category, 122 in Breathing Problems, and 104 in Unknown Problem/Man Down. Thirty-one cardiac arrests occurred in non-MPDS dispatch categories ($n = 62,989$), most of which were calls for medical assistance from police or fire units. **Conclusions.** MPDS was designed to detect cardiac arrest with high sensitivity and low specificity, leading to a significant degree of overtriage. The NND for each cardiac arrest may be a useful way to quantify the degree of overtriage and optimize EMS dispatch. This large descriptive study revealed that a large number of ambulances were dispatched per cardiac arrest, many with lights and sirens. We also demonstrated significant variability in the NND per cardiac arrest among MPDS determinants.

85. THE ASSOCIATION BETWEEN CARDIAC ARREST CENTER PATIENT VOLUME AND SURVIVAL IN A STATEWIDE POST-CARDIAC ARREST CARE SYSTEM **Brian Geyer, Tyler F. Vadeboncoeur, Daniel W. Spaite, Arthur B. Sanders, Lani Clark, Vatsal Chikani, Margaret Mullins, Bentley J. Bobrow, University of Arizona**

Introduction. Post-cardiac arrest care is a critical aspect of a cardiac arrest system. Other specialty care models (ST-segment elevation myocardial infarction [STEMI], STROKE, TRAUMA) have determined an association between patient volume and outcome. **Objective.** To determine whether there was an association between out-of-hospital cardiac arrest (OHCA) patient volume and cardiac arrest center (CAC) outcomes. **Methods.** In December 2007, Arizona initiated a program of CACs based on ability to 1) provide American Heart Association (AHA)-guideline postarrest therapy; 2) perform percutaneous cardiac interventions 24 hours a day/7 days a week; and 3) report accurate data to the statewide database. Established protocol allows emergency medical services (EMS) personnel to bypass local hospitals to take comatose patients with return of spontaneous circulation (ROSC) to a CAC provided the increase in transport interval is ≤15 minutes.

A standardized data-collection tool for OHCA victims transported to CACs was linked to a statewide Utstein-style database. Participants were consecutive OHCA victims transported to CACs between June 2007 and June 2009. Based on our preliminary experience of the CAC system, a well-functioning CAC was able to double survival among comatose patients with ROSC compared with before implementation (improving to approximately average 20% survival rates). We evaluated the association between CAC patient volume and survival to identify whether a cutpoint (20%+ survival) was identified. **Results.** After a 90-day run-in period after CAC recognition, 420 patients were transported to 15 different CACs. Systemwide all-rhythm survival to discharge increased from 9.9% (before CAC implementation) to 18.6% ($p = 0.0004$). Survival at CACs ranged from 0% to 29%. Logistic regression analysis revealed that a patient volume cutpoint of 60/year yielded a major difference in survival. CACs receiving >60 patients/year had significantly greater survival to hospital discharge (21.0%) than those receiving ≤ 60 patients/year (11.8%; $p = 0.0134$). **Conclusions.** There is a significant association between higher-volume CACs and outcome in the Arizona OHCA system. Our data suggest that CACs should receive at least 60 patients/year to achieve optimal outcomes. These findings should be confirmed in other systems, and their implications for EMS protocols require further research.

86. THE RELATIONSHIP OF SOCIOECONOMIC STATUS TO THE OUTCOME OF OUT-OF-HOSPITAL CARDIAC ARREST
Juok Park, Soo Jin Kim, Sang Do Shin, Kyoung-Jun Song, Ki Ok Ahn, College of Medicine in Cheju National University

Introduction. Socioeconomic status (SES) has been related to outcome of cardiac disease, but its influence on outcome from out-of-hospital cardiac arrest (OHCA) is not well understood. **Objective.** To determine the relationship between SES and the outcome of OHCA. **Methods.** The Korean national emergency medical services (EMS) data from January 2006 to December 2007 were collected from the fire department database of ambulance run sheets. Cases recorded as respiratory arrest, cardiac arrest, and cardiopulmonary resuscitation (CPR) applied were included. The medical record of those patients was reviewed retrospectively in accordance with Utstein style. Regional SES was measured by five levels (the richest, level 1; the poorest, level 5) on the basis of the Townsend deprivation index. The index is determined by four variables: households without a car; overcrowded households; households not owner-occupied; and persons unemployed. After calculating the incidence rate and univariate analysis, logistic regression was conducted to deter-

mine the effect of SES on survival of OHCA. **Results.** Among 36,724 OHCA cases in which the patients were transported by EMS, 34,227 cases were enrolled. The incidence rates of OHCA from levels 1, 2, 3, 4, and 5 were 63.2, 69.2, 69.0, 79.2, and 93.4 per 100,000 person-years, respectively. The witness rate ($p < 0.001$), bystander CPR rate ($p < 0.001$), and in-hospital CPR rate ($p < 0.001$) were significantly decreased as deprivation level grew higher. In terms of outcome, the ROSC rate and survival discharge rate were significantly decreased as deprivation level grew higher. In the logistic regression model adjusted for other variables, the higher deprivation level showed the lower survival rate, for which the odds ratios (ORs) of deprivation levels 2, 3, 4, and 5 were 0.84 (95% confidence interval [CI], 0.69–1.03), 0.72 (95% CI, 0.58–0.88), 0.62 (95% CI, 0.49–0.78), and 0.59 (95% CI, 0.46–0.75), respectively. **Conclusions.** The lower SES is apt to have a bad attitude for OHCA in bystander and poor outcomes of OHCA.

87. COMPARISON OF TIME TO INSERTION BETWEEN STANDARD ENDOTRACHEAL INTUBATION AND THE KING LTS-D DURING THE ADVANCED AIRWAY RESEARCH TRIAL
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Objective. To compare time to insertion between endotracheal intubation (ETI) and the King LTS-D airway in a prospective, randomized, multicenter prehospital trial. **Methods.** Paramedics from four sites were recruited and consented to participate in this study following institutional review board approval. All providers completed a 60-minute didactic training session and a hands-on skills test for ETI and King LTS-D insertion. Providers treated all patients meeting criteria for advanced airway management according to a preassigned treatment calendar randomized by week. Following insertion, providers contacted a study hotline (available 24 hours a day/7 days a week/365 days a year) to complete data collection. All data were analyzed as intent-to-treat (ITT) and as-treated (AT). Time to insertion was measured using a standard stopwatch. Mean times to insertion (seconds), defined as the time from when the provider had "tube in hand" immediately prior to placement to the time at which the first ventilation to bilateral chest rise was achieved, were compared with an unadjusted Student's *t*-test. General linear model analyses were used to examine the effect of primary impression (cardiac arrest, respiratory arrest, nonarrest with RSI, nonarrest without RSI), provider characteristics (age, gender, years of experience), patient characteristics (age, gender, body mass

index [BMI], mechanism), and complications on average time to insertion. **Results.** Between June 2008 and June 2009, a total of 205 placements (ITT: 129 King LTS-D, 76 ETI; AT: 123 King LTS-D, 82 ETI) were completed by 109 of the 272 providers who consented to participate. Timing data were reported in 150 (72%) of the 205 cases. No difference (ITT or AT) in time to insertion was detected between ETI and King LTS-D (ITT: 23.35 vs. 22.55 seconds, $p = 0.75$). Generalized linear models showed no differences in time to insertion when adjusted for primary impression, provider characteristics, and patient characteristics. Time to insertion within device group was significantly longer in cases where complications were reported (ET: 26.6 vs. 20.57 seconds; King: 25.17 vs. 20.58 seconds; $p = 0.019$), but no difference was detected between device groups. **Conclusion.** Insertion success times appear to be equal between ETI and the King LTS-D. The timing interval definition should be revised for future studies to include the time required to insert the laryngoscope and visualize the patient's vocal cords during ETI.

88. A MODIFIED LEMON SCORING SYSTEM FOR PREDICTING DIFFICULT INTUBATION IN EMERGENCY AIRWAY MANAGEMENT: A MULTICENTER OBSERVATIONAL STUDY
Young Min Kim, Ji Hoon Kim, Young Min Oh, Chun Song Youn, Byung Hak So, Tae Ho Lim, Hyuk Joong Choi, Hyun Soo Chung, Jun Ho Cho, Hyeon Woo Yim, Seung Hee Jeong, The Catholic University of Korea

Introduction. Prediction of difficult intubation is one of the challenging issues in emergency airway management. The airway assessment system in emergency situations needs to be simple to perform and also easily remembered. **Objective.** To assess whether a modified LEMON scoring system composed of 10 predictors is useful to predict difficult intubation in emergency airway management. **Methods.** We performed a prospective observational study from April to September 2008 using airway registry data of eight academic emergency departments. Only orotracheal intubations using conventional laryngoscopes by emergency physicians were included in the study. Intubation episodes that were impossible to assess and pediatric cases were excluded. Difficult intubation was defined as a Cormack-Lehane grade (CLG) III/IV or Intubation Difficulty Scale (IDS) score more than 5. We compared the incidences of each predictor and the modified LEMON scores between easy and difficult intubation groups. Diagnostic values of the scoring system were also evaluated. **Results.** A total of 346 cases (32.5%) were analyzed. Patients with a limited mouth opening, abnormal thyrohyoid distance, morbid obesity, or limited neck mobility were more likely to have a difficult intubation ($p < 0.05$, respectively). The modified

LEMON score of the patients with poor laryngoscopic view and moderate to severe intubation difficulty were significantly higher than that of the patients with a good laryngoscopic view or who were easily intubated ($p < 0.05$). The area under the curve of the scoring system was 0.697 in CLG-based analysis and 0.676 in IDS-based analysis. With a cutoff value of 3.0, sensitivity, specificity and positive likelihood ratio were 22%, 96%, and 4.8 in CLG-based analysis, and 32%, 95%, and 6.45 in IDS-based analysis. **Conclusions.** A modified LEMON scoring system is a clinically feasible method and is able to stratify the intubation difficulty in emergency airway management. The predictors, a limited mouth opening, abnormal thyrohyoid distance, morbid obesity, and limited neck mobility, may be useful to predict difficult intubation. Patients with a high score were more likely to have a difficult intubation. However, the diagnostic value of the scoring system was relatively low.

89. REGULATION OF FiO_2 USING MANUAL VENTILATION PARAMETERS AND SUPPLEMENTAL OXYGEN FLOW RATE
Anthony C. Salazar, Daniel P. Davis, UC San Diego, Department of Emergency Medicine

Background. Recent studies have revealed that there may be negative outcomes associated with early extreme hyperoxemia in the traumatic brain injury (TBI) patient. Theoretical risks of hyperoxygenation of tissues in TBI include a preferential effect on noninjured tissue, hyperoxic cerebral vasoconstriction, inhibition of metabolic enzymes, and formation of oxygen free radicals. These risks have already resulted in recommendations to limit the use of supplemental oxygenation in other critical resuscitations such as stroke and neonatal asphyxia. Data from our system document adverse outcomes associated with extreme hyperoxemia. This may impact prehospital oxygenation practices, which have typically involved early intubation/bag-valve-mask [BVM] ventilation and the use of a fractional concentration of oxygen in inspired gas (FiO_2) of 1.0. Future protocols will likely recommend $FiO_2 < 1.0$ to limit partial pressure of oxygen in arterial blood (PaO_2) values and avoid hyperoxemia. **Objective.** To demonstrate that FiO_2 can be controlled using oxygen (O_2) flow rate using various combinations of tidal volume and ventilation rate during BVM ventilation. **Methods.** This laboratory-based experiment was conducted using a BVM apparatus (1,000-mL Ambu bag) connected to a variable O_2 flow rate source and a gas analyzer capable of measuring output FiO_2 and tidal volume. Manual ventilations were performed at specified rate and volume. Tidal volume was recorded for each ventilation. FiO_2 was measured at variable O_2 flow rates (1, 2, 4,

and 6 L/min) for three separate ventilation settings (1,000 mL · 6/min, 500 mL · 12/min, and 300 mL · 20/min) using standard minute ventilation. Twenty different measurements were recorded for each trial, and a 1-minute washout period was used prior to each. Subsequently, FiO_2 was measured at a constant flow rate of 2 L/min with variable minute ventilation (6, 12, and 20/min for three different volumes: 300, 500, and 1,000 mL). **Results.** FiO_2 varied inversely with the rate of ventilation and tidal volume and directly with the O_2 flow rate. Lower flow rates (2–4 L/min) achieved FiO_2 values of 0.4–0.6 under the majority of tidal volume and ventilation rate combinations. **Conclusions.** FiO_2 can be regulated to moderate levels using lower O_2 flow rates, even with various combinations of ventilation rate and tidal volume. This may help guide prehospital providers in the treatment of TBI.

90. COMPARISON OF THE TIME OF INSERTION OF THREE AIRWAY DEVICES Valerie Homier, Eli Segal, Dave Ross, Sébastien Légaré, Benoit Touchette, Michel Loyer, François de Champlain, McGill University–Emergency Medicine Residency Program

Introduction. Prehospital airway management entails securing the airway in oftentimes difficult situations. Endotracheal intubation, considered the “gold standard” of airway management, can be challenging for anatomic or clinical reasons. Furthermore, not all emergency medical services (EMS) providers are trained in this technique. Alternative airway devices that require less training can be inserted without visualization of the vocal cords. Several of these devices use similar principles of ventilation; however, the manner in which they are inserted varies, and this may affect their insertion times. **Objective.** To compare the insertion times of the Combitube, the King LTS-D, and the EasyTube by emergency medical technicians (EMTs) on an airway manikin. **Methods.** Full-time EMTs from two different regions, all with experience using the Combitube, received training on the insertion of the three devices on Laerdal Crash Kelly manikins. The four-hour training consisted of didactic components followed by practice inserting all three tubes. Following the training, the EMTs were timed inserting each device. The time of insertion was measured from the beginning of the intubation attempt with the distal part of the device at the level of the incisors until confirmation of the first successful ventilation. Mean time differences and 95% confidence intervals (CIs) were calculated using mixed-model analysis with EMTs as a random effect. **Results.** Eleven basic life support–level EMTs from one region and nine advanced life support–level EMTs from the

second region participated voluntarily. Each EMT inserted the devices three times, for a total of 60 insertions per device. The mean times of insertion (in seconds) for the devices were as follows: King LTS-D: 10.12, EasyTube 15.08, and Combitube 14.82. The King LTS-D took significantly less time than the EasyTube (diff = 4.97, 95% CI 4.09 to 5.84) and the Combitube (diff = 4.70, 95% CI 3.86 to 5.54). There was no significant difference between the EasyTube and the Combitube (diff = 0.26, 95% CI –0.63 to 1.17). **Conclusions.** In this manikin model of airway device insertion, the King LTS-D had a statistically shorter time of insertion than either the Combitube or the EasyTube. However, the clinical significance of this 5-second difference is questionable. Comparison in clinical situations is required to validate whether this difference persists in real-life situations and is clinically relevant.

91. METHOD OF END-TIDAL CARBON DIOXIDE MONITORING AFFECTS ACCURACY WHILE ADMINISTERING CONTINUOUS POSITIVE AIRWAY PRESSURE Marshall Washick, Keith Wesley, HealthEast Medical Transportation

Objective. To determine the most accurate means of measuring end-tidal carbon dioxide (EtCO_2) while administering continuous positive airway pressure (CPAP) in the prehospital environment. **Methods.** Twelve healthy nonsmokers received CPAP at 5 cmH_2O with three commercially available devices while having their EtCO_2 monitored. The CPAP devices included the Respironics WhisperFlow (WF), the Emergent PortOvent (PV), and the Vitaid Boussignac (B). EtCO_2 (via both capnometry and capnography) was measured utilizing the Nonin LifeSense device with sidestream technology, which also measured saturation of peripheral oxygen (SpO_2), pulse rate, and respiratory rate; cardiac monitoring and noninvasive blood pressure (NIBP) was obtained using ZOLL E Series monitors. EtCO_2 was measured from four different positions per the CPAP device instructions, with an exception for the Boussignac because of its unique design (three positions). EtCO_2 was measured using two cannula devices (one included a split nasal/mouth piece) under the CPAP mask, in-line at a T-piece and at the CPAP exhalation port (Boussignac was the only device without an exhalation port). Each device and sampling position was monitored for 5 minutes with pre- and postmonitoring without the CPAP device to establish baseline. Peak EtCO_2 levels and waveforms were captured simultaneously via Bluetooth technology using an LSI software program. **Results.** There was no statistical difference in resting heart rate, respiratory rate, or EtCO_2 for all volunteers. The EtCO_2 results are listed in the table with mean and standard deviation (SD).

| | Nasal Cannula | Split Cannula | In-Line | Exhalation Port |
|--------------|---------------|---------------|------------|-----------------|
| Rest | 37.2 (6.1) | | | |
| Whisper Flow | 33.9 (4.8) | 31.7 (5.4) | 6.1 (5.9) | 1.9 (5.3) |
| PortOVent | 32.7 (5.6) | 36.0 (5.4) | 27.7 (8.4) | 10.3 (15.5) |
| Boussignac | 36.8 (3.6) | 35.1 (5.7) | 37.1 (4.3) | |

Compared with the resting state, the split cannula was most accurate with PV. WF revealed an equal degree of variation with cannulas, while B was equally accurate. In-line sampling was poor with WF and PV but accurate with B. Except for B, WF and PV had significant variation of EtCO₂ between modalities. Capnography waveforms were significantly altered from physiological baseline when obtained from the in-line port in all three devices and from the exhalation port of WF and PV. **Conclusions.** EtCO₂ can be accurately measured while treating patients with CPAP when appropriate attention is paid to selecting the proper sampling method. Although CPAP devices have a number of options available for EtCO₂ monitoring, a nasal cannula device, preferably a split mouth/nasal cannula, appears to be optimal.

92. PERFORMANCE OF THE KING LTS-D IN OUT-OF-HOSPITAL AIRWAY MANAGEMENT Valerie Homier, François de Champlain, Dave Ross, Benoit Touchette, Sébastien Légaré, Michel Loyer, Eli Segal, McGill University–Emergency Medicine Residency Program

Background. Quebec paramedics have used the Combitube as their primary airway device for over 15 years. New extraglottic airway devices have been developed that may be superior to older ones. **Objective.** To prospectively evaluate the performance of the King LTS-D in an urban prehospital setting. **Methods.** This was a prospective, observational study of advanced life support paramedics inserting the King LTS-D airway device in cardiac arrest patients. Paramedics received a formal four-hour training session including practice on manikins. The King LTS-D was inserted as part of the standard management of out-of-hospital cardiac arrest. Data-collection forms were filled out by paramedics following each insertion. The insertion time was calculated by audio review of the monitor-defibrillator recordings by quality insurance personnel not involved in data collection. The primary outcome was the time of insertion calculated from the beginning of the intubation attempt with the distal part of the device at the level of the incisors until confirmation of the first successful ventilation. Secondary outcomes included the presence of significant resistance during insertion, the need to stop cardiopulmonary resuscitation (CPR), adequate bilateral ventilation, ease of use, and observed complications. **Results.** The King LTS-D

was inserted in 50 cardiac arrest patients. The time of insertion, available in only 30 cases, was 25.87 ± 11.26 seconds (mean \pm standard deviation), with a median of 27 seconds. A significant resistance was noted in 16 (33%) patients, and CPR had to be stopped in six (13%) patients during insertion. Adequate bilateral ventilation was documented in 41 (91%) patients, and the median ease of use rating on a scale from 0 (difficult) to 10 (easy) was 8. Blood was noted in the oropharynx after the tube insertion on two (4%) occasions, and gastric distension was noted in five (10%) patients. **Conclusions.** The King LTS-D was rapid to insert, but significant resistance during insertion and gastric distension were frequently observed. Comparison with other extraglottic devices such as the EasyTube and the Combitube would provide further information on the relative performance of this device.

93. PREVALENCE OF METHICILLIN-RESISTANT *Staphylococcus aureus*, VANCOMYCIN-RESISTANT ENTEROCOCCUS, AND PULMONARY TUBERCULOSIS IN PATIENTS TRANSPORTED BY AMBULANCE Soo Jin Kim, Young Sun Ro, Sang Do Shin, Hyun Noh, Jung In Kim, Seoul National University School of Public Health

Objective. To determine the prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococcus (VRE), and active pulmonary tuberculosis (TB) in emergency patients transported by ambulance. **Methods.** This study was performed in a regional emergency department (level I) in a metropolitan area (population = 10 million). The demographic data were collected from the hospital electronic medical record (EMR) and merged with the hospital's microbiologic study registry for two years (2007–2008). Patients were categorized into the ambulance group (fire department ambulances for field transport and private ambulances for interfacility transport) and the nonambulance group. We analyzed demographic findings and compared the prevalence rates between the three groups regarding ambulance use. A multivariate logistic regression analysis was done with adjustment for age, gender, insurance type, injury, visit date and time, and season. **Results.** A total of 89,206 patients were enrolled. Of these, 9,378 (10.5%) used fire department ambulances and 4,799 (5.4%) used private ambulances. The prevalence of all three pathogens for the total group of emergency patients was 1.46% (MRSA 0.28%, VRE 1.05%, and TB 0.25%). Compared with the nonambulance group, the odds ratio (OR) (95% confidence interval) of having either pathogen was 2.13 (1.82–2.48) for fire department ambulances and 5.94 (5.18–6.81) for private ambulances. The adjusted ORs for MRSA were 2.41 (2.02–1.91) for fire department ambulances and 6.50 (5.55–7.62) for private ambulances. For VRE, the adjusted ORs were

2.74 (1.91–3.95) and 10.29 (7.67–13.81), and for TB, 1.23 (0.83–1.82) and 2.58 (1.76–3.77), respectively. **Conclusions.** Emergency patients using a metropolitan ambulances showed significant higher prevalence of MRSA, VRE, and pulmonary TB compared with nonambulance patients. Strict regulation, including a bacterial control program, is needed.

94. BACTERIAL CONTAMINATION OF A METROPOLITAN AREA'S AMBULANCES Hyun Noh, Sang Do Shin, Young Sun Ro, Seoul National University Hospital

Objective. To determine the prevalence of bacterial contamination of the vehicle surfaces, equipment, and materials of ambulances that provide prehospital services. **Methods.** This study was performed in a metropolitan area (population = 10 million) that provides fire department-based single-tiered basic life support (BLS) services. The ambulance authority has guidelines for bacterial decontamination for vehicles and crews. A total of 13 ambulances among 117 ambulances (11.1%) in April 2009 were enrolled, and 33 sites per each ambulance were sampled using soft rayon swabs and aseptic containers to be cultured. Ambulance crews were blinded to the sampling. The samples were then plated onto a screening media of blood agar and MacConkey agar. Specific identification with antibiotic susceptibility was performed for methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococcus (VRE). We categorized sampling sites into the critical group, the semicritical group, and the noncritical group regarding the possibility of direct contact to patients' mucosa. For example, an endotracheal tube was categorized in the critical group. **Results.** Two hundred fourteen of 429 samples showed positive results (49.9%) for any kinds of bacteria. Four of these were pathogenic (0.9%) (MRSA, MroNS, and K pneumonia), and 210 of these were environmental flora (49.0%). However, the prevalences (number positive /number of samples) of bacterial contamination in the critical, semicritical-airway, and critical-breathing apparatus groups were as high as 15.4% (4/26), 28.8% (15/52), and 39.7% (47/104), respectively. **Conclusions.** Despite the current formal guidelines, critical equipment and semicritical equipment were contaminated with pathogens and normal flora. It can be proposed that a more strict infection control and prevention modality should be introduced.

95. A SIMPLE DISPATCH RULE CAN REDUCE EMERGENCY MEDICAL SERVICES LIGHTS-AND-SIRENS RESPONSE TO MOTOR VEHICLE CRASHES Derek L. Isenberg, David C. Cone, Yale University School of Medicine

Background. Most patients involved in motor vehicle crashes (MVCs) are not seriously injured. How-

ever, dispatch protocols require that an ambulance be sent with lights and sirens (L&S) to the vast majority of MVCs. Responding with L&S puts the public and emergency medical services (EMS) crew at risk. **Objective.** Our goal was to derive a dispatch rule to reduce the need for L&S response by using MVC characteristics that could easily be described by a 9-1-1 caller. We used the U.S. Centers for Disease Control and Prevention Guidelines for Field Triage as the standard for needing L&S response: We assumed that if a patient did not require transport to a trauma center, he or she did not need an L&S response. **Methods.** Data were extracted from prehospital patient care reports (PCRs) of patients transported by ambulance to a level I trauma center between July 2007 and June 2008 with injuries sustained in MVCs. Patients with completed prehospital PCRs and hospital charts were included in the study. Using MVC characteristics that could easily be identified by a 9-1-1 caller, we developed a dispatch rule to determine when an ambulance can respond to an MVC without L&S. We calculated the sensitivity and specificity of this dispatch rule for both patients who met trauma center triage criteria and patients who required trauma center resources, defined as those who underwent surgical intervention, who had intracranial hemorrhage, or who were admitted to an intensive care unit. **Results.** Five hundred nine patients were included in the analysis. We developed the following dispatch rule for when an ambulance can respond without L&S to an MVC: 1) the MVC does not occur on an interstate/highway and 2) the MVC involves more than one car and 3) all patients are ambulatory. This dispatch rule was 96% sensitive and 33% specific for patients who met trauma center criteria, and 96% sensitive and 32% specific for patients who required trauma center resources. The study was limited by the large number of patients for whom prehospital PCRs were not available. **Conclusions.** A simple three-step dispatch rule for MVCs can safely reduce L&S responses by one-third, as judged by the need for transport to a trauma center or the use of trauma center resources. Prospective validation is needed.

96. SECONDARY TRIAGE OF LOW-ACUITY 9-1-1 CALLERS USING A NURSE ADVICE LINE Jonathan R. Studnek, Tom Blackwell, Lars Thestrup, Carolinas Medical Center

Introduction. As emergency medical services (EMS) call volumes increase, novel approaches to providing appropriate care to unique patient populations may be practical. Certain calls categorized as low-acuity by the Medical Priority Dispatch System may be appropriate to transfer to nurse advice lines where alternate care delivery may be offered in lieu of EMS response and transport. **Objective.** To determine whether secondary

triage by a nurse to receive care urgently or delayed was associated with subsequent hospital admission among identified low-acuity patients. **Methods.** This was a retrospective review of low-acuity 9-1-1 patients transported by a single, countywide, all-paramedic system to seven local hospitals from October 1, 2008, to July 31, 2009. Only patients transported to the hospital after receiving secondary triage by a nurse advice line were included in this analysis. All study patients received an ambulance response regardless of whether the 9-1-1 caller was transferred to a nurse advice line. Study outcome was hospital admission or discharge home. Based on nurse secondary triage, patients were classified as having either an urgent or a delayed need for medical care. Data analysis consisted of descriptive statistics and chi-squared analysis. **Results.** Of the 70,742 calls, 2,256 were identified as low-acuity, 1,180 (52.3%) of which were transferred to a nurse advice line. Nurses were able to provide advice to patients in 947 (80.2%) cases, 412 (43.5%) of which resulted in hospital transport. Of those 412 patients, nurses determined that delayed care would be appropriate for 147 (35.7%). Overall, 102 (24.8%) patients were admitted to the hospital, with three (0.07%) admitted to the intensive care unit. Patients classified by nurse advice as requiring delayed care were less frequently admitted (24/147, 16.3%) than those classified as needing urgent care (78/265, 29.4%) ($p = 0.003$). **Conclusions.** Patients in this study identified as being appropriate for delayed medical care were less likely to require hospital admission. Initiating a protocol utilizing secondary nurse triage may be a viable solution for ensuring that low-acuity patients receive appropriate care. This may increase the availability of resources allocated to higher-acuity patients. Future research should identify alternate methods of care for patients with low-acuity illness and injury.

97. MEDIC PERCEPTION OF THE EFFECTS OF ON-SCENE MEDICAL DIRECTION ON PATIENT CARE **Jason Andrew Carter, Noel Wagner, Mary Lynn Arvanitis, Harold Jay Cooper, Synergy Medical Education Alliance Emergency Medicine Residency**

Introduction. Emergency medical services (EMS) medical directors play a very important role in the development and sustainment of EMS systems. However, no studies have been found that explore this role by the medics involved in the system. Our system has a medical director who regularly dedicates time to utilizing a response vehicle. **Objective.** To examine medic perception of the effect of having a medical director on scene (MDOS) on patient care. **Methods.** We collected a convenience sample of questionnaires from 26 emergency medical technicians (EMTs) and 30 paramedics

(medics) from our local EMS system who had experience with an MDOS in August 2009. The exclusion criterion was zero calls run with an MDOS. **Results.** Thirty-nine (69.6%) surveys (which reported running calls with an MDOS) out of 56 were collected and included in the analysis. The median (interquartile range [IQR]) experience at the certification level was four (2.25) years. The median (IQR) reported number of weekly calls with the MDOS was two (2). Twenty-three (59%) respondents either agreed or strongly agreed that their ability to care for patients in general was enhanced by an MDOS. Enhanced care for trauma, medical, and pediatric patients was agreed upon by 22 (56.4%) respondents. Twenty-seven (69.2%) respondents reported that their patients benefited by having an MDOS. An overwhelming 34 (94.4%) respondents reported that their ability to obtain additional orders was enhanced. Having an MDOS positively affected quality assurance and performance improvement (QA/PI) and enhanced ongoing education by 75% and 77%, respectively. When performing high-risk treatments or therapies, 19 (52.7%) medics reported that a medical director on scene provided them with a "safety net." A total of 25 (71.4%) medics reported that they believe the best model of EMS collectively involves protocols, physicians available on the radio, and an MDOS. **Conclusion.** EMS systems throughout the country utilize different models of physician oversight. This survey shows a majority of our local medics felt that having an MDOS improved patient care. A significant majority felt they had better access to additional orders, followed by enhanced ongoing education and QA/PI. Medical directors in other EMS systems should consider the impact of this model of direction when involved in physician oversight.

98. THE UTILITY OF POINT-OF-CARE CARBON MONOXIMETRY IN FIREGROUND EMERGENCY MEDICAL SERVICES REHABILITATION OPERATIONS **Jennifer M. Bahr, Ann L. Lapine, Jeffery D. Ho, Hennepin County Medical Center**

Introduction. Carbon monoxide (CO) exposure to firefighters (FFs) during fireground operations is a threat to the health and safety of these emergency medical services (EMS) personnel. Since CO is an odorless and tasteless poisonous gas, it is impossible to detect without direct measurement. Burning household and building materials gives off significant amounts of poisonous gases, but the direct risk to firefighting personnel is difficult to monitor. Although there are national standard recommendations for FF rehabilitation during operations, the reality is that most are evaluated on a subjective basis by the fireground safety officer (FSO). **Objective.** To evaluate whether knowing the

CO level measured in a FF will change the decisions made by the FSO to send the FF back to duty. **Methods.** A Masimo Rad-57c CO monitor was used on each FF during each fire scene requiring rehabilitation operations. The FSO completed a data form describing the incident, the location of the FF during the incident, personal protective equipment used, any symptoms, and vital signs. Given this information, the FSO formed an impression of whether the FF should return to duty or not. Then, the CO level was checked using the Rad-57c monitor and the decision to send the FF back to active duty was reevaluated. Data were collected on every FF involved in the scene. **Results.** CO levels were checked during four different structural fires over a four-month period. A total of 66 measurements were taken. The average FF CO level of was 1.6%. None of the FFs reported any symptoms. The impression of fitness to return to duty was the same before and after the CO check in every case. We did not see any change in this decision based on CO level. **Conclusions.** In this initial study of the utility of CO measurements in FF rehabilitation, we found no instances in which the decision to return the FF to duty was changed based on the CO level. We recommend continued study in this area to increase the number of study subjects to validate or refute our findings.

99. PREHOSPITAL USE OF THE KING LT-D WITH MECHANICAL VENTILATION **Seth Ritter, Francis X. Guyette, University of Pittsburgh School of Medicine**

Introduction. While the King LT-D (KLTD) has been described in the anesthesia and emergency medical literature, its use with a ventilator has not. The safety and efficacy of the KLTD when used with a transport ventilator remain unknown. **Objective.** To describe whether the KLTD provides adequate ventilation and oxygenation with a mechanical ventilator in a prehospital setting. **Methods.** We conducted a retrospective review from March 1, 2006, to July 31, 2009, to evaluate the KLTD with a transport ventilator. Patients were ventilated with BVM or a ventilator set to a tidal volume of 8 cc/kg, a rate of 12, 5 of positive end-expiratory pressure (PEEP), and a fractional concentration of oxygen in inspired gas (FiO_2) of 100%. Vent settings were adjusted to maintain an end-tidal carbon dioxide (EtCO_2) of 35 to 45 mmHg and a saturation of peripheral oxygen (SpO_2) of >92%. All patients were monitored with continuous pulse oximetry and EtCO_2 sampling. Adverse events were described as failure to seal or dislodgment of the KLTD. Results are presented using descriptive statistics. **Results.** We deployed the KLTD 90 times in our prehospital system, including 24 cases in conjunction with a mechanical ventilator. Transport times on the ventilator ranged from 9 to 115 minutes (median 18, interquartile range

[IQR] 14.8, 28.5). Ninety-two percent (22/24) of patients managed with the KLTD and ventilator were oxygenated with saturations above 92%. One patient's saturation improved from 82% to 90% while on the ventilator, and one patient's data were lost because of a faulty SpO_2 probe. Thirteen patients (54%) were well ventilated, with EtCO_2 readings maintained between 35 and 45 mmHg. In five (21%) cases, the patient's EtCO_2 value was abnormal but improved during mechanical ventilation. Four (17%) patients had values that were outside the normal range but remained unchanged. Two patients (9%) experienced worsening of their conditions; one went from an EtCO_2 value of 41 to 32 mmHg. The second patient was retaining CO_2 ; this patient had a partial pressure of carbon dioxide in arterial blood (PaCO_2) value of 105 mmHg prior to transport, and the EtCO_2 value increased from 68 to 86 mmHg during transport. **Conclusions.** In this retrospective observational study, no adverse events were documented with use of the KLTD with a ventilator. Most (91%) patients receiving mechanical ventilation through the KLTD were adequately ventilated and oxygenated.

100. A COLLABORATIVE HEALTH INITIATIVE FOR RURAL RAPID-SEQUENCE AIRWAY **Darren Braude, Michael Richards, Michael Torres, Timothy Bajema, John Martinez, University of New Mexico, Department of Emergency Medicine**

Background. Our state emergency medical services (EMS) regulations provide a process for a service to exceed the scope of practice by applying for a "special skill" (SS). Pharmacologically assisted intubation requires such approval. The process requires evidence of active quality assurance (QA), justification of need, medical director involvement, community support, adequate training, and ongoing reporting to the state EMS regulatory agency. **Objective.** We postulated that centralized resources, including training, QA, and assistance with the application process, would aid a rural medical director to institute an advanced airway program, specifically rapid-sequence airway (RSA). **Methods.** The university department of emergency medicine (UDEM) planned to draft the SS application, assist with on-site RSA training, assist with purchase of continuously recording pulse oximeters (CRPOs), and participate in the ongoing QA. The QA assistance included hiring a part-time QARN with extensive EMS experience to review each case within 24 hours. **Results.** The UDEM applied for and received a \$15,000 grant from a local program that supports collaborative health initiatives between the medical school and the community. This award supported QARN expenses for one year as well as partial funding to purchase CRPOs. Through this SS program, a

total of \$8,530 was spent and 10 RSA cases have been performed. Adequate CRPO tracings were available in seven cases. Contact was made with the QARN and charts were faxed appropriately in all 10 cases. The QARN was able to obtain follow-up in nine of 10 cases. Each case was reviewed by the local medical director with input from the UDEM and QARN. All 10 cases were deemed appropriate and adequately performed. The local medical director and EMS agency plan to continue the program after completion of the year of grant support. **Conclusions.** Well-funded centralized resources from a UDEM, including active involvement of a QARN, can assist local medical directors in implementation of a successful RSA advanced airway program. Whether the program can continue and be successful without UDEM support remains to be seen.

101. ADEQUACY OF OXYGENATION AND VENTILATION IN THE CAPRA HIRCUS MODEL USING AN IMPROVISED CRICOTHYROTOMY PERFORMED WITH AN INTRAVENOUS DRIP CHAMBER SPIKE APPARATUS Jack Tuepker, Robert Kacprowicz, San Antonio Uniformed Services Health Education Consortium

Background. Cricothyrotomy using a standard intravenous (IV) drip chamber and spike has been postulated as a viable option in the prehospital setting. Pressure flow studies on spontaneously breathing subjects suggest that this apparatus may provide adequate ventilation and oxygenation; however, apneic subjects have not been studied. **Objectives.** To determine whether an improvised cricothyrotomy fashioned from a standard macrodrip IV drip chamber and spike is capable of maintaining adequate oxygenation and ventilation in the *Capra Hircus* (goat) model. **Methods.** We completed a prospective feasibility study in which six goats were sedated, anesthetized, and paralyzed. Electrocardiogram leads, pulse oximeter, and end-tidal carbon dioxide monitoring devices were placed. Following a vertical skin incision over the cricothyroid membrane, a standard IV drip chamber and spike was inserted through the membrane. The animals were placed on continuous mechanical ventilation through the device. Arterial blood gases were obtained every 15 minutes for a period of two hours. Ventilator parameters were adjusted as needed based on blood gas values. The major outcome parameter was time to reach a partial pressure of oxygen (pO_2) of 60 mmHg or a partial pressure of carbon dioxide (pCO_2) of 130 mmHg. Descriptive statistics were used for the results. **Results.** The average time to device placement was 27 seconds. Sixty-seven percent of the animals maintained a $pO_2 > 60$ mmHg and a $pCO_2 < 130$ mmHg at one hour. The mean pH at one hour was 7.09, pCO_2 was 108 mmHg (range 77–139), and the

mean pO_2 was 116 mmHg (range 76–186). Two goats were removed from the study at one hour because of elevated pCO_2 values of 133 and 139 mmHg. At two hours the mean pH of the remaining four subjects was 7.02, the mean pCO_2 was 117 mmHg, and the mean pO_2 was 181 mmHg. **Conclusions.** The improvised cricothyrotomy is capable of providing adequate oxygenation and ventilation up to one hour from placement. Limitations of the study include the small sample size and the lack of evaluation for anatomic damage due to placement. Additional studies are needed to further evaluate a cricothyrotomy using a standard IV drip chamber and spike.

102. FIELD ENDOTRACHEAL INTUBATION SUCCESS RATES: COMPARISON OF PARAMEDIC STUDENTS AND THEIR WORKING PARAMEDIC PRECEPTORS Joshua G. Salzman, Sara Richter, Regions Hospital EMS

Introduction. Prehospital pediatric endotracheal intubation (ETI) is a rare event, particularly for paramedic students (PS) to perform during their required field internship. **Objective.** To examine ETI success rates between PS and their paramedic preceptors (PP) during the field internship phase of their paramedic program. **Methods.** Institutional review board (IRB) review was waived for this study. De-identified records for all patients ≤ 18 years old who received ETI in the field from 2001 to 2007 were obtained from the Field Internship Student Data Acquisition Project (FISDAP), an administrative database used by paramedic programs across the country. The following variables were extracted for patients treated by PS and PP: patient age, year of run, provider impression, placement success/failure, number of attempts, and geographic region of placement. First-attempt, second-attempt, and overall success rates were compared between PS and PP using an unadjusted chi-square test. The overall success rates between PS and PP were compared using Cochran-Mantel-Haenszel statistics when controlling for patient age, provider primary impression, geographic region of placement, and placement year. **Results.** Data from 238 patient encounters met the inclusion criteria and were abstracted for analysis. PS performed a total of 130 ETI placement attempts on 104 patients, while their working PP performed 208 attempts on 138 patients. Median patient age was 4 years (interquartile range [IQR] = 0–15). The primary impression distribution was 93 (40.3%) cardiac arrests, 32 (13.9%) respiratory arrests, nine (3.9%) seizures, 79 (34.2%) trauma cases, and 18 (7.8%) other medical cases. First-attempt success rates between PS and PP were significantly different (70% vs. 84%, $p = 0.03$), but second-attempt (57.1% vs. 61.8%, $p = 0.73$) and overall (68.2% vs. 77%, $p = 0.13$) success rates were not significantly different between PS and PP. Overall success rates between PS

and PP were also not significantly different when factoring in patient age ($p = 0.33$), provider impression ($p = 0.26$), geographic region of placement ($p = 0.17$), and year of placement ($p = 0.36$). **Conclusions.** In this sample, first-attempt ETI success rates were lower for PS compared with PP, but overall success rates were not different between groups. This study is limited by the nonrandom fashion of patient selection for ETI between students and their preceptors.

103. PREHOSPITAL CONTINUOUS POSITIVE AIRWAY PRESSURE AND THE IMPACT ON HOSPITAL INTUBATION RATES
Jaime Massucci, Ketaki Abhyankar, James F. Reed, Debra Resurreccion, Diane McGinnis-Hainsworth, Laura S. Murphy, Lawrence E. Tan, Ross Megargel, Christiana Care Health System

Objective. To examine prehospital variables that may affect intubation in the hospital. Such variables include the paramedic's decision to use continuous positive airway pressure (CPAP), total contact time with emergency medical services (EMS) before arrival to the hospital, gender, age, diagnosis, and whether or not intubation is required. Our hypothesis was that CPAP is more likely to decrease intubation rates for congestive heart failure (CHF) and chronic obstructive pulmonary disease (COPD) when compared with pulmonary edema and pneumonia. **Methods.** This was a retrospective study analyzing CPAP use by paramedics in the Delaware EMS system, specifically New Castle County. The study population included all patients aged ≥ 18 years who received CPAP between July and December 2008. The data list includes the primary impression of the patient status, age, gender, diagnosis, and whether intubation occurred during the hospital stay. Statistical testing included chi-test analysis, Student-Newman-Keuls test, and analysis of variance (ANOVA). **Results.** The intubation rates for CHF and COPD were similar (14.3% and 15.4%, respectively, $p = 0.280$) as were the intubation rates for pulmonary edema and pneumonia (33.3% and 57.4%, respectively, $p = 0.139$). However, when CHF and COPD were grouped and compared with pulmonary edema and pneumonia, intubation rates were significantly increased in the latter groups ($p = 0.001$). Intubation rates were similar when comparing male and female patients (28.2% vs. 27.0%, $p = 0.851$). No statistical differences in intubation rates were revealed for age ($p = 0.139$). **Conclusions.** CPAP prevents intubation more often in CHF and COPD than in pulmonary edema and pneumonia. One possible explanation for this finding is that both CHF and COPD occur more acutely than pulmonary edema and pneumonia and, therefore, patients improve more quickly with CPAP and do not require intubation. Another possibility is that pneumonia patients, some of whom may have sepsis, are sicker

overall and often rapidly decompensate, thus requiring intubation. Interestingly, intubation rates did not differ by gender or age. This finding may indicate that younger patients requiring CPAP may have more comorbidities or underlying diagnoses that cause them to decompensate more quickly. These findings have important implications for the continued use of prehospital CPAP in a multitude of patient populations.

104. ANALYSIS OF THE EFFICACY OF WAVEFORM CAPNOGRAPHY MONITORING USING BAG-VALVE-MASK VENTILATION
Richard A. Wales, Wayne Dyott, Shore Health System

Background. Microstream capnography (Oridion) effectively monitors ventilation and airway patency for spontaneously breathing, assisted breathing, and fully supported patients during resuscitation. **Objective.** To determine the influence of different sampling sites on exhaled carbon dioxide (CO_2) measurement during simulated resuscitation with a bag-valve-mask (BVM) apparatus in normal subjects. **Methods.** Fifteen healthy volunteers between the ages of 20 and 57 years were enrolled for simultaneous parallel data measurements from two monitors (Capnostream 20, Oridion), each connected to one CO_2 sampling site. One monitor measured CO_2 directly from the nose and mouth utilizing the Microstream Uni-Junction (Oridion Smart CapnoLine Plus) and the second monitor sampled CO_2 inline with BVM after the exhaust valve (Oridion FilterLine Set with airway adapter). Subjects were supine and monitored during nose breathing for 3 minutes as baseline, mouth breathing for 3 minutes as baseline, and assisted breathing for 6 minutes with BVM during nose breathing and 6 minutes in the sniffing position mouth breathing, with readings recorded every minute (end-tidal carbon dioxide [etCO_2], respiratory rate [RR], oxygen saturation, and heart rate). Bag synchrony was monitored by observation and verified with waveform observation. **Results.** Data from the two monitored sampling sites showed that etCO_2 was within ± 2 torr during BVM-supported breathing with both nose and mouth breathing. RR variation was within 1 breath for all BVM monitoring sessions. Fractional concentration of carbon dioxide in inspired gas (FiCO_2) greater than 0 was seen only with the nasal/oral Uni-Junction sampling patient interface. There was no clinically significant change in etCO_2 using the nasal/oral Uni-Junction between nose breathing baseline, BVM nose breathing, mouth breathing baseline, or BVM mouth breathing. **Conclusions.** There was no clinically significant difference in monitoring the subjects when comparing the direct nasal/oral Uni-Junction patient interface data in parallel to the typical inline monitoring with the BVM. Limitations of the typical inline monitoring are that etCO_2

monitoring is lost when the mask is removed and the patient returns to spontaneous breathing. FiCO_2 , indicating dead space ventilation, is not seen with the typical inline monitoring and may be helpful identifying rebreathing with mask ventilation or CPAP. Flexibility and continuous monitoring of capnography are enhanced using the nasal/oral patient interface with mask ventilation combined with periods of spontaneous breathing.

105. THERE IS INCREASED CARDIOPULMONARY RESUSCITATION VARIABILITY DURING GROUND AMBULANCE TRANSPORT OF PATIENTS IN CARDIAC ARREST **Mark Venuti, Terence Mason, Gary Smith, Gordon Ewy, Frank LoVecchio, Steve Stapczynski, Lani Clark, Margaret Mullins, Annemarie Silver, Bentley Bobrow, SHARE Resuscitation Writing Group**

Introduction. Questions have been raised about the safety and efficacy of performing manual chest compressions during the ambulance transport of patients in cardiac arrest. **Objective.** To quantify and compare the quality of chest compressions at the scene of a resuscitation attempt and during transport. **Methods.** A monitor-defibrillator with accelerometer-based chest compression measurement (E-series, ZOLL Medical) was utilized to continuously record chest compression quality during resuscitation both at the scene and during ground ambulance transport. Real-time audiovisual feedback was inactivated. Minute-by-minute data were compiled for minutes at the scene and during transport. Minutes with return of spontaneous circulation (ROSC) were excluded from analysis. Paired t-tests were utilized to compare measures of chest compression quality at the scene and during transport. Variability was defined as the average of minute-by-minute standard deviations in depth or rate. **Results.** A total of 90 adult cardiac arrest events were electronically recorded, of which 45 included chest compressions both at the scene and in the ambulance. Variability in chest compression rate (18 compressions/minute at the scene vs. 26 during transport, $p < 0.0001$) and chest compression depth (0.20 inches at the scene vs. 0.26 during transport, $p < 0.0001$) were significantly greater during transport compared with those at the scene. Absolute chest compression depth (1.81 ± 0.43 inches at the scene vs. 1.71 ± 0.42 during transport, $p = 0.08$) and chest compression rate (114 ± 21 compressions/minute vs. 108 ± 25 compressions/minute, $p = 0.1$) tended to be lower during transport. The percentage of chest compressions in compliance with American Heart Association (AHA) 2005 guidelines for depth (1.5–2 inches) and rate (100 ± 10 compressions/minute) was nearly double at the scene compared with that during transport, although this did not reach statistical significance

($11\% \pm 16\%$ vs. $6\% \pm 11\%$, respectively, $p = 0.09$). **Conclusions.** There is increased variability of chest compression quality during the ground transport of cardiac arrest patients. Further investigation is needed to determine the causes of the increased variability of chest compressions during transport and the optimal timing and method of manual chest compression delivery.

106. THE RELATIONSHIP BETWEEN AMBULANCE SPEED AND ACCELERATION FORCES AFFECTING BALANCE OF PREHOSPITAL PROVIDERS DURING CARDIOPULMONARY RESUSCITATION **Brian J. Puckett, Ulrich R. Herken, Annemarie E. Silver, T. Hammer, Michael Christopher Kurz, Virginia Commonwealth University**

Introduction. Emergency medical services (EMS) personnel are subjected to numerous acceleration forces during ambulance transport. These forces may increase the risk of crew injury due to balance loss and negatively affect patient care, especially if crew members are standing to perform interventions such as cardiopulmonary resuscitation (CPR). Previous research has demonstrated the potential impact of acceleration and jerk forces on prehospital providers' balance; however, the relationship of these forces to ambulance speed has not been described. **Methods.** An onboard monitoring system (Road Safety, Thousand Oaks, CA) was utilized to record lateral and axial acceleration data during the transport of 50 cardiac arrest patients. Acceleration and acceleration change vectors (i.e., jerk) were calculated for every second of drive time (speed >0 mph) and averages were calculated for all speeds. Events exceeding critical acceleration or jerk thresholds previously reported for balance loss ($>0.93 \text{ m/s}^2$ and $>0.6 \text{ m/s}^3$, respectively) were then associated with the momentary speed. **Results.** The total transport time analyzed was 20,881 seconds (mean 6.95 minutes per transport). Ambulance speed was inversely related to the average magnitude of unbalancing forces (acceleration: $r = 0.81$, $p < 0.001$; jerk: $r = 0.82$, $p < 0.001$), resulting in a greater portion of drive time with unbalancing forces exceeding critical thresholds at lower speeds. Average (\pm standard deviation) jerk was highest ($0.64 \pm 0.54 \text{ m/s}^3$) at speeds between 1 and 5 mph, exceeding critical threshold during 39% of drive time, and was lowest ($0.35 \pm 0.28 \text{ m/s}^3$) at speeds between 51 and 55 mph, exceeding critical threshold 14% of the time. Average acceleration was highest ($1.28 \pm 0.56 \text{ m/s}^2$) at speeds between 6 and 10 mph, exceeding critical threshold during 82% of drive time, and was lowest ($0.68 \pm 0.42 \text{ m/s}^2$) at speeds above 60 mph, exceeding critical threshold 33% of the time. Ambulance speed was below 25 mph during 56% of drive time. **Conclusions.** Unbalancing forces that may potentially compromise EMS provider safety and patient care are more

frequent and of greater magnitude at lower speeds. Further research is needed to investigate the influence of these forces on the quality of patient care.

107. EFFECT OF LEVEL AND NUMBER OF PREHOSPITAL CARE PROVIDERS ON THE OUTCOME OF OUT-OF-HOSPITAL CARDIAC ARREST PATIENTS **Won Chul Cha, Sang Do Shin, Kyoung Jun Song, Ki Ok Ahn, Seong Chun Kim, Seoguipo Medical Center, Department of Emergency Medicine**

Hypothesis. We hypothesized that patients treated by a higher number of and a higher level of emergency medical technicians (EMTs) would have better outcomes after out-of-hospital cardiac arrest (OHCA). **Methods.** A Korean nationwide emergency medical services (EMS)-assessed OHCA database (2006–2007) (the CAVAS project) that was constructed from ambulance run sheets and followed by medical record review was used. Patients with confirmed outcomes were selected. The level of EMT was categorized into two groups, the EMT-intermediate (EMT-I) and the EMT-basic (EMT-B). The number of EMTs was also categorized into two groups, three EMTs and less than three EMTs. EMS performance was analyzed as the rate of electrocardiography (ECG), the rate of defibrillation, and the rate of basic life support (BLS) provided. Finally, a multivariate logistic regression analysis was carried out to determine the adjusted effect of the EMT level and number on a patient's outcome. We also adjusted for the province of the EMS agency for the multivariate analysis. **Results.** A total of 34,408 patients were included in the study. The mean age was 60.6 years (60.4–60.8). Causes of arrest were cardiac (55.4%), traumatic (14.7%), other (24.4%), and unknown (5.6%). The mean BLS time was 7.72 minutes (7.67–7.78) and the mean advanced life support (ALS) time was 24.3 minutes (24.2–24.5). The numbers of providers in the EMT-I group and the EMT-B group were 16,313 (47.4%) and 18,095 (52.6%), respectively. Regarding the number, only 5,346 (14.3%) were treated by three EMTs, and the others (87.7%) were treated by less than three. The rates of return of spontaneous circulation (ROSC) for the EMT-I and EMT-B groups were 15.2% and 12.4%, respectively ($p < 0.001$). The rates of survival to admission were 11.8% and 9.7%, respectively ($p < 0.001$). The rates of survival to discharge were 2.4% and 1.8%, respectively ($p < 0.001$). However, the adjusted odds ratios (ORs) (95% confidence intervals) for EMT-I over EMT-B were 1.03 (0.96–1.11) and 1.04 (0.89–1.23) for survival to admission and survival to discharge, respectively. The ORs for three EMTs over less than three were 1.04 (0.90–1.21) and 1.20 (0.88–1.63), respectively. **Conclusions.** After adjusting for the province of EMS agency, the level and number of EMTs

were not significantly associated with the rate of survival to discharge of OHCA patients.

108. SPATIAL DISTRIBUTION AND GEOGRAPHIC DEMOGRAPHIC DETERMINANTS OF PREHOSPITAL CARDIAC ARRESTS IN SINGAPORE **Marcus E. H. Ong, Arul Earnest, A. Shahidah, Wen Min Ng, Chuanyang Foo, David J. Nott, Singapore General Hospital**

Introduction. Geographic–demographic variations can affect the incidence of out-of-hospital cardiac arrest (OHCA). **Objectives.** To calculate the relative risk (RR) of cardiac arrests at the Development Guide Plan (DGP) level in Singapore, and to examine its relationship with key area-level determinants. **Methods.** This was an observational ecological study design. We calculated the RR as the ratio of the observed and population-standardized expected counts of pre-hospital cardiac arrests. Data on cardiac arrests were collected from October 2001 to October 2004, and population numbers with other geographic–demographic data were collated from the 2000 Singapore census. We used Bayesian conditional autoregressive spatial models to examine the drivers of increased risk at the DGP level. **Results.** We found significant spatial variation in the RR of cardiac arrests across Singapore. The RR of cardiac arrests for DGPs with population aged 65 years and above was 1.19 (95% confidence interval [CI]: 1.05–1.35). The risk of cardiac arrests was lower for DGPs with a larger proportion of Chinese people living there, $RR = 0.96$ (95% CI: 0.93–0.98), and higher for DGPs with a higher proportion of “no family nucleus,” with an RR of 1.09 (95% CI: 1.03–1.13). We did not find any significant associations with other covariates such as gender, type of dwelling, monthly income, and economic status. **Conclusions.** The risk of cardiac arrests in Singapore is related to the age, racial distribution, and family structure of DGPs in Singapore. This information can help to direct public health education, cardiopulmonary resuscitation training, and public-access defibrillation programs in a more geographically targeted manner.

109. FEASIBILITY OF INITIATING CARDIOPULMONARY BYPASS DURING MECHANICAL CHEST COMPRESSION CARDIOPULMONARY RESUSCITATION **James J. Menegazzi, David D. Salcido, Eric Logue, University of Pittsburgh**

Background. Recently, portable cardiopulmonary bypass (CPB) machines have become commercially available in Europe, with U.S. availability pending. This creates the opportunity to utilize CPB for the treatment of out-of-hospital cardiac arrest (OOHCA). **Objective.** To determine the feasibility of installing the CPB circuit while mechanical chest compression cardiopulmonary

resuscitation (CPR) was being done. **Methods.** We used five mixed-breed domestic swine with a mean mass of 26.0 kg. After induction of anesthesia, the animals were instrumented with micromanometer-tipped transducers placed in the aorta and right atrium via the left femoral artery and vein. Ventricular fibrillation (VF) was induced electrically with a transthoracic shock and left untreated for 8 minutes. Then, mechanical chest compressions were begun (LUCAS, Jolife, Lund, Sweden) and manual ventilations were performed to maintain end-tidal carbon dioxide (ETCO₂) between 35 and 45 torr. Compressions continued until CPB flow was started. Ten minutes after induction of VF, drugs were given (epinephrine, vasopressin, and propranolol), and at 13 minutes installation of CPB was started via cutdown on the right external jugular vein and right femoral artery for placement of venous and arterial catheters. CPB installation start time varied from 17 to 30 minutes after the start of compressions and continued until electrocardiography (ECG) indicated a shockable rhythm. First rescue shocks were given at 22, 32, 35, 44, and 65 minutes. **Results.** CPB was successfully installed in all five animals without incident. It was necessary to briefly discontinue chest compressions during the most delicate part of inserting the catheters into the vessels. CPB also allowed for very rapid cooling of the animals and facilitated postresuscitation hemodynamic support. Only the 65-minute animal did not attain return of spontaneous circulation (ROSC). **Conclusions.** Mechanical chest compression may be a suitable therapeutic bridge to the installation of CPB and does not interfere with CPB catheter placement. Emergency medical services (EMS) providers and physicians could play important roles in advancing the capability of delivering CPB in the out-of-hospital setting. This has the potential to greatly extend the therapeutic window for the treatment of OOHCA.

110. SELF-REPORTED PROVIDER SAFETY IN AN URBAN EMERGENCY MEDICAL SYSTEM Molly Furin, Katherine Murray, William G. Fernandez, Patricia Mitchell, K. Sophia Dyer, Ryan Carter, Laura J. Eliseo, Boston Medical Center

Introduction. Emergency medical services (EMS) emergency medical technicians (EMTs) and paramedics are frequently first responders to dangerous scenes and often subdue hostile patients or others interfering with care, without police support. **Objective.** To quantify self-reported abuse, report of abuse to authorities, and perceptions of safety in a two-tiered third-service urban EMS system with >100,000 calls/year serving a population of 590,763. **Methods.** This was a cross-sectional survey among EMS providers, self-administered during required training sessions in fall 2008. The survey included

demographics, years of experience, history of verbal and physical assault, whether the provider obtained medical care after assault or reported assault to police, and the provider's fear for his or her own safety. This descriptive analysis reports frequencies with 95% confidence intervals (CIs) and medians with interquartile ranges (IQRs). **Results.** One hundred ninety-six of 221 (89%) EMS providers completed surveys; 142 (72%) were male. The median age category was 36–40 years (IQR 25–30 to 41–45); median experience in the system was eight years (IQR 2–17). Physical and verbal assaults were reported by 172 of 196 respondents (88%, 95% CI: 83.5%–92.6%). Although 156 of 196 (80%) reported physical assaults, only 62 of 196 (32%) had sought medical care and 76 of 196 (39%) had reported assaults to police. Those providers in the system for <11 years were less likely to seek medical care (16/78, 21% vs. 37/63, 59%, $p < 0.0001$) and report assault to police (23/77, 30% vs. 46/63, 73%, $p < 0.0001$). Fear for one's own personal safety was reported by 134 of 196 (68%). Compared with one year prior, 22 of 196 (13%) felt safer, 117 of 196 (67%) felt equally safe, and 34 of 196 (20%) felt less safe. There was no statistical difference in assault by gender; however, the women feared more for their safety than the men did (38/43, 88% vs. 96/135, 71%, $p = 0.02$). More paramedics than EMTs reported being assaulted, even when results were adjusted for years of experience (35/36, 97% vs. 117/148, 79%, $p = 0.01$). More assaults were experienced by night-shift than day-shift providers (41/45, 91% vs. 50/70, 71%, $p = 0.01$). **Conclusions.** The majority of EMS providers surveyed reported an assault. Most reported feeling equally or less safe in their jobs compared with one year prior. Female providers, paramedics, and night-shift workers have a perceived increased risk of violence. Increases in personal safety training, safety gear, and police support are needed.

111. REGIONAL VARIATION OF EMERGENCY MEDICAL SERVICES USE BY SOCIOECONOMIC STATUS Juok Park, Sang Do Shin, Ki Ok Ahn, Kyoung-Jun Song, Soo Jin Kim, College of Medicine in Cheju National University

Introduction. It is believed that socioeconomic status (SES) affects patterns of medical use. **Objective.** To determine the relationship between emergency medical services (EMS) activation rates and SES of the community. **Methods.** The Korean national EMS data for the year 2007 were collected from the fire department database of ambulance run sheets. Regional SES was measured by five levels (the richest, level 1; the poorest, level 5) on basis of the Townsend deprivation index. The index is determined by four variables: households without a car; overcrowded households; households not owner-occupied; and persons unemployed. After calculating the standardized incidence

rates (SIRs) of EMS activation, relative risk (RR) was calculated for each SES level. **Results.** During 2007, the total number of EMS activations was 1,227,670. Among them, 5,268 (0.43%) that had inaccurate or unknown data of gender and age were excluded. Finally, 1,222,402 patients were enrolled in our study. Among them, 696,564 (56.98%) were male and the mean (\pm standard deviation) age was 50.5 ± 23.9 years. The SIRs for levels 1, 2, 3, 4, and 5 were 2,451, 2,504, 2,569, 2,639, and 3,018 per 100,000 person-years, respectively. The total EMS activation rate was 2,598 per 100,000 person-years. The risk of EMS activation was significantly higher in SES level 4 and level 5 regions (RR, 1.08; 95% confidence interval [CI], 1.02–1.14; and RR, 1.23; 95% CI, 1.17–1.30, respectively). **Conclusions.** The EMS use is seriously influenced by regional SES, which implies that the poor SES induces a tendency of more EMS activation.

112. CARBON FOOTPRINTING IN NORTH AMERICAN EMERGENCY MEDICAL SERVICES OPERATIONS: DEVELOPING PRELIMINARY EMISSION BENCHMARKS Ian Blanchard, Lawrence Brown, and the North American EMS Emissions Study Group, City of Calgary Emergency Medical Services

Objectives. To characterize the carbon emissions from a broad sample of North American emergency medical services (EMS) agencies, and to begin the process of establishing EMS-related emission benchmarks. **Methods.** A data-collection tool, based on Carbon Trust recommendations and eliciting direct energy consumption of EMS systems (including diesel, gasoline, liquefied petroleum gas, natural gas, compressed natural gas, heating oil, aviation fuel, electricity, and commercial air travel), was used by 15 diverse North American EMS systems with over 500,000 combined annual unit responses and serving a total population of 5.8 million to report their energy consumption for the preceding year. We calculated total carbon dioxide (CO₂) emissions using Environmental Protection Agency, Energy Information Administration, and, where available, locality-specific conversion factors. We also calculated per-response and population-based emissions. We report descriptive summary data. **Results.** Participants included government “third-service” ($n = 4$), public-utility model ($n = 1$), private contractor ($n = 6$), and rural rescue squad ($n = 4$) systems; call volumes ranged from 800 to 114,280 (median 18,574; interquartile range [IQR] 1,100–55,217). Emissions totaled 46,107,549 pounds of CO₂ (20,748 metric tons); 75% of emissions were from diesel or gasoline. Ten of the systems provided complete data enabling calculation of a “tier 2” carbon footprint, with median emissions per response of 80.8 pounds (IQR 63.4–106.8) of CO₂ and median emissions per service-

area resident of 7.8 pounds (IQR 5.0–10.5) of CO₂. Two systems reported aviation fuel consumption associated with fixed- and rotor-wing air medical services, with emissions of 2,395 pounds (>1 metric ton) of CO₂ per flight, but only 0.7 pounds of CO₂ per service-area resident. **Conclusions.** EMS operations produce substantial carbon emissions, primarily from vehicle-related fuel consumption. Using the 75th percentiles from our data as preliminary target benchmarks suggests that systems should strive to stay below 107 pounds of CO₂ per unit response and/or 11 pounds of CO₂ per service-area resident. Air medical services can anticipate much higher per-flight emissions but much lower population-based emissions. Further research is necessary to refine these benchmarks, create urban- and rural-specific measures, compare the carbon footprints of different operational models, and evaluate the effectiveness of potential emission-reduction strategies.

113. PLANNING AND SIMULATING A NATIONWIDE ADVANCED HELICOPTER EMERGENCY MEDICAL SERVICES ALLOCATION Won Chul Cha, Sang Do Shin, Kyoung Jun Song, Seoguipo Medical Center, Department of Emergency Medicine

Introduction. In Korea, we are in need of upgrading our current helicopter emergency medical services (HEMS). **Objectives.** We hypothesized that with a geographic information system (GIS) and the linear planning method, we could allocate helicopters and heliports. We also aimed to validate the newly planned allocation with the discrete event simulation method. **Methods.** Data were collected from the fire department database of ambulance run sheets. Patients who used 119 ambulances from January 1, 2006, to December 31, 2007, were included. Clinical characteristics and geographic descriptions were extracted. Then, the location of each event was geocoded. We mapped the 16 HEMS heliports and 41 level I and II trauma centers. For all EMS patients during the study period, the following criteria were used to select patients who potentially needed HEMS care. All three criteria had to be met to be a HEMS candidate: 1) patients with trauma; 2) patients with an abnormal Revised Trauma Score (RTS) (V on the AVPU [alert, verbal, painful, unresponsive] scale, Glasgow Coma Scale [GCS] score of ≥ 13 , systolic blood pressure [SBP] of < 90 mmHg, or respiratory rate of ≥ 30 breaths/min or < 10 breaths/min); and 3) patients whose distance was farther than 30 km from the nearest emergency center. We used the linear planning method to allocate helicopters to each present heliport. Relocating and building new heliports were also done with the planning mode. We also used the discrete event simulation method to measure the performance of new allocation. We assumed 6 minutes for takeoff, 8 minutes for field management, and 6 minutes for

landing at the destination hospital. **Results.** A total of 2,341,591 patients were registered during the study period. Geocoding was successful for 2,045,462 patients (89.4%). Of these, 19,110 (0.82%) fulfilled the criteria and were defined as advanced HEMS candidates. The results of linear planning proposed 19 helicopters to be allocated (two helicopters each for eight heliports, one each for three heliports, and none for four heliports). The simulations have shown that with the new plan, the success rate of transporting patients within 60 minutes would increase to 62.8%. Afterward, we relocated the heliports. With new locations, 10 heliports with 10 helicopters each showed a 66.7% success rate, and 19 heliports with 30 helicopters showed an 83.4% success rate. **Conclusions.** With the linear planning and the discrete event simulation, we could allocate helicopters and heliports and predict the future performance of HEMS successfully.

114. REDUCING ADVANCED LIFE SUPPORT (ALS) RESPONSE TIMES FOR A DEPARTMENT OF DEFENSE (DOD) INSTALLATION WITH PLACEMENT OF DEDICATED ALS UNITS WITHIN THE DOD INSTALLATION Robert Hennessy, John McManus, Richard Schwartz, Craig Manifold, Brooke Army Medical Center

Background. After the terrorist attacks on September 11, 2001, many installations in North America, especially Department of Defense (DOD) installations, heightened security requirements for base entry (limited access, identification checks, etc.). These requirements may have impacted access and advanced life support (ALS) response times. **Objective.** The purpose of this study was to determine whether having a dedicated ALS unit based within a DOD installation would improve ALS response times. The current standard is 12 minutes or less, 90% of the time, for our DOD installation. **Methods.** We performed a retrospective chart review of emergency medical services (EMS) calls for a DOD installation that recently placed an ALS ambulance inside the secure boundaries. A total of 1,199 calls occurred from April 2008 to July 2009, which accounts for eight months before and eight months after a dedicated ALS unit was placed on the installation; the dedicated ALS unit avoided gate security entry after being dispatched. **Results.** ALS response rates for each month prior to having an ALS unit within the DOD installation met the response standard of 12 minutes or less only 64% of the time, with a range from 58% to 82%. After the ALS ambulance was placed within the installation, the monthly response rates were 89% to 95%, with an overall response rate of 91%. The improvement in achieving the response rate standard was significant, 27% ($p \leq 0.0001$, Student t-test). **Conclusions.** An ALS ambulance based within a DOD installation significantly improves response times. All

DOD installations as well as any facility with heightened security access should consider having a dedicated ALS unit located within its boundaries, especially during peak call times.

115. LEARNING FROM TRAGEDY: TACTICAL MEDICAL SKILL REQUIREMENTS FOR LAW ENFORCEMENT OFFICERS Matthew D. Sztajnkrycer, Mayo Clinic

Introduction. Increasingly, military Tactical Combat Casualty Care (TCCC) precepts are being adapted to law enforcement needs. **Objective.** To better define the nature of potentially preventable law enforcement line-of-duty deaths (LODDs) occurring through felonious assaults in order to determine the appropriateness of this knowledge translation. **Methods.** This was a retrospective analysis of open source data available through the U.S. Federal Bureau of Investigation Uniform Crime Reporting (UCR) Law Enforcement Officers Killed and Assaulted (LEOKA) program for the years 1998–2007, inclusive. **Results.** A total of 533 LODDs were reported during the study period. After applying exclusion criteria, 341 victim officers were included in the study. The most common cause of death was head trauma ($n = 198$), followed by chest trauma ($n = 90$). One hundred twenty-three victim officers suffered potentially preventable deaths. The majority of these injuries involved the chest. During the 10-year study period, only two officers (0.6%) died from isolated extremity hemorrhage. **Conclusions.** The current emphasis of TCCC on immediate extremity hemorrhage management above all other medical interventions may not meet the needs of law enforcement personnel in an environment with expedited access to well-developed trauma systems. Further study is needed to better examine the causes of preventable death in law enforcement officers, as well as the most appropriate law enforcement tactical medical skill set and treatment priorities.

116. IN-FLIGHT AUTOMATIC EXTERNAL DEFIBRILLATOR USE AND CONSULTATION PATTERNS Aaron M. Brown, Jon C. Rittenberger, Charles M. Ammon, Scott T. Harrington, Frank X. Guyette, University of Pittsburgh Affiliated Residency in Emergency Medicine

Background. Limited information exists about the in-flight use and outcomes associated with automated external defibrillators (AEDs) on commercial airlines. **Objective.** To better define current use patterns and outcomes. **Methods.** We collected self-reported cases of AED use to an airline consultation service from three U.S. airlines between May 2004 and May 2009. We reviewed all available data files, related consult forms, and recordings. For each case, demographics,

initial rhythm, shock delivery/success, survival to admission, and ground medical consultation use were obtained. Success was defined as the return of a perfusing rhythm. Initial rhythms were classified as sinus, heart block, supraventricular tachycardia (SVT), atrial fibrillation/flutter, asystole, pulseless electrical activity (PEA), and ventricular fibrillation/ventricular tachycardia (VF/VT). **Results.** There were 169 AED applications with 40 cardiac arrests. The mean ages were 58 years (standard deviation [SD] 15) for the AED cases and 63 years (SD 12) for the cardiac arrest cases; both populations were 64% male. AEDs were applied for monitoring 129 (76%) times, with the following initial rhythms: sinus, 115 (89%); atrial fibrillation/flutter, seven (5%); complete heart block, four (3%); and SVT, 3 (2%). Presenting rhythms among the cardiac arrest population were as follows: asystole, 16 (40%); VF/VT, 10 (25%); and PEA, 14 (35%). Fourteen patients were defibrillated, including nine of 10 patients with initial VF/VT and five with VF/VT after resuscitation for initial PEA/asystole. Defibrillation was advised but not performed in the remaining case of initial VF/VT, and no medical consultation was obtained. All five successful defibrillations occurred in patients with initial VF/VT. There were six (15%) survivors, with five occurring after successful defibrillation for initial VF/VT and one with return of a perfusing rhythm after cardiopulmonary resuscitation (CPR) for a junctional rhythm. Survival in those with VF/VT was five of 10 (50%). Medications were delivered twice. The mean time to first shock was 19 seconds from AED application. Medical consultation was obtained in 56 (33%) of the 169 AED cases and 14 (35%) of the cardiac arrest cases. **Conclusions.** Use of AEDs resulted in 50% survival among those with VT/VF in flight. Survival is poor among patients presenting with non-shockable rhythms. AEDs are used extensively for in-flight monitoring, with significant rhythms identified. Ground medical consultation is sought in only one-third of AED uses and cardiac arrests.

117. RESUSCITATION TECHNOLOGY USE IN THE CARDIAC ARREST REGISTRY TO ENHANCE SURVIVAL (CARES) COMMUNITIES Adam B. Landman, Comilla Sasson, Lisa Lin, Prasanthi Govindarajan, Bryan McNally, Allison Crouch, Jason McMullan, on behalf of the CARES Study Group, Yale University

Introduction. There is regional variation in survival rates from out-of-hospital cardiac arrest (OHCA). However, little is known about the underlying reasons for these survival differences. One possible explanation for these variations in OHCA survival is differential use of resuscitation technologies. **Objective.** To describe the use of resuscitation technologies by U.S. communities participating in the Cardiac Arrest Reg-

istry to Enhance Survival (CARES). **Methods.** CARES is network of 25 communities across the United States that provides standardized data on cardiac arrests, linking patient-level data from 9-1-1 call centers, emergency medical services (EMS) providers, and receiving hospitals. In April 2009, we administered a survey to CARES community participants regarding their EMS systems' demographics, protocols for cardiac arrest, and use of resuscitation technologies. In this study, we performed a descriptive analysis of resuscitation technology use in these communities, exploring the number of communities using each resuscitation technology, length of usage, and consistency of use in individual OHCA. **Results.** Survey responses were available for 20 of 25 (80%) communities participating in CARES. Overall, nine (45%) communities use external compression devices, 14 (70%) intraosseous lines, 19 (95%) alternate/blind airways, seven (35%) impedance threshold devices, 10 (50%) field hypothermia, and two (10%) real-time cardiopulmonary resuscitation (CPR) feedback devices. No community uses all six resuscitation technologies; the median was three technologies (interquartile range [IQR] 2–4). Three "high-tech" communities (15%) use five resuscitation technologies. Alternate/blind airways have been in use the longest, with a median of 5 years (IQR 2–11). Field hypothermia is the newest technology, with a median usage of 0.75 years (IQR 0.5–1). On average, communities using real-time CPR feedback devices and impedance threshold devices utilize these devices in over 50% of their individual OHCA. Other resuscitation technologies are used less consistently in individual arrests. **Conclusions.** There is wide variation in use of OHCA resuscitation technologies between and within communities participating in the CARES study. Future work is needed to better understand the relationship of the use of resuscitation technologies and OHCA outcomes to inform clinical practice guidelines, improve allocation of expensive and scarce resuscitation resources, and ultimately save lives.

118. CASE VOLUME OF BASIC LIFE SUPPORT BY EMERGENCY MEDICAL SERVICES: DOES IT INFLUENCE OUTCOME OF OUT-OF-HOSPITAL CARDIAC ARREST? Won Chul Cha, Sang Do Shin, Koung Jun Song, Ki Ok Ahn, Seong Chun Kim, Seoguipo Medical Center, Department of Emergency Medicine

Hypothesis. We hypothesized that emergency medical services (EMS) units with large volumes of out-of-hospital cardiac arrest (OHCA) cases would be associated with better outcomes. **Methods.** A Korean nationwide EMS-assessed OHCA database (2006–2007) (the CAVAS project) that was constructed from ambulance run sheets and followed by medical record review was used. Patients with confirmed outcomes

were selected from the registry. The provision of basic life support (BLS) by ambulance crews, return of spontaneous circulation (ROSC), survival to admission, and survival to discharge were determined. We grouped ambulance stations into four groups regarding their annual volume of BLS for OHCA. The rates of ROSC, survival to admission, survival to discharge, and favorable neurologic outcome were compared among the four groups. Then, we performed a multivariate logistic regression analysis to determine the adjusted effect of case volume for survival to admission. **Results.** During the study period, 34,552 patients were included in the registry. One thousand one hundred thirty ambulance stations were selected. The mean annual numbers of OHCA and BLS runs were 16.59 (95% confidence interval [CI]:15.89–17.29) and 7.32 (CI: 6.92–7.72), respectively. Group 1 was the lowest quartile of BLS volume, and group 4 was the highest. Groups with higher BLS volume showed significantly higher rates of performing BLS, survival to admission, and survival to discharge ($p < 0.001$). The overall rates of survival to admission and survival to discharge were 11.62% and 2.26%. A multivariate logistic regression showed that the adjusted odds ratios (ORs) (95% confidence intervals) for groups 2, 3, and 4 (reference: group 1) were 1.29 (1.02–1.62), 1.60 (1.28–1.99), and 2.03 (1.63–2.53) for survival to admission, and 1.65 (0.83–3.27), 2.07 (1.07–4.02), and 2.80 (1.44–5.39) for survival to discharge, respectively. The ORs of EMS volume for EMS-treated patients were 1.08 (0.84–1.30), 1.12 (0.86–1.46), and 1.24 (0.96–1.62) for survival to admission, and 10.16 (1.39–74.25), 10.84 (1.50–78.43), and 13.21 (1.83–95.49) for survival to discharge, respectively. Adjusted factors were gender, age, BLS and ALS intervals, presence of a witness, bystander cardiopulmonary resuscitation, initial electrocardiogram, cause of arrest, level of emergency medical technicians (EMTs), number of EMTs, and lesion. **Conclusions.** EMS volume of BLS services was significantly associated with patient outcome such as survival to admission and survival to discharge.

119. ADVANCED RESCUER VS. CITIZEN-WITNESSED CARDIAC ARREST: IS THERE A DIFFERENCE IN OUTCOME?
Amy Kaji, Mohammed A. Hanif, James T. Niemann,
Harbor-UCLA Medical Center

Background. Substantial financial and human resources are invested in training and maintaining advanced life support (ALS) skills of paramedics who are deployed to the field in response to out-of-hospital (OOH) cardiac arrest (CA). It is assumed that patients who experience arrest in the presence of a trained health care practitioner, such as a paramedic, have better outcomes. **Objective.** To compare rates of survival to hospital discharge (SHD) between paramedic-

witnessed (PW) OOH-CA and citizen-witnessed (CW) OOH-CA. **Methods.** In this retrospective cohort study, the records of all OOH-CA patients presenting to a municipal teaching hospital from November 1, 1994, through June 30, 2008, were reviewed. The type of field airway provided, age, gender, race, rhythm on paramedic arrival, presence of bystander cardiopulmonary resuscitation (CPR), whether it was a witnessed arrest, site of arrest, return of spontaneous circulation (ROSC), comorbid illnesses, and SHD were noted. A Mantel-Haenszel chi-square was computed to describe the association between PW OOH-CA vs. CW OOH-CA and SHD. A multivariable logistic regression analysis was also performed, controlling for rhythm on paramedic arrival, bystander CPR, and the type of airway. **Results.** Of the total cohort of 1,299 OOH-CAs, 751 (57.9%) were either PW or CW CAs. Among the witnessed CAs, SHD was 52 of 751 (6.9%). One hundred fifty-four of 751 patients (29.9%) with witnessed CAs had PW OOH-CAs, of whom nine (5.8%) survived to hospital discharge. Of the 597 CW OOH-CA patients, 43 (7.2%) survived to hospital discharge. The univariate odds ratio (OR) for SHD for PW vs. CW was 0.8 (95% confidence interval [CI] 0.38, 1.68), $p = 0.55$. In contrast, a presenting rhythm of ventricular tachycardia/ventricular fibrillation (VT/VF) (OR 5.7 [95% CI 1.28, 18.83], $p = 0.0014$) and the use of bag-valve-mask vs. endotracheal intubation (ETI) (OR 2.51 [95% CI 1.28, 3.51], $p = 0.006$) improved the OR for SHD. Even after multivariable adjustment, the OR for SHD for PW OOH-CA vs. CW OOH-CA remained less than one (OR 0.51 [95% CI 0.21, 1.28], $p = 0.15$). **Conclusions.** When compared with CW OOH-CA, PW OOH-CA does not appear to improve SHD. The resources expended on training and maintaining ALS skills for paramedics may be better allocated to facilitating a regional system for rapid defibrillation by citizens.

120. EMERGENCY MEDICAL SERVICES PROVIDERS' ATTITUDES TOWARD OUT-OF-HOSPITAL CARDIAC ARREST RESEARCH USING EXCEPTION FROM INFORMED CONSENT
Robert A. Swor, Robert M. Domeier, Jennifer Fowler,
Duane Robinson, *William Beaumont Hospital*

Introduction. Exception from informed consent (EFIC) has been used with increasing frequency in prehospital resuscitation trials. **Objective.** To characterize emergency medical services (EMS) providers' attitudes toward out-of-hospital cardiac arrest (OOHCA) research and EFIC in a multicenter OOHCA device trial. **Methods.** We conducted an anonymous 24-item survey of EMS providers in two suburban EMS systems (26 transporting and first-response agencies). Both systems were participating in a randomized OOHCA trial and had enrolled patients for more than a year. EMS

providers received education on the study protocol and ethical issues regarding research, including EFIC. The survey tool was modified from Schmidt et al. (*Prehosp Emerg Care*. 2009;13(2):160-8) and assessed provider attitudes toward research in general, ethics of EFIC, willingness to enroll patients, and attitudes toward the OOHCA trial. Provider demographics, item responses, and text comments were collected. Anonymous paper surveys were distributed by the study authors to agencies and were collected via blank envelopes. A five-level Likert scale was used and responses were collapsed to agree, neutral, or disagree for analysis. **Results.** A total of 1,212 surveys were distributed, and 591 (48.6%) responses were received. The respondents' demographics (means) were as follows: age, 36.9 years; and years in EMS, 12.0; the number of paramedics was 316 (54.3%). Of all respondents, 399 (68.4%) had enrolled a patient in the trial. Of these, 553 (93.7%) agreed that research in EMS was important;

a minority, 253 (45.4%), agreed the current OOHCA care was adequate; and 400 (68.1%) were willing to be enrolled in the current study. A minority of respondents agreed with the assertions that individual rights should be limited for public health (254, 43.3%) and that it was sometimes acceptable to enroll patients before they were able to consent (273, 46.7%). The respondents agreed that EMS medical directors (387, 66.3%) should decide whether EMS providers should enroll patients in research trials and 211 (35.9%) agreed that EMS providers should have the individual right to refuse to enroll patients. Overall, 83 (14.1%) felt the current OOHCA trial was unethical because the patient could not consent. **Conclusions.** EMS providers in these systems conceptually support research, most supported the current trial, and their responses suggest ambivalence toward the concept of EFIC. Further work is needed to understand EMS providers' attitudes toward research ethics.